Lokmanya Tilak Jankalyan Shikshan Sansth's

PRIYADARSHINI COLLEGE OF ENGINEERING, NAGPUR

M.Tech. First Semester Academic Calendar (2024-25)

Month	Mon	Tue	Wed	Thu	Fri	Sat	No. of days	Activities
August 2024	26	27	28	29	30			26: Display list of students admitted (After CAP-2) 27: Display of Time-table
September 2024	2	3	4	5	6	7	05	02: Commencement of Classes 07: Ganesh Chaturthi 11: Mahalaxmi Pujan 16: Eid –A- Milad 17: Anant Chaturthi 18-21 : Teacher Assessment activity (Quiz / Seminar) 30 : Laxminarayan Day
	9	10	11	12	13		05	
	16	17	18	19	20	21	05	
	23	24	25	26	27		05	
	30							
October 2024		1	2	3	4	5	04	2: Mahatma Gandhi Jayanti 7-11: Mid Term: 1 Examination 12: Dussera 14-19: Subject Seminar 28: -09 Nov : Diwali Vacation (Tentative)
	7	8	9	10	11		05	
	14	15	16	17	18	19	06	
	21	22	23	24	25		05	
	28	29	30	31				
November 2024					1	2		15: Gurunanak Jayanti 18-22: Mid-Term 2 Examination 25-27 : subject Quiz
	4	5	6	7	8			
	11	12	13	14	15	16	05	
	18	19	20	21	22		05	
	25	26	27	28	29	30	06	

December 2024	2	3	4	5	6	7	06	2-13: Make up/Remedial classes 16-21: Internal Marks Finalization/ Entry 25: Christmas
	9	10	11	12	13	[redacted]	05	
	16	17	18	19	20	21	06	
	23	24	25	26	27	[redacted]	04	
	30	31					02	
January 2025			1	2	3	4	04	1-4 : External Practical Examination (Tentative) 6:11 End Semester Examination (Tentative)
	6	7	8	9	10	11		

Total Number of Instructional Days : 90

Note :

1. Quiz/ Seminar is to be conducted after completion of each unit..
2. Mid-Term1 Examination will be conducted on half syllabus and Mid-Term2 on remaining half.

Dr.U.E.Hiwase
Coordinator –Post Graduate Studies

Dr.S.A.Dhale
Principal

Principal
Priyadarshini College of Engg
Nagpur

Copy to: -

1. Dr.K.B.Porate –COE (PCE-Autonomy)
2. Vice-Principal for kind information.
2. All Deans, for information.
3. Hod(s): EE,EP, ME,CSE,E&T , Chemical Engg for information and n.a.
4. Registrar, Assistant Registrar (Academics) for information and n.a.
5. Students Notice Board

Lokmanya Tilak Jankalyan Shikshan Sanstha

PRIYADARSHINI COLLEGE OF ENGINEERING, NAGPUR

M.Tech. Even Semester Academic Calendar (2024-25)

Month	Mon	Tue	Wed	Thu	Fri	Sat	No. of days	Activities
January 2025								13-18 : Project Progress Seminar _1 (4th Sem) 20: Display of Time Table for Second Semester 26: Republic day 27: Commencement of Classes of 2nd semesters 29-31: Project Progress Seminar _2 (4th Sem)
	13	14	15	16	17	18	06	
	20	21	22	23	24	25	05	
	27	28	29	30	31		05	
February 2025						1	01	03-07: Project Progress Seminar _2 (4th Sem) 10-17 Feb: Student's Activity 17: Assignment _1 display (2nd Semester) 19 : Shivaji Maharaj Jayanti 24-28 : Subject Seminar (2nd Sem) 26: Mahashivratri 28: Display of cumulative Attendance (2nd Sem)
	3	4	5	6	7	8	05	
	10	11	12	13	14	15	06	
	17	18	19	20	21	22	05	
	24	25	26	27	28		05	
March 2025						1	01	3-6: Project Progress Seminar_3 (4th Sem) 10-15: Mid Term -I Examination 14: Holi (2ND Day) 17-21: Subject Seminar_2 (2nd Sem) 26-29: Academic Audit-I 29: Display of cumulative Attendance 31: Ramzan Eid
	3	4	5	6	7	8	05	
	10	11	12	13	14	15	05	
	17	18	19	20	21	22	05	
	24	25	26	27	28	29	06	
	31						00	
April 2025		1	2	3	4	5	05	1-5: Project Submission Seminar (4th Sem) 10: Mahavir Jayanti 14: Dr.B.R.Ambetkar Jayanti 15:Display of Assignment-II 18: Good Friday 21-25: Mid Term-II Examination 28-30: ESE Practical Examination (Probable)
	7	8	9	10	11	12	04	
	14	15	16	17	18	19	04	
	21	22	23	24	25	26	05	
	28	29	30				03	

May 2024				1	2	3	02	1: Maharashtra Day 2-9: ESE S/25 Examination (Probable) 13-17: Display of Internal Marks (Closing of sessic
	5	6	7	8	9	10	05	
	12	13	14	15	16	17	05	

Total Number of Working Days : 92

Note :

1. Quiz is to be conducted after completion of each unit.
2. MID Term I Examination will be conducted on half syllabus and MID -II on remaining half.
3. Certificate Enhancement Society Activities to be conducted as per the requirement. Online programs may be conducted as per availability of experts.
4. Capability Enhancement and Development schemes to be implemented as per the requirement.
5. Programs like FDPs, STTPs, Workshops, Conferences etc for teaching faculty, training programs for non teaching etc. to be conducted in the month of February to April 2025. Preferably Online programs may be conducted as per availability of experts.
6. Identifying weak students on the basis of evaluation test to be conducted by individual subject teacher
7. Make-up Classes/ Remedial Classes to be conducted as per requirement.

Dr.U.E.Hiwase
PG Coordinator

Dr.S.A.Dhale
Principal
Principal
Priyadarshini College of Engg.
Nagpur.

Copy to: -

1. CoE office for kind information
2. Vice-Principal for kind information and guidance.
3. All Deans,for information.
4. Hod(s): EP, ME, CSE,CHEM , ETC for information and n.a.
5. Registrar, Assistant Registrar (Academics) for information and n.a.

COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

V.L.S.I.

Of

RASHTRASANT TUKDOJI MAHARAJ

NAGPUR UNIVERSITY, NAGPUR

Lokmanya Tilak Jankalyan Shikshan Sanstha's

PRIYADARSHINI COLLEGE OF ENGINEERING, NAGPUR
(An Autonomous Institute affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)
SCHEME OF EXAMINATION

I Semester M.Tech. VLSI (CBCS)

Sr. No.	Course Code	Course Name	Contact Hours				Marks				Total Marks	Min Marks	ESE Duration
							Theory		Practical				
			L	T	P	Credits	CE	ESE	CE	ESE			
1	25PVL101T	VLSI Subsystem Design	3	0	0	3	40	60	-	-	100	50	3
2	25PVL102T	Advanced Digital Image Processing	3	0	0	3	40	60	-	-	100	50	3
3	25PVL11XT	Program Elective-I	3	0	0	3	40	60	-	-	100	50	3
4	25PVL12XT	Program Elective-II	3	0	0	3	40	60	-	-	100	50	3
5	25PVL103T	Research Methodology and IPR	4	0	0	4	40	60	-	-	100	50	3
6	25PVL101P	VLSI Subsystem Design	0	0	4	2	-	-	25	25	50	25	-
7	25PVL102P	Advanced Digital Image Processing	0	0	4	2	-	-	25	25	50	25	-
Total			**16**	**0**	**8**	**20**	**200**	**300**	**50**	50	**600**	**300**	**-**

Course Code	Program Elective – I
25PVL111T	Mixed Signal Processing
25PVL112T	Low Power VLSI Design
25PVL113T	Advanced Digital Signal Processing

Course Code	Program Elective - II
25PVL121T	Embedded Systems & RTOS
25PVL122T	Modeling of Digital System
25PVL123T	Semiconductor devices

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PRIYADARSHINI COLLEGE OF ENGINEERING, NAGPUR
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SCHEME OF EXAMINATION

Sr. No.	Course Code	Course Name	Contact Hours				Marks				Total Marks	Min Marks	ESE Duration
							Theory		Practical				
			L	T	P	Credits	CE	ESE	CE	ESE			
1	25PVL201T	Analog IC Design	3	0	0	3	40	60	-	-	100	50	3
2	25PVL202T	System Verilog for Verification	3	0	0	3	40	60	-	-	100	50	3
3	25PVL203T	VLSI circuits	4	0	0	4	40	60	-	-	100	50	3
4	25PVL21XT	Program Elective-III	3	0	0	3	40	60	-	-	100	50	3
5	25PVL22XT	Program Elective-IV	3	0	0	3	40	60	-	-	100	50	3
6	25PVL201P	Analog IC Design	0	0	4	2	-	-	25	25	50	25	-
7	25PVL202P	System Verilog for Verification	0	0	4	2	-	-	25	25	50	25	-
Total			**16**	**0**	**8**	**20**	**200**	**300**	**50**	**50**	**600**	**300**	**-**

Course Code	Program Elective III
25PVL211T	VLSI Testing
25PVL212T	Artificial Intelligence and Robotics
25PVL213T	VLSI Signal Processing

Course Code	Program Elective IV
25PVL221T	Wireless Sensor Network
25PVL222T	Micro Electro Mechanical Switches
25PVL223T	Embedded system testing and verification

Exit Option: After completion of First year with 40 credit (1st& 2nd sem) students shall be awarded a Postgraduate Diploma

First semester

23PVL101T VLSI Subsystem Design

Course Objectives:

1. To study the fundamentals of MOS devices and their characteristics.
2. To lay good foundation on the design and analysis of CMOS analog integrated circuits.
3. To study Transient Optimization techniques.
4. To learn and understand clocking strategies.

Course Outcome: By the end of the course, the students shall be able to

1. Design different CMOS based circuits.
2. Analyze the model parameters of CMOS based circuits.

UNIT I: Electrical Properties of MOS Transistors

Electrical Properties, Junction Diode, MOS Transistor: Operation Modes: Threshold Voltage: Metal and Polysilicon; Trapped Charge; Implants, Strong Inversion: Charge Modeling; Constant Vt model: NMOS/PMOS transistors: I/V characteristics, Parasitic Bipolar Transistors: CMOS Latch-up, Analysis (D.C. and Transient).

UNIT II:

Device Capacitances and Charge Storage in MOS: NMOS/CMOS circuit analysis, Small signal amplifier model; Miller Effect, Layout / Fabrication, Diffusion / Implants / Wires, NMOS/CMOS processes, SCMOS Design Rules - special derivation; self-aligned processes, Logic Level Design, Realization of Duals for CMOS, Euler path layout, Topological Considerations.

UNIT III:

Don’t Cares and Redundancy, Layout Parasitic Reduction, I/V for MOS Logic Families, Prop. Delay for CMOS/NMOS/PNMOS, Layout Capacitance/Resistance Estimation; Gain effects; MOS Performance Estimation, Buffers/Capacitive Loading, Power Dissipation.

UNIT IV:

Transient Optimization, Sidewall/2-d and 3-d effects: Cross-talk, Fringing, Ball-Park numbers for process Estimation: Scaling CMOS Design Optimization: High-Speed Logic Strategies, Interconnection, Distributed R/C, Cross-Talk, Noise

UNIT V:

Clocking Strategies, Sub-System Design and Partitioning Dynamic Logic, Dynamic Circuits, Stored Charge and timing, Domino Logic, Switched Capacitor and Charge Flow Circuits, Pass-Transistor Logic (CPL) Data-Path and Memory Circuits: Static/Dynamic Memories, Ancillary Memory Analog Circuits.

TEXT BOOKS:

1. Weste, "Principles of CMOS VLSI Design(2nd Edition)
2. Douglas A.Pucknell and Kamran Eshraghian, "Basic VLSI Systems and Circuits", Prentice Hall of India , 1993
3. Wayne Wolf,"Modern VLSI Desin" 2nd Edition, Prentice Hall 1998

REFERENCE BOOK:

1. Sung-Mo-Kang, Yusuf Labelbici,"CMOS Digital Integrated Circuits" 3rd Ed, Mc Graw Hi

23PVL102T Advanced Digital Image Processing

Course Objectives:

1. To study fundamentals of image processing.

2. To learn different types of image enhancement and restoration techniques.

3. To study the image features and it‟s analysis.

4. To understand pattern recognition and its application in image processing.

Course Outcome: By the end of the course, the students shall be able to

1. Identify the suitable image enhancement and restoration techniques based upon the application.

2. To be able to design and implement segmentation schemes.

UNIT I: FUNDAMENTALS OF IMAGE PROCESSING

Introduction, Elements of visual perception, Steps in Image Processing Systems, Image Acquisition, Sampling and Quantization, Pixel Relationships, Colour Fundamentals and Models, File Formats, Introduction to the Mathematical tools.

UNIT II: IMAGE ENHANCEMENT AND RESTORATION

Spatial Domain Gray level Transformations, Histogram Processing Spatial Filtering, Smoothing and Sharpening, Frequency Domain: Filtering in Frequency Domain, DFT, FFT, DCT, Smoothing and Sharpening filters, Homomorphic Filtering, Noise models, Constrained and Unconstrained restoration models.

UNIT III: IMAGE SEGMENTATION AND FEATURE ANALYSIS

Detection of Discontinuities, Edge Operators, Edge Linking and Boundary Detection, Thresholding, Region Based Segmentation, Motion Segmentation, Feature Analysis and Extraction.

UNIT IV: MULTI RESOLUTION ANALYSIS AND COMPRESSIONS

Multi Resolution Analysis: Image Pyramids, Multi resolution expansion, Wavelet Transforms, Fast Wavelet transforms, Wavelet Packets. Image Compression: Fundamentals, Models, Elements of Information Theory, Error Free Compression, Lossy Compression, Compression Standards, JPEG/MPEG.

UNIT V: APPLICATIONS OF IMAGE PROCESSING & PATTERN RECOGNITION

Representation and Description, Image Recognition, Image Understanding, Image Classification, Video Motion Analysis, Image Fusion, Steganography, Colour Image Processing, Image Recognition, Patterns and pattern classes, Recognition based on decision, theoretic methods Matching by minimum distance classifier,Matching by correlation, Optimum statistical classifiers, Bayes classifier, Neural networks, Perceptron model, Multilayer feedforward neural network to recognize shapes, Structural methods, matching shape numbers and string matching, Fuzzy system-optimization techniques for recognition, Genetic algorithm, Simulated annealing.

TEXT BOOKS:

1. Rafael C.Gonzalez and Richard E.Woods, "Digital Image Processing", Third Edition, Pearson Education, 2008.

2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision'', Third Edition, Third Edition, Brooks Cole, 2008.

REFERENCE BOOKS:

1. Anil K.Jain, "Fundamentals of Digital Image Processing", Prentice-Hall India, 2007.

2. 2. Madhuri A. Joshi, „Digital Image Processing: An Algorithmic Approach", Prentice-Hall

23PVL103T Research Methodology and IPR

Course Outcomes:

At the end of this course, students will be able to

1)Understand research problem formulation.

2)Analyze research related information

3)Follow research ethics

4)Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

5)Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

6)Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Contents:

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics.

Unit 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR:

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.

5. Mayall, “Industrial Design”, McGraw Hill, 1992.

6. Niebel, “Product Design”, McGraw Hill, 1974.

7. Asimov, “Introduction to Design”, Prentice Hall, 1962.

8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.

9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

23PVL111T Mixed Signal Processing

Course Objectives:

1. To study different aspects of analog and mixed signals.
2. To study different types of ADCs and DACs.
3. To study simulation of mixed signals through VHDL and Verilog.

Course Outcome: By the end of the course, the students shall be able to

1. Describe the processing and analysis of mixed signals
2. Simulate the analog and mixed signals.

UNIT I:

Analog circuit analysis, Network independent, dependent data sampled analog system loading effects, Analog and Mixed Signal Extensions To VHDL: Introduction, language design objectives, theory of differential algebraic equation the 1076.1. Language tolerance groups, conservative system

UNIT II:

Time and simulation cycle A/D and D/A interaction, quiescent point, frequency domain modeling and examples, Analog and discrete-time signal processing, Analog integrated continuous-time and discrete-time (switched-capacitor) filters, Basics of Analog to digital converters (ADC), Basics of Digital to analog converters (DAC).

UNIT III:

Successive approximation ADCs, Dual slope ADCs, High-speed ADCs (e.g. flash ADC, pipeline ADC and related architectures), High-resolution ADCs (e.g. delta-sigma converters), DACs, Mixed-Signal layout, Interconnects, Phase locked loops, Delay locked loops.

UNIT IV:

Analog Extensions To Verilog: Introduction Equation construction solution, waveform filter functions, simulator, control analysis, multi-disciplinary model, Behavioral Generic model of operational amplifiers: Introduction, description of generic Opamp model structure, configuration functional specification

UNIT V:

Auxiliary block conflict resolution, application examples, Non -Linear state space averaged modeling of 3-state –digital phase-frequency detector, Introduction model, resell table integrator AC analysis, sample application.

TEXT BOOKS:

1. Alain Vachoux Jean -Michel Berge OZ Levia “Analog and mixed signal hardware description languages (current issues in Electronic Modeiling V.10) Kluwer Academic Publisher 1997.
2. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2 Edition, Cambridge University Press, 2004.

REFERENCE BOOKS:

1. Andrzej Handkiewicz, “Mixed-Signal Systems: A Guide to CMOS CircuitsDesign”.
2. E.N. Farag and M.I. Elmasry, Mixed SignalVLSI Wireless Design: Circuits & Systems, Kluwer,1999

23PVL112T Low Power VLSI Design

Course Objectives:

1. To study the sources of Power Dissipation.
2. To study the concepts on different levels of power estimation and optimization techniques.
3. To study different Low Power Design Approaches.

Course Outcome: By the end of the course, the students shall be able to

1. Use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnect.
2. Design and model Low Power VLSI applications.

UNIT I: Fundamentals:

Need for Low Power Circuit Design, Sources of Power Dissipation, Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects, Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

UNIT II: Low-Power Design Approaches:

Low-Power Design through Voltage Scaling, VTCMOS circuits, MTCMOS circuits, Architectural Level Approach, Pipelining and Parallel Processing Approaches, Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures, Mask level Measures.

UNIT III: Low-Voltage Low-Power Adders:

Introduction, Standard Adder Cells, CMOS Adder's Architectures, Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Design Techniques, Trends of Technology and Power Supply Voltage, Low-Voltage Low-Power Logic Styles.

UNIT IV: Low-Voltage Low-Power Multipliers:

Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh-Wooley Multiplier, Booth Multiplier, Introduction to Wallace Tree Multiplier.

UNIT V: Low-Voltage Low-Power Memories:

Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.

TEXT BOOKS:

1. CMOS Digital Integrated Circuits –Analysis and Design –Sung-Mo Kang, Yusuf Leblebici, TMH, 2011.
2. Low-Voltage, Low-Power VLSI Subsystems –Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.

REFERENCE BOOKS:

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective –Ming-BO Lin, CRC Press, 2011
2. Low Power CMOS Design – AnanthaChandrakasan, IEEE Press/Wiley International, 1998.
3. Low Power CMOS VLSI Circuit Design –Kaushik Roy, Sharat C. Prasad, John Wiley & Sons, 2000.
4. Practical Low Power Digital VLSI Design –Gary K. Yeap, Kluwer Academic Press, 2002.
5. Low Power CMOS VLSI Circuit Design –A. Bellamour, M. I. Elamasri, Kluwer Academic Press, 1995.
6. Leakage in Nanometer CMOS Technologies –Siva G. Narendran, AnathaChandrakasan, Springer, 2005.

23PVL113T Advanced Digital Signal Processing

Course Objectives:

1. To study the basic concepts of digital signal processing.
2. To study analysis and processing of signals for different kind of applications and retrieval of information from signals.
3. To study designing of digital filters and its realization.
4. To study analysis of signals using the discrete Fourier transform (DFT) and Z-Transform.
5. To Study Power Spectrum Estimation.
6. To study the application of Wavelet Transforms.

Course Outcome: By the end of the course the students shall be able to:

1. Represent discrete-time signals analytically and visualize them in the time domain.
2. Meet the requirement of theoretical and practical aspects of DSP with regard to sampling and reconstruction.
3. Design and implement digital filter for various applications.
4. Estimation of Power Spectrum
5. Describe the concept of multi rate signal processing and how to apply it for the wavelet transform.
6. Describe the various transforms for analysis of signals and systems.

UNIT I: Multirate Digital Signal Processing:

Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion Multirate Digital Signal Processing Multistage, Implementation of Sampling Rate Conversion, Applications of Multirate Signal Processing, Sampling Rate Conversion of Bandpass Signals Linear Prediction and Optimum Linear

UNIT II: Filters:

Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of the Normal Equations, Properties of linear prediction - Error Filter, AR Lattice and ARMA Lattice-Ladder Filters.

UNIT III: Power Spectral Estimation:

Estimation of Spectra from Finite Duration Observations of a signal, the Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey Methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods.

UNIT IV: Parametric Method of Power Spectrum Estimation:

Parametric Methods for power spectrum estimation, Relationship between Auto-Correlation and Model Parameters, AR (Auto-Regressive) Process and Linear Prediction, Yule-Walker, Burg and Unconstrained Least Squares Methods, Sequential Estimation, Moving Average(MA) and ARMA Models Minimum Variance Method, Piscaranko's Harmonic Decomposition Methods, MUSIC Method.

UNIT V:

Window Selection, Wavelet Transform, STFT to Wavelet conversion, Basic Wavelet, Discrete time orthogonal Wavelet, Continuous Time Orthogonal Wavelets.

TEXT BOOKS:

1. Proakis JG and Manolakis DG Digital Signal Processing Principles, Algorithms and Application, PHI.
2. Openheim AV & Schafer RW, Discrete Time Signal Processing PHI.

REFERENCE BOOKS:

1. Samuel D Stearns, "Digital Signal Processing with examples in Matlab. " CRC Press.
2. ES Gopi. "Algorithm collections for Digital Signal Processing Applications using Matlab", Springer.
3. Taan S.Elali, "Discrete Systems and Digital Signal Processing with Matlab, " CRC Press,2005.

23PVL121T Embedded System and RTOS

Course Objectives:

The objective of this course is to provide students with

1. Understanding of ARM architecture and its organization.
2. Interfacing and Programming concepts of ARM based microcontroller.
3. Fundamental concepts of Real Time Operating Systems (RTOS)
4. Knowledge of various aspects of □COS and Linux as Embedded OS.

Course Outcomes:

Upon the completion of this course, students will demonstrate the ability to:

1.Apply the knowledge of ARM architecture and organization for modern ARM Contex - M devices.

2.Utilize knowledge, techniques & skill to integrate microcontroller hardware and software component using Contex - M

3. Apply the concepts of Embedded OS.

4. Implement OS based embedded system.

UNIT I: Embedded System:

Introduction to Embedded Systems, Concepts, Embedded System Design Issues. RISC Principles.

UNIT II: The Cortex - M processor:

Applications, Simplified view – block diagram, programming model – Registers, Operation modes, Exceptions and Interrupts, Reset Sequence, Instruction Set, Unified Assembler Language, Pipeline, Bus, Priority, Vector Tables, Interrupt Inputs and Pending behavior, Fault Exceptions, Supervisor and Pendable Service Call, Nested Vectored Interrupt Controller, SYSTICK Timer, Interrupt Sequences, Introduction to the Cortex microcontroller software interface standard (CMSIS), Interfacing of GPIOs, Timers, ADC, UART and other serial interfaces, PWM.

UNIT III: Concept and Fundamentals of RTOS:

RTOS examples, Interrupts, Handling an Interrupt, Interrupt Service Routines, Context Switching, Process States, Communication Mechanism, Scheduling Algorithm, Priority Inversion, Priority Inheritance. Inter-task Communication: Shared Variables, Monitors, Messages, Events, Semaphores, Priority inversion problem, Deadlocks, Starvation.

UNIT IV: Concepts, Structure of COS-II: -

Kernel Structure: Tasks, Task States, TCB, Ready List, Task Scheduling, Interrupts, Clock Tick, Initialization, Starting the OS, Task Management, Time Management, Event Control Blocks, Synchronization in □COS - II: - Semaphore Managemen Mutual Exclusion Semaphores, Event Flag Management, Communication in □COS - II: - Message Mailbox Management, Message Queue Management, Memory management, Porting of □COS – II

UNIT V: Linux:

Linux as an embedded OS, Tools and development, Applications and products, Building Linux Kernel

Text Books:

1. The Definitive Guide to the ARM Cortex-M0 : Joseph Yiu, Elsevier , (1/E)2011
2. An Embedded Software Primer: David E Simon, Pearson education Asia, 2001
3. Micro C/OS II The Real Time Kernel: Jean J. Labrosse, CMPBooks,(2/E) 2002
4. Embedded Linux Primer: christopher Hallinan, Pearson (1/E) 2007

Reference Books:

1. ARM System Developer's Guide Designing and Optimizing System Software: Andrew N. Sloss, Dominic Symes, Chris Wright, Morgan Kaufmann publications, (1/E) 2004.

23PVL122T Modeling of Digital System

Course Objective

The objective of this course is to provide students with

1. Concept of modeling and testing the digital designs using HDL
2. Idea of digital system design flow
3. Synthesis and optimization techniques for digital designs
4. Knowledge of timing analysis and programmable devices

Course Outcome

Upon the completion of this course, students will demonstrate the ability to:

1. Model and test the digital designs
2. Describe the digital system design flow
3. Write a optimize and synthesizable HDL code
4. Analyze the timing issues and implement the digital logic on various programmable devices

UNIT I: Hardware Description Languages:

Introduction to HDL, Basic Language Elements, Syntax and Semantics HDL, Modeling Styles for building blocks, use of Procedures –functions / Task –function in designs, Attributes, Writing Test Benches, Handling Text files, Combinational & Sequential Design examples : Adders, Multipliers, ALU, Memories, FSM, FIFO.

UNIT II : System Design Flow:

Top-Down and Bottom-Up methodology, Word Length Determination, Data Path Control Path, Implementation of DSP algorithm.

UNIT III: Synthesis–

Analysis and Introduction to Optimization Techniques: Methodology, Logic Synthesis of HDL, Critical Path analysis, Speed, Area and Power optimizations at Architectural level.

UNIT IV: Timing and Signal Integrity:

Timing Basics and Signal integrity, Dealing with Clock Skew and Jitter, Synchronizers.

UNIT V: Programmable ASICs:

Technology Overview, CLBs, Architecture, Realization of functions

Text books:

1. A VHDL Primer, Third Edition: J. Bhasker, Prentice Hall, (1999).
2. Verilog HDL: A guide to Digital Design and Synthesis: Samir Palnitkar, Prentice Hall (1996)
3. Advanced Digital Design with the Verilog HDL: M.D. Ciletti, Prentice Hall, (2003).
4. Synthesis and Optimization of Digital Circuits, G. De Micheli, McGraw-Hill, (1994).

Reference books:

1)The Verilog Hardware Description Language, Fifth Edition: Donald E. Thomas, Philip R. Moorby,Kluwer Academy Publisher. (2002).

2)Digital Systems Design Using VHDL, Second Edition: Charles H. Roth. Jr., L Kurian John, Cengage Learning, (2008).

3)Logic Synthesis using Synopsys, Second edition, P. Kurup and T. Abbasi, Kluwer, (1996)

4)Logic synthesis and verification algorithms: Gary D. Hachtel, Fabio Somenzi, Springer(1996)

23PVL123T Semiconductor Devices

Course Objectives:

The objective of this course is to provide students with

1. Essentials of semiconductor physics to mathematically analyze PN junctions, and MOSFETs.
2. Understanding of various semiconductor device models and parameters.
3. Insight useful for understanding new semiconductor devices and technologies.

Course Outcomes:

Upon completion of this course, students should demonstrate the ability to

1. Estimate drift and diffusion carrier concentration in semiconductors, given the type and doping level of impurities.
2. Utilize the basic governing equations to analyze pn junctions & schottky junction under various operating conditions.
3. Predict qualitative and quantitative operating conditions of MOS transistors and MOS Models & understand the concept of advanced MOSFET technology.

Basic Semiconductor Physics

Crystal lattice, energy band model, density of states, distribution statics – Maxwell-Boltzmann and Fermi-Dirac, doping, carrier transport mechanisms, drift, diffusion, thermionic emission, and tunneling; excess carriers, carrier lifetime, recombination mechanisms – SHR, Auger.

p-n junction and metal-semiconductor junction

p-n junctions - fabrication, basic operation – forward and reverse bias, DC model, charge control model, I-V characteristics, steady-state and transient conditions, capacitance model, reverse-bias breakdown, SPICE model; metal- semiconductor junctions –fabrication, Schottky barriers, rectifying and non-retifying contacts, I-V characteristics.

MOS Capacitors and MOSFETs

The MOS capacitor – fabrication, surface charge – accumulation, depletion, inversion, threshold voltage, C-V characteristics – low and high frequency; the MOSFET – fabrication, operation, gradual channel approximation, simple charge control model (SCCM), Pao-Sah and Schichman – Hodges models, I-V characteristics, second-order effects – Velocity saturation, short-channel effects, charge sharing model, hot-carrier effects, gate tunneling; subthreshold operation – drain induced barrier lowering (DIBL) effect, unified charge control model (UCCM), SPICE level 1, 2, and 3, and Berkeley short-channel IGFT model (BSIM).

Advanced MOSFET technology:

SOI MOSFET, high-k MOS devices, FinFETs and Multi gate MOSFETs

Text Books:

1. Physics of Semiconductor Devices: S. M. Sze, Wiley Eastern, (1981).
2. Semiconductor physics and Devices, Donald Neamen, McGraw-Hill, 3rd edition
3. Solid State Electronic Devices ,B.G.Streetman and S.Banerjee ,Prentice Hall India

Second semester

23PVL201T Analog IC Design

Course Objectives:

The objective of this course is to provide students with

1. Sound understanding of complementary metal-oxide-semiconductor field-effect transistor and the relationship of process technology with models used for analog IC.
2. Analysis, up to and including second - order effects caused by scaling of CMOS technology and modeling deficiencies.
3. Techniques for analyzing and designing a variety of analog circuits in CMOS technology.

Course Outcomes:

Upon the completion of this course, students will demonstrate the ability to:

I. Use mathematical models of MOS transistors to evaluate their behavior in analog circuits.
2. Select suitable design approaches while trading off conflicating requirements.
3. Investigate various analog IC performance parameters.

Introduction to analog VLSI and analog design issues in CMOS technologies. **Basic analog building blocks :** Switches, Active resistors, current, voltage sources and sinks, current mirrors, current and voltage reference, Bandgap references.

Amplifiers, Common source, source flower, common gate and cascode amplifiers, Frequency Response. **Frequency Response of Amplifiers :** Miller Effect, Association of Poles with nodes, Frequency Response of all single stage amplifiers.

Differential Amplifier - Basic Differential Pair, common mode response, CMRR, Differential Pair with MOS load, GilbertCell.

OPAMP Design : Single stage and two Stage OP-Amps, Frequency Compensation.

Switch Capacitor circuits : General Considerations, sampling switches, Switched capacitor integrator.

Data Converter Fundamentals: DAC/ADC Specifications, Data Converter Architectures : DAC architectures, Resistor String, Charge -Scaling DACs, Cyclic DAC, Pipeline DAC. ADC Architectures -Flash, The Two -Step Flash ADC, The Pipeline ADC, Integrating ADCs, The Successive Approximation ADC.

Text Books

1. Design of Analog CMOS IC : B Razavi, Tata Mcgraw Hill (2002)
2. CMOS Circuit Design, Layout and Simulation : J. Baker, D.E. Boyee., IEEE press (2010).
3. VLSI Design techiques for Analog and digital Circuits : R. L. Geiger, P.E. Allen, D.R. Holberg, OUP (2/E) McGraw Hill (2002)

Reference Books :

1. VLSI Design techniques for Analog and digital Circuits : Randel Geiger, P. Allen, N. Strader, Tata Mcgraw, Hill, (2/E)(2010)

23PVL202T System Verilog for Verification

Course Objectives:

The objective of this course is to provide students with

1. Insight to apply System Verilog concepts to do synthesis, analysis and architecture design.
2. Understanding of SystemVerilog and SVA for verification, and understand the improvements in verification efficiency.
3. Understand advanced verification features, such as the practical use of classes, randomization, checking, and coverage.
4. Knowledge to communicate the purpose and results of a design experiment in written and oral presentations.

Course Outcomes:

Upon completion of this course, students should demonstrate the ability to

I. Use System Verilog to create correct, efficient, and re-usable models for digital designs

II. Use System Verilog to create testbenches for digital designs

III. Understand and effectively exploit new constructs in System Verilog for verification

Verification Guidelines: Introduction, Verification Process, Verification Plan, Verification Methodology Manual, Basic Testbench Functionality, Directed Testing, Methodology Basics, Constrained-Random Stimulus, Functional Coverage, Testbench Components, Layered Testbench,

Data Types: Built-in Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Creating New Types with typedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings

Procedural Statements And Routines: Procedural Statements, Tasks, Functions, and Void Functions

Basic Object Oriented Programming: Where to Define a Class, OOP Terminology, Understanding Dynamic Objects

SystemVerilog Assertions: Types of Assertions and examples

Threads and Inter-process Communication: Working with Threads, Inter-process Communication, Events, Semaphores, Mailboxes, Building a Testbench with Threads and IPC

Functional Coverage: Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, Coverage Options, Parameterized Cover Groups, Analyzing Coverage Data, Measuring Coverage Statistics During

Simulation

Introduction to Perl: Learning Perl, how it can be used for automation.

Text books :

1. System Verilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear, Springer 2006
2. Writing Testbenches Using SystemVerilog, Janick Bergeron, Springer, 2006
3. SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling, 2nd Edition, Stuart Sutherland, Simon Davidman and Peter Flake, Springer

Reference books:

1. Writing Testbenches: Functional Verification of HDL Models, Second edition, Janick Bergeron, Kluwer Academic Publishers, 2003.
2. Open Verification Methodology Cookbook, Mark Glasser, Springer, 2009
3. Principles of Functional Verification, Andreas S. Meyer, Elsevier Science, 2004
4. Assertion-Based Design, 2nd Edition, Harry D. Foster, Adam C. Krolnik, David J. Lacey, Kluwer Academic Publishers, 2004.

23PVL203T VLSI Circuits

Course Objectives:

1. To study basics of VLSI Design methodologies.
2. To study different VLSI design rules.
3. To study in depth the flow of VLSI System Design.
4. To study VLSI Design Modeling and it's synthesis.

Course Outcome: By the end of the course, the students shall be able to

1. Describe and formulate the flow of VLSI Design for any application.
2. Simulate and Analyze the VLSI Circuits.

UNIT I: VLSI Design Methodologies (9)

Introduction to VLSI Design Methodologies – Review of Data Structures and algorithms - Review of VLSI Design Automation tools – Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable problems – General Purpose methods for combinatorial optimization.

UNIT II: Design Rules (9)

Layout Compaction – Design Rules – Problem Formulation – Algorithms for constraint graph compaction – placement and partitioning – Circuit representation – Placement algorithms - partitioning

UNIT III: Floor Planning (8)

Floor planning concepts – shape functions and floor plan sizing – Types of local routing problems – Area Routing – Channel Routing – Global Routing – Algorithm for Global Routing.

UNIT IV: Simulation (9)

Simulation – Gate-Level modeling and simulation – Switch-level modeling and simulation – Combinational Logic Synthesis – Binary Decision Diagrams – Two Level Logic Synthesis.

Unit V: Modeling and Synthesis (9)

High Level Synthesis – Hardware models – Internal representation – Allocation – assignment and scheduling – Simple Scheduling algorithm – Assignment problem – High level transformations.

Text Books:

1. S. H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.
2. N. A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

References Books:

1.Sadiq M. Sait, Habib Youssef, “ VLSI Physical Design Automation: Theory and Practice”, World Scientific 1999.

2.Steven M. Rubin, “ Computer Aids for VLSI Design”, Addison Wesley Publishing 1987.

23PVL211T VLSI Testing

Course Objectives:

1. To know about the various test Generation Algorithms and Fault Simulation Techniques.

Course Outcome: By the end of the course, the students shall be able to

1. Do testing of various Memory Modules and Combinational & sequential logic Circuits.

UNIT I: INTRODUCTION TO TESTING

Faults in digital circuits, Modeling of faults, Logical Fault Models, Fault detection, Fault location, Fault dominance, Logic Simulation, Types of simulation, Delay models, Gate level Event-driven simulation.

UNIT II: TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS

Test generation for combinational logic circuits, Testable combinational logic circuit design, Test generation for sequential circuits, design of testable sequential circuits.

UNIT III: DESIGN FOR TESTABILITY

Design for Testability, Ad-hoc design, Generic scan based design, Classical scan based design, System level DFT approaches.

UNIT IV: SELF-TEST AND TEST ALGORITHMS

Built-In Self Test, Test pattern generation for BIST, Circular BIST, BIST Architectures, Testable Memory Design, Test algorithms, Test generation for Embedded RAMs.

UNIT V: FAULT DIAGNOSIS

Logic Level Diagnosis, Diagnosis by UUT reduction, Fault Diagnosis for Combinational Circuits Self-checking design, System Level Diagnosis.

TEXT BOOKS:

1. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House, 2002.

2. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed -Signal VLSI Circuits", Kluwer Academic Publishers, 2002.

REFERENCE BOOKS:

1. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002.
2. A.L. Crouch, "Design Test for Digital IC's and Embedded Core Systems", Prentice all International, 2002

23PVL212T (MEMS) Micro Electro Mechanical Switches

Course Objectives:

1. To understand Standard microfabrication techniques and the issues surrounding them.
2. To understand Major classes, components, and applications of MEMS devices/systems and to demonstrate an understanding of the fundamental principles behind the operation of these devices/systems
3. To understand microfabrication techniques and applications to the design and Manufacturing of an MEMS device or a microsystem**.**

Course Outcome: By the end of the course, the students shall be able to

1. Understand working principles of currently available microsensors, actuators used in Microsystems.
2. Apply scaling laws that are used extensively in the conceptual design of micro devices and systems.
3. Understand the basic principles and applications of micro-fabrication processes.

UNIT I:

Micro-fabrication and Micromachining : Integrated Circuit Processes, Bulk Micromachining : Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA)

UNIT II:

Physical Microsensors: Classification of physical sensors, Integrated, Intelligent, or Smart sensors, Sensor Principles and Examples: Thermal sensors, Electrical Sensors, Mechanical Sensors, Chemical and Biosensors

UNIT III:

Microactuators: Electromagnetic and Thermal microactuation, Mechanical design of microactuators, Microactuator examples, microvalves, micropumps, micromotors-Microactuator systems : Success Stories, Ink-Jet printer heads, Micro-mirror TV Projector

UNIT IV:

Surface Micromachining: One or two sacrificial layer processes, Surface micromachining requirements, Polysilicon surface micromachining, other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface Micromachined Systems: Success Stories, Micromotors, Gear trains, Mechanisms.

UNIT V:

Application Areas: All-mechanical miniature devices, 3-D electromagnetic actuators and sensors, RF/Electronics devices, Optical/Photonic devices, Medical devices e.g. DNA-chip, micro-arrays. MEMS for RF Applications: Need for RF MEMS components in communications, space and defense applications.

TEXT BOOKS:

1. Sensor Technology and Devices: Ristic L (ed), Artech House, London, 1994.
2. Semiconductor Sensors: Sze S.M. (ed), John Wiley, New York, 1994.
3. RF MEMS and Their Applications: Vijay Varadan, K. J. Vinoy, K. A. Jose, Wiley, 2002.

REFERENCE BOOKS :

1. Integrated Sensors, Micro actuators and micro-systems (MEMS): K.D. Wise, Special Issue of proceedings of IEEE, Vol. 86, No.8, August 1998
2. RF MEMS: Theory, Design, and Technology: Gabriel M. Rebeiz, Wiley, 2003.
3. Fundamentals of Microfabrication: Marc Madou, CRC Press, 1997.

23PVL213T VLSI Signal Processing

Course Objectives:

The objective of this course is to provide students with

1.Concepts of pipelining, parallel processing, retiming, folding and unfolding for digital signal processing architectures.

2.Knowledge of systolic architecture

3.Analysis to optimize fast convolution algorithms for digital signal processing architectures in terms of computational complexity.

Course Outcomes:

Upon the completion of this course, students will demonstrate the ability to:

- Apply the concepts of pipelining, parallel processing, retiming, folding and unfolding to optimize digital signal processing architectures.
- Analyze data flow in systolic architectures.
- Minimize the computational complexity using fast convolution algorithms.

Introduction to Digital Signal Processing Systems: Introduction, Typical DSP Algorithms, Representations of DSP Algorithms.

Iteration Bound: Introduction, Data Flow Graph Representations, Loop Bound and Iteration Bound, Algorithms for Computing Iteration Bound, Iteration Bound of Multirate Data Flow Graphs.

Pipelining and Parallel Processing: Introduction, Pipelining of FIR Digital filters, Parallel Processing. Pipelining and Parallel Processing for Low Power.

Retiming: Introduction, Definitions and Properties, Solving System of Inequalities, Retiming Techniques.

Unfolding: Introduction, Algorithm for Unfolding, Properties of Unfolding, Critical Path, Unfolding and Retiming, Applications of Unfolding.

Folding: Introduction, Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding of Multirate Systems.

Systolic Architecture Design: Introduction, Systolic Array Design Methodology, FIR systolic Arrays, Selection of scheduling vector, Matrix-Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations containing Delays.

Fast Convolution: Introduction, Cook-Toom Algorithm, Winogard Algorithm, Iterated Convolution, Cyclic Convolution, Design of Fast Convolution Algorithm by Inspection.

Text Books :

2. VLSI Digital Signal Processing Systems: Design and Implementation Keshab K. Parhi. John Wiley- Inter science. publication (1999).
3. Analog VLSI Signal & information processing: Mohammed Ismail, Terri, Fiez, McGraw Hill. (1994).

Reference Books:

7. VLSI and Modern Signal Processing: kung.S.Y., H.J.Whitehouse T.Kailath, prentice hall, (1985).
8. Design of Analog Digital VLSI circuits for telecommunications and signal processing: Jose E. France, Yannis Tsividls, prentice Hall, (1994).

23PVL221T **Wireless Sensor Network**

Objectives:

1. To enable the student to understand the role of sensors and the networking of sensed data for different applications.

2. To expose the students to the sensor node essentials and the architectural details, the medium access and routing issues and the energy constrained operational scenario.

3. To enable the student to understand the challenges in synchronization and localization of sensor nodes, topology management for effective and sustained communication, data management and security aspects.

Outcome: By the end of the course, the students shall be able

1. The student would be able to appreciate the need for designing energy efficient sensor nodes and protocols for prolonging network lifetime.

2. The student would be able to demonstrate an understanding of the different implementation challenges and the solution approaches.

UNIT I: OVERVIEW OF WIRELESS SENSOR NETWORKS

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- case study, Enabling Technologies for Wireless Sensor Networks.

UNIT II: ARCHITECTURES

Single-Node Architecture, Hardware Components, Energy Consumption of Sensor Nodes ,Operating Systems and Execution Environments, Network Architecture, Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Physical Layer and Transceiver Design Considerations.

UNIT III: MAC AND ROUTING

MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols And Wakeup Concepts, S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols, Energy-Efficient Routing, Geographic Routing.

UNIT IV: INFRASTRUCTURE ESTABLISHMENT

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT V: DATA MANAGEMENT AND SECURITY

Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation, Directed diffusion, Tiny aggregation, greedy aggregation, security in WSN.

TEXT BOOKS:

1. Anna Hac, ―Wireless Sensor Network Designs‖, John Wiley, 2003.

2. Bhaskar Krishnamachari, ‖Networking Wireless Sensors‖, Cambridge Press,2005.

3. Mohammad Ilyas and Imad Mahgaob,‖Handbook Of Sensor Networks: Compact Wireless And Wired Sensing Systems‖, CRC Press, 2005.

4. Wayne Tomasi, ―Introduction To Data Communication And Networking‖, Pearson Education, 2007.

REFERENCE BOOKS:

1. Ian F. Akyildiz, Mehmet Can Vuran, ―Wireless Sensor Networks‖ John Wiley, 2010

2. Yingshu Li, My T. Thai,Weili Wu, ― Wireless Sensor Networks and Applications‖ Springer 2008

3. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.

4. Feng Zhao & Leonidas J. Guibas, ―Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

5.Kazem Sohraby, Daniel Minoli, & Taieb Znati, ―Wireless Sensor Networks-s

23PVL222T **Artificial Intelligence and Robotics**

Course Objectives:

To introduce the fundamental concepts of artificial intelligence.

To equip students with the knowledge and skills in logic programming using PROLOG and LISP.

To explore the different paradigms in knowledge representation and reasoning.

To evaluate the effectiveness of hybridization of different artificial intelligence techniques.

To study the fundamentals of Robotics.

Course Outcome: By the end of the course, the students shall be able

1. Understand the history, development and various applications of artificial intelligence.

2. Familiarize with propositional and predicate logic and their roles in logic programming.

3. Understand the programming language PROLOG and LISP and write programs in declarative programming style.

4. Apply and integrate various artificial intelligence techniques in intelligent system development as well as understand the importance of maintaining intelligent systems. Identify the devices required for Robot based applications.

Unit- I

Artificial Intelligence:

History and Applications, Production Systems, Structures and Strategies for state space search- Data driven and goal driven search, Depth First and Breadth First Search, DFS with Iterative Deepening, Heuristic Search- Best First Search, A* Algorithm, AO* Algorithm, Constraint Satisfaction, Using heuristics in games- Minimax Search, Alpha Beta Procedure

Unit-II

Knowledge representation -

Propositional calculus, Predicate Calculus, Theorem proving by Resolution, Answer Extraction, AI Representational Schemes- Semantic Nets, Conceptual Dependency, Scripts, Frames, Introduction to agent based problem solving.

Unit- III

Machine Learning- Symbol based and Connectionist, Social and Emergent models of learning, The Genetic Algorithm- Genetic Programming, Languages and Programming Techniques for AI Introduction to PROLOG and LISP-features. Basics of search strategies and Logic Programming in LISP

Unit- IV

Overview of Expert System Technology - Rule based Expert Systems, Expert systems Inference: Forward chaining and backward chaining, Deduction process, Languages and tools, Knowledge acquisition and uncertainty: Explanation facilities, knowledge acquisition, dealing with uncertainty, fuzzy reasoning, Introduction to natural language processing, Understanding, perception, learning; explanation facilities and knowledge acquisition.

Unit- V:

Introduction to Robotics, Basic Concepts, Three laws of Robotics, Types of Drives, Actuators and its selection while designing a robot system, Types of Controllers, Introduction to closed loop control, second order linear systems and their control, Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation.

TEXT BOOKS:

1. G. F. Luger, Artificial Intelligence- Structures and Strategies for Complex Problem Solving, 4 thedition, Pearson Education, Delhi, 2002

2. E. Rich and K. Knight, Artificial Intelligence, 2nd ed., Tata McGraw-Hill, New Delhi, 1991

3. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition,2004

4. K.S. Fu, R.C. Gonzales, C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill,1987.

5. Shah S. K., Introduction to Robotics, Tata McGraw Hill International, 2008.

6. Mittal R. K. and Nagrath J. J. Robotics and control, Tata McGraw Hill, New Delhi

REFERENCE BOOKS:

1. D. W. Rolston, Principles of Artificial Intelligence & Expert Systems Development, McGraw Hill, Ney York, 1988

2. D. W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India,New Delhi, 1990

3. N. J. Nilsson, Principles of Artificial Intelligence, Narosa Publishing House, New Delhi, 1990.

4. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 2002.

5.Niku, Saeed B. Introduction to Robotics – Analysis, Systems Applications, Pearson Education Inc. New Delhi

6. Mataric M. J., The Robotic Primer, University Press, 2009.

23PVL223T Embedded System Testing and Verification

Unit I : Introduction Types, Hardware and software testing Methodologies, Types, Different Approaches for embedded testing, Temb Method, overview, Temb generic, Mechanism for assembling the dedicated test approach.

Unit II : Life Cycle Multiple V Model, Test activities in the multiple Vs, The nested multiple V model, Master Test planning, Elements and Activities of Master Test Planning, Testing by developers, Testing by an independent test team

Unit III : Techniques Risk based test strategy, Testability review, Inspections, Safety analysis, Test design techniques, Checklists

Unit IV : Organization Test roles, Test case designing, Test case interface, Test case execution, Test pattern, methods , approaches, Human resource management, Organization structure, Test control, Pseudo code evolutionary algorithms.

Unit V : Verification of embedded systems, Use of formal techniques decision diagrams, logic based approaches, Physical faults and their modeling. Fault equivalence and dominance; fault collapsing. Fault simulation parallel, deductive and concurrent techniques; critical path tracing. Fault Tolerance,Reliability.

Text Books

1. Testing Embedded Software Dart Breakman and Edvin.

References

1. N. K. Jha and S. Gupta, Testing of Digital Systems, Cambridge University Press.

2. M. L. Bushnell and V. D. Agrawal, Essentials of Electronic Testing, Kluwer Academic Publishers.

3. M. Abramovici, M. A. Breuer and A. D. Friedman, Digital Systems Testing and Testable Design, Wiley IEEE Press.

4. P. H. Bardell, W. H. McAnney and J. Savir, Built in Test for VLSI Pseudorandom Techniques, Wile Interscience.

5.P. K. Lala, Fault Tolerant and Fault Testable Hardware Design, Prentice Hall.

COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

CHEMICAL ENGINEERING

Of

RASHTRASANT TUKDOJI MAHARAJ

NAGPUR UNIVERSITY, NAGPUR

PRIYADARSHINI COLLEGE OF ENGINEERING,NAGPUR

FIRST SEMESTER M.TECH (C.B.C.S.) (CHEMICALENGINEERING)

Sr. No.	Code (Board) Theo./ Pract	Subject	Work load				Credit				Total Marks				
											Th eory		Practical		Total
			L	P	T	Total	L	P	T	Total	Sessional	University	Sessional	University	
1.	23PCH101T	Modeling & Simulation In Chemical Engineering	4	-	-	4	4	-	-	4	40	60	-	-	100
	23PCH101P	Modeling & Simulation Of Chemical Processes	-	4	-	4	-	2	-	2	-	-	100	100	200
2.	23PCH102T	Advanced Transport Phenomena	4	-	-	4	4	-	-	4	40	60	-	-	100
3.	23PCH103T	Advanced Reactor Design	4	-	-	4	4	-	-	4	40	60	-	-	100
4.		**Elective-I (Core)**	4	-	-	4	4	-	-	4	40	60	-	-	100
4.1	23PCH111T	Process Design, Integration and Intensification	-	-	-	-	-	-	-	-	-	-	-	-	-
4.2	23PCH112T	Bioprocess Engineering	-	-	-	-	-	-	-	-	-	-	-	-	-
.3	23PCH113T	Fluidization Engineering	-	-	-	-	-	-	-	-	-	-	-	-	-
4.4	23PCH114T	Industrial Waste Management	-	-	-	-	-	-	-	-	-	-	-	-	-
5.		**Elective-II (Open)**	4	-	-	4	4	-	-	4	40	60	-	-	100
5.1	23PCH121T	Advance food processing Engineering	-	-	-	-	-	-	-	-	-	-	-	-	-
5.2	23PCH122T	Modern Chemical Instrumentation	-	-	-	-	-	-	-	-	-	-	-	-	-
5.3	23PCH123T	Corporate Social Responsibility	-	-	-	-	-	-	-	-	-	-	-	-	-
Total			**20**	**4**	**-**	**24**	**20**	**2**	**-**	**22**	**200**	**300**	**100**	**100**	**700**

PRIYADARSHINI COLLEGE OF ENGINEERING, NAGPUR

SECOND SEMESTER M.TECH (C.B.C.S.) (CHEMICALENGINEERING)

Sr. No.	Code (Board) Theo./Pract	Subject	Workload				Credit				MARKS				Total Marks
			L	P	T	Total	L	P	T	Total	Theory		Practical		
											Sessional	University	Sessional	University	
1.	23PCH201T	Advanced Separation Processes	4	-	-	4	4	-	-	4	40	60	-	-	100
2.	23PCH202T	Advanced Process Dynamics &Control	4	-	-	4	4	-	-	4	40	60	-	-	100
3.	23PCH203T	Advanced Biochemical Engineering	4	-	-	4	4	-	-	4	40	60	-	-	100
4.		**Elective-III**	4	-	-	4	4	-	-	4	40	60	-	-	100
4.1	23PCH231T	Advanced Petroleum Refining	-	-	-	-	-	-	-	-	-	-	-	-	-
4.2	23PCH232T	Nanotechnology	-	-	-	-	-	-	-	-	-	-	-	-	-
4.3	23PCH233T	Multiphase Flow	-	-	-	-	-	-	-	-	-	-	-	-	-
4.4	23PCH234T	Fuel Cell Technology	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	23PCH205T	Research Methodology	4	-	-	4	4	-	-	4	40	60	-	-	100
Total			**20**	**-**	**-**	**20**	**20**	**-**	**-**	**20**	**200**	**300**	**-**	**-**	**500**

PRIYADARSHINI COLLEGE OF ENGINEERING,NAGPUR

THIRD SEMESTER M.TECH (C.B.C.S.) (CHEMICAL ENGINEERING)

Sr. No.	Code(Board)Theo./ Pract	Subject	Workload				Credit				MARKS				Total Marks
			L	P	T	Total	L	P	T	Total	Theory		Practical		
											Sessional	University	Sessional	University	
1	23PCH301 T	Project Planningand Management	4	-	-	4	4	-	-	4	40	60	-	-	100
2	23PCH302 P	*Project Seminar	-	3	-	3	-	8	-	8	-	-	200	-	200
3		**Elective IV (Open)**	4	-	-	4	4	-	-	4	40	60	-	-	100
3.1	23PCH341 T	Waste to Energy	-	-	-	-	-	-	-	-	-	-	-	-	-
3.2	23PCH342 T	Energy Conservation & Planning	-	-	-	-	-	-	-	-	-	-	-	-	-
3.3	23PCH343 T	Green & Cleaner Technology	-	-	-	-	-	-	-	-	-	-	-	-	-
Total			**8**	**3**	**-**	**11**	**8**	**8**	**-**	**16**	**80**	**120**	**200**	**-**	**400**

*ForWorkLoad:2Hours/week/faculty

PRIYADARSHINI COLLEGE OF ENGINEERING,NAGPUR

FOURTH SEMESTERM.TECH(C.B.C.S.) (CHEMICALENGINEERING)

Sr. No.	Code (Board) Theo./ Pract	Subject	Workload				Credit				MARKS				Total Marks
			L	P	T	Total	L	P	T	Total	Theory		Practical		
											Sessional	University	Sessional	University	
1.	23PCH401P	*Project	-	6	-	6	-	10	-	16	-	-	200	200	400
Total			-	6	-	6	-	10	-	16	-	-	200	200	400

*ForWorkLoad:3Hours/week/faculty

FIRST SEMESTER M.Tech Chemical Engineering

Subject **:23PCH101T** (BCHE) **Modeling & Simulation in Chemical Engineering (Theory)**

Lecture	:4 Hours	No. of Credits	4
University	:60 Marks	College Assessment	: 40 Marks

Duration of Examination: 3 Hours

Course Objectives: To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators.

Course Outcomes (CO):

Upon completion of this course, the students will be able to:
CO1: analyze physical and chemical phenomena involved in various process.
CO2: develop mathematical models for various chemical processes by using various simulation approaches.
CO: designed to have detailed understanding of process simulation, tools of simulation, parameter estimation, models and classification of models, alternate classification of models, mathematical modelling.
CO4: formulate mathematical models for mass transfer, heat transfer, fluid flow operations and reaction engineering aspects.
CO5: Simulate a process using process simulators (ASPEN Plus/ ASPEN Hysys).

Unit 1: Introduction to process modeling, Applications of models, classification of models, Principles of Formulation,fundamental laws,general modeling procedure,industrialusage of process modelling and simulation; Macroscopic and microscopic mass, energyandmomentum balances

Unit2: Parameter estimation techniques in theoretical as well as numerical models, population balance, stochastic, andempirical models

Unit3: Modeling of various mass and heat transfer equipment: distillation, absorption, extraction columns; evaporators;furnaces; heat exchangers;flash vessels etc.

Unit4: Modeling of Chemical Reactors: single phase and multiphase reactors

Unit5: Numerical Methods for chemical engineering applications.Introduction and use of different software for modeling and simulation

RecommendedBooks:

1. W.L.Luyben,ProcessModelingSimulationandControlforChemicalEngineers,McGrawHill,1990.
2. S.C.Chapra,R.P.Canale,NumericalMethodsforEngineers,6thEdition,Tata-McGrawHillPublications,2012.
3. R.E.G.Franks,ModelingandSimulationinChemicalEngineering,WielyIntrscience,NY,1972.
4. J.Ingam,I.J.Dunn,ChemicalEngineeringDynamicModelingwithPCsimulation,VCHPublishers,2008.
5. D.Himmelblau,Bischof ProcessAnalysis &Simulation,JohnWiley&Sons, 1968.

Subject **:PGCHE102T** (BCHE) **Advanced Transport Phenomena (Theory)**

Lecture :4 Hours No. of Credits 4

University :60 Marks College Assessment : 40 Marks

Duration of Examination: 3 Hours

Course Objective: Transport phenomena deals with the exchange of mass, energy, and momentum between systems, which plays an important role in engineered and natural systems. The course provides a systematic analysis and fundamental understanding of transport phenomena and its mathematical description which builds the foundation of modern simulation software packages.

Course Outcomes

After passing the course the student will be able to:

CO1: Apply the shell balance approach to derive differential mass and heat balance equations in Cartesian, cylindrical, and spherical coordinates

CO2: Apply the generalized differential mass and heat balance equations and the Navier-Stokes equations to analyze transport problems

CO3: Analyze transport problems in simple geometries and derive analytically the concentration, temperature or velocity distribution and the equations of change for mass, momentum and heat transport.

CO4: Analyze transport problems in complex geometries and calculate numerically the concentration, temperature, or velocity distribution using a simulation software

CO5: Elaborate conceptual and mathematical models, from conservation principles, to complicated systems involving simultaneous mass, momentum, and/or heat transfer processes as well as reactions or other sources/sinks of transport for multi-component mixtures.

Unit1: Review of mathematics: Scalar, Vectors, Tensors, divergence, relation between rectangular coordinates and cylindrical coordinates, relation between rectangular coordinates and spherical coordinates, partial derivative, substantial derivative, total derivative, lineintegral, surface integral, integral theorems.

Unit2:

Equations of continuity, equation of motion,the equation of mechanical energy, application of Navier-Stokes equation to solve problems, the equations of change for in compressible non-Newtonian fluids.

Unit3: Developing equations for obtaining velocity & shearstress distribution for flow of Newtonian, Binghamplastic & powerlaw fluids in spheres etc.from Istprinciple, Introduction to 2 dimensional & turbulent momentum transfers

Unit 4:

Equations of energy, the energy equation in curvilinear coordinates, use of equations of changeto set up steadystateheat transfer for problems.

Unit 5:

Unsteady state heat conduction expression for rectangular, spherical and cylindrical co-ordinate system from Ist principles, Numerical methods for 2 dimensional steady state conduction and Schmidt method for unsteady state heat conduction with / without surface resistance for obtaining temperature profiles

RecommendedBooks:

1. R.B.Bird,W.E.StewartandE.N.LightfootTransportPhenomenaWileyinternationalEdition,New York 2002.
2. JamesR.Welty,CharlesE.WicksandRobertE.Wilson,Fundamentalsofmomentum,heatandmass transfer, John Wiley&sons,Inc, NewYork, 2008.

Subject :**PGCHE103T**(BCHE) **Advanced Reactor Design(Theory)**

Lecture :4 Hours No.of Credits 4

University :60 Marks College Assessment : 40 Marks

Duration of Examination: 3 Hours

Course Objective: Review of Basic Principles of Chemical Reaction Engineering. Basic Flow Models. Introduction to Stability of Chemical Reactors, Bifurcation Analysis of Reaction Systems. Non-Elementary Homogeneous Reaction Systems. Introduction to Combustion and Analytical Methods in Combustion.

Course Outcomes

CO1: Understand the fundamentals of advanced reactor designs and their characteristics.

CO2: Obtain in-depth knowledge of three types of advanced reactors: metal-cooled reactors, molten salt reactors, and high-temperature gas-cooled reactors.

CO3: Develop a working knowledge of the characteristics of advanced reactors from the perspective of reactor physics, thermal-hydraulics, and fuel performance.

CO4: Gain experience in performing reactor core design for advanced reactors using advanced modeling and simulation tools.

CO5: knowledge of regulations and policies for advanced reactors. Understand the basics of nuclear fuel design and performance in advanced reactors and cost component associated with the advanced nuclear reactor and associated advanced fuel cycle.

Unit 1:

Nonideal flow, RTD function, characteristics of RTD, Zero-parameter models,one-paramete rmodels, two-parameter models

Unit2:

Heterogeneous catalysis: Diffusion with reaction in porouscatalyst, Mechanism of catalytic creactions. Langmuir-Hinshel wood model, Rideal-Eiley Mechanism, Ratecontrolling steps**,** Development of rate equations for solid catalysed fluid phase reactions; External/internal mass and heat transfer resistances in catalyst particles,catalyst deactivation.

Unit3:

Heterogeneous Catalytic Reactors: Isothermal and adiabatic fixed bed reactors,Non-isothermaland non-adiabaticfixed bed reactors.

Unit4:

Introduction to multiphase reactor design, fluidized bedreactor, slurryreactor, Trickle bedreactor, Photocatalyticreactor, Sonochemical reactors

Unit5:

Theory of mass transfer with chemical reaction (regimes and examples),model contactors

Recommended Books:

1. H.S.Fogler, Elementsof Chemical Reaction Engineering,Prentice–Hall, 1986.
2. O.Levenspeil, Chemical Reaction Engineering, 3rdEdition,Wiley,1999.

3. J.M.Smith,Chemical Engineering Kinetics,McGraw-Hill,1981.
4. G.F.Froment,K.B.Bischoff, Chemical Reactor Designand Analysis,Addision-Wesley,1982.
5. L.K.Doraiswamy, M.M.Sharma,Heterogeneous Reactionsvo l.Iand II,JohnWiley& SonsInc.
6. P.V.Danckwerts, Gas Liquid Reactions,McGraw-Hill Book Co.,NewYork,1970.

Subject :PGCHE 104T (BCHE) ElectiveI-1.**Process Design, Integration and Intensification (Theory)**

Lecture :4 Hours | No.of Credits 4
University :60 Marks | College Assessment : 40 Marks
Duration of Examination: 3 Hours

Course Objective: To learn the concept of Process Intensification. Apply the technique of intensification to a range of chemical processes and process Equipment

CO1: Understand The Fundamental of chemical process design, integration and intensification of a desired product through Onion model

CO2: Make an initial choice of reactor for desire product based on conditions of reaction, performance, configuration and heat integration of reactor

CO3: Sequence the distillation column with &/or without heat integration for multicomponent system

CO4: Analyze the design of heat exchanger network based on energy target, utilities and integration of heat & power

CO5: Plan and design a chemical process of desired product by the application of integration of heat & power

Unit1: Introduction to chemical process design, integration and intensification. Hierarchy and approach of chemical process design and integration

Unit2: Choice of reactors: Performance, conditions, configurations, heat integration of reactorsetc.

Unit3: Distillations equencing: multicomponent, extractive,azeotropic distillation systemsetc.withand without heat integration.

Unit4: Heat exchangernet works:Energy Target and network design, trade-off & utilities, Heat & power integration.

Unit5: Case studies on chemical process design, integration and intensification.

RecommendedBooks:

1. R.Smith,Chemical Process Design and Integration,John Wileyand Sons.Ltd.,NewDelhi,2005.
2. J.Douglas,Conceptual Design of Chemical Processes.NewYork,NY:McGraw-HillScience /Engineering/ Math,1988.
3. W.D.Seider, J.D.Seader ,D.R.Lewin. Product and Process Design Principles: Synthesis, Analysis, and Evaluation. 2nd ed. New York,Wiley, 2004.
4. R.Turton, R.C.Bailie, W.B.Whiting, J.A.Shaeiwitz. Analysis, Synthesis, and Design of Chemical Processes, 2^{nd} Edition, PrenticeHall, 2002.
5. L.T.Biegler, I.E.Grossmann, A.W.Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, 1997.

Subject **:PGCHE104T** (BCHE) **ElectiveI–2-Bioprocess Engineering (Theory)**

Lecture	:4 Hours	No. of Credits	4
University	:60 Marks	College Assessment	:40 Marks

Duration of Examination: 3 Hours

Objectives: To understand the principles, stichiometry, kinetics, modeling and instrumentation of biological processes employed in industrial fermentation.

CO1: Understand The Fundamental of fermentation process.

CO2: Understand the basic principle of enzyme kinetics.

CO3: Analyze the Stoichiometry And Kinetics Of Substrate Utilization And Biomass And Product Formation

CO4: Analyze the design of Bioreactor And Product Recovery Operations.

CO5: Plan and design a Introduction To Instrumenation, monitoring & Process Control In Bioprocesses Measurement of physical and chemical parameters in bioreactors.

Unit-I-Introduction: Fermentation Processes General requirements of fermentation processes-An overview of aerobic and anaerobic fermentation processes andtheir application in industry - Medium requirements for fermentation processes -examples of simple and complex media Design and usage of commercial media for industrial fermentation.Sterilization:Thermal death kinetics of micro-organisms - Batch and Continuous Heat-Sterilization of liquid Media- Filter Sterilization of Liquid Media andAir.

Unit-II-Enzyme Technology, Microbial Metabolism: Enzymes: Classification and properties-Applied enzyme catalysis - Kinetics ofenzyme catalytic reactions-Metabolic pathways-Protein synthesis in cells.

Unit-III-Stoichiometry And Kinetics Of Substrate Utilization And Biomass And Product Formation: Stoichiometry of microbial growth, Substrate utilization and product formation-Batch and Continuous culture, Fedbatch culture

Unit-IV- Bioreactor And Product Recovery Operations: Operating considerations for bioreactors for suspension and immobilized cultures, Selection, scale-up, operation of bioreactors-Mass Transfer in heterogeneous biochemical reactionsystems; Oxygen transfer in submerged fermentation processes; oxygen up take rates and determination of oxygen transfer rates and coefficients ;role of aeration and agitation in oxygen transfer. Heat transfer processes in Biologicalsystems.Recovery and purification of products.

Unit-V-Introduction To Instrumenation And Process Control In Bioprocesses: Measurement of physical and chemical parameters in bioreactors- Monitoringand control of dissolved oxygen, pH, impeller speed and temperature in astirred tankfermenter.

TEXT BOOKS:

1.M.L.ShulerandF.Kargi,"Bio-processEngineering",2ndEdition, Prentice Hall of India,NewDelhi. 2002.

2 J.E.BaileyandD.F.Ollis,"Biochemical Engineering Fundamentals",2ndEdn.,McGrawHill,Publishing Co.NewYork., 1985.

3 D,G. Rao, Second Edition, Introduction to Biochemical Engineering, Mc Graw Hill India, 2016

REFERENCE:

1.P.Stanbury,A.Whitakarand S.J.Hall,"Principles of Fermentation Technology"2ndEdn., Elsevier-Pergamon Press, 1995.

Subject	**:PGCHE104T**(BCHE)	**ElectiveI-**3.**Fluidization Engineering (Theory)**	
Lecture	:4 Hours	No.of Credits	4
University	:60Marks	College Assessment	: 40 Marks
Duration of Examination:3Hours			

Course Objectives: To study the fluidization phenomena, fluidized bed regimes and models.

Course outcomes:
On successful completion of the course, the student should be able to

CO1: Explain the basics of fluidization.

CO2: Describe the various industrial applications of fluidization.

CO3: Explain the various fluidization regimes, classification of particles.

CO4: Describe the K-L bubbling model.

CO5: Describe the staging of fluidized beds, and calculation of the exchange coefficient.

Unit 1: Introduction: Phenomenon of fluidization, behavior of fluidized bed, contacting modes,advantages and disadvantages of fluidization, fluidization quality, selection of contactingmode

Unit2: Mapping of fluidization regimes: Characterization of particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, design of gas distribut or, power consumption

Unit 3: Bubbles in dense bed: Davidson model for gas flow, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles,bubble formation above a distributor, slug flow. **Bubbling fluidized beds:** Emulsion movement, estimation of bedproperties,bubblerise velocity, scaleupaspects, flow models, two phasemodel,K-Lmodel

Unit 4:Entrainment and elutriation: Freeboard behavior, gas outlet, entrainment from tall vessel,freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fastfluidization.

Solids movement: Vertical and horizontal movement of solids, Dispersionmodel, large solids in beds of smaller particles, staging of fluidized beds.

Gas dispersion: Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gasinterchange coefficient

Unit5: Design of fluidized bed reactors: Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts, Design of noncatalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion ofsolids of unchanging size

Recommended Books:

1. O.Levenspiel,D.Kunnii, Fluidization Engineering,JohnWiley,1972.
2. Liang-ShihFan,Gas-Liquid-Solid Fluidization Engineering, Butterworths, 1989.

Subject **:PGCHE104T** (BCHE) **ElectiveI-4.Industrial Waste Management (Theory)**

Lecture :4 Hours

University :60 Marks

Duration of Examination: 3 Hours

No. ofCredits 4

CollegeAssessment : 40 Marks

Course Objective - The purpose of this course is to train the students in different waste management techniques.A special emphasis will be ontechniquesfor transformation of waste materials into products that can be beneficially utilized. The ultimate goalshould, of course, be that no waste is formed in industry or society.

Course outcomes:

On successful completion of the course, the student should be able to

CO1: Explain the basics of Water Pollutants, Effects of pollutants on environment and health Monitoring and Quality standards.

CO2: Describe the various Water Pollution Sources, classification and treatment methods.

CO3: Explain the various Waste water Treatment Plant Design: Physical unit operations.

CO4: Describe the Advanced Waste water and Water Treatment, Membrane processes

CO5: Describe the Solid waste disposal methods, Emerging technologies

UNIT-1-Water Pollutants, Effects, Monitoring and Quality standards: Pollution of water and soil, effect of pollutants on environment and health, monitoring waterpollution, water pollution laws and minimum national standards, monitoring, compliance withstandards,Latest norms for effluent treatment.

UNIT-2-Water Pollution Sources, Analysis and Methods of control: Water pollution sources and classification of water pollutants-Waste water sampling and analysis. Treatment of water-pollution: BOD, COD of waste water and itsreduction– Fundamentals of Anaerobic digestion and Aerobic digestion.

UNIT-3-Wastewater Treatment Plant Design: Physical unit operations: Screening, Flow equalization, sedimentation etc.,Chemical Unit Processes:chemical precipitation,dis-infection, colour removal by adsorption Biological unitprocesses: Aerobic suspended - growth treatment processes, aerobic attached-growth treatment processes, anaerobic suspended - growth treatment processes,anaerobic attached-growth treatment processes.

UNIT-4-Advanced Waste water and Water Treatment:Carbon adsorption-Ion exchange, Membrane processes- Nutrient (nitrogen and phosphorus) removal - Designof plant for treatment and disposal of sludge

UNIT-5-Solids Waste and Landfill Management: Sources and classification - methods ofsolid waste disposal-Composting (natural)-Accelerate dcomposting with industrial sludge - Landfill technology - Methods adopted for municipal solidwaste-Toxic-waste management, Incineration of industrial waste, Design aspects, economics. Hazardous Waste Management and Risk Assessment: Types of hazardous Wastes-Health effects - Nuclear fission and radioactive waste treatment and disposal methods. Risk assessment

TEXT BOOKS:

1. C.S.Rao,"Environmental Pollution Control Engineering", Wiley 2nd Edition,New Age International Publishers,2006.
2. S.P.Mahajan,"Pollution Control in Process Industries", Tata McGraw Hill,New Delhi,1985

REFERENCES:

1. P.SinceroandG.A. Sincero,Environmental Engineering: A Design Approach Prentice Hall of India pvt Ltd,N.Delhi.1996
2. Tchbanoglous and F.L. Burton, Metcalf and Eddy'sWaste water Treatment-Disposal And Reuse (Third Ed.), TMH publishing CoLtd, N.Delhi. (1996)

Subject **: PGCHE-OPEN 105T** (BCHE) **Elective II-1- Modern Chemical Instrumentation (Theory)**

Lecture	: 4 Hours	No. of Credits	: 4
University	: 60 Marks	College Assessment	: 40 Marks

Duration of Examination: 3 Hours

Course objective: The purpose of this course is to train the students in different modern chemical Instrumentation techniques.A special emphasis will be on techniques for transformation of related knowledge on research & industrial application.

Course Outcomes:

Upon completion of this course, the students will be able to:

CO1: Understand the spectroscopy and its applications

CO2: Understand thespectrophotometry and its applications

CO3: Understand the concept of mass spectrometry and its applications

CO4: Understand the NMR Phenomena principle & application in chemical analysis

CO5: Understand the Characterization techniques for any sample

Unit 1: UV & IR spectroscopy, basic principles of UV & IR, Microwave spectroscopy, radiation sources, monochromators, detectors, instrumentation & Application of qualitative & Quantitative chemical analysis, Raman spectroscopy, sample handling & illumination & applications

Unit 2: Atomic absorption & Atomic emission spectroscopy, flame & flame temperatures, instrumentation & Application, in chemical analysis, fluorescence & phosphoresce, spectrophotometry

Unit 3: Mass spectrometry, basic principles, commercial mass spectrometers, correlation of mass spectra with molecular structure for a few typical cases, application of mass spectral data

Unit 4 : NMR spectroscopy, NMR phenomena, principle & Instrumentation, chemical shift , its measurement, spin – spin coupling, spin – spin splitting, application of NMR in structural diagnosis & Quantitative analysis, electron spin resonance spectroscopy, principle & application in chemical analysis,

Unit 5: Gas chromatography, HPLC, GCMS, SEM, Basic principal of XRD & XRF techniques, Differential Thermal Analysis & Differential scanning calorimeter, thermogravimetry, thermometric titrimetry, electrogravimetry, colorometry, principles applications of colorometry, colorometric titration stripping analysis

Recommended Books:

1. V.M. Parikh, Absorption Spectroscopy of Organic Molecules, Addison - Wesley Publishing Company, 1974.
2. H.H. Willard, I.I. Merritt, J.A. Dean, F.A. Settle, Instrumental Methods of Analysis, Sixth edition, CBS publishers, 1986.
3. D.A. Skoog, D.M. West, Fundamentals of Analytical Chemistry, Saunders-College Publishing, 1982.
4. G.C. Banwell, Fundamentals of Molecular Spectroscopy, TMH, 1992.

Subject : PGCHE-OPEN 105T

(BCHE) Elective II-2-ADVANCED FOOD PROCESS ENGINEERING (Theory)

Lecture : 4 Hours

University : 60 Marks

Duration of Examination: 3 Hours

No. of Credits : 4

College Assessment : 40 Marks

Course objective: The purpose of this course is to develop the understanding of students in different Advance food processing techniques for transformation of related knowledge on research & industrial application.

Course Outcomes:

Upon completion of this course, the students will be able to:

CO1: Understand the FoodProcessEngineeringFundamentals.

CO2: Understand theUnit Operations in Food Processing.

CO3: Understand the fundamentals of Food Canning Technology.

CO4: Understand the Separation And Mixing Process In Food Industries.

CO5: Understand the Characterization of FoodBiotechnology.

Unit 1: Food Process Engineering-Fundamentals: Raw material and the process-Geometric, Functional and Growth properties of the raw material, Mechanization and the raw material, cleaning-contaminants in food raw materials, function of cleaning andcleaning methods, sorting and Grading ofFoods.

Unit 2: Operations in Food Processing: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations to food processing. Heat processing of foods -modes ofheat transfer involved in heat processing of foods.

Unit 3: Food Canning Technology: Fundamentals offood canning technology, Heatsterilization of canned food, containers- metal, glass and flexible packaging,Canning procedures for fruits,vegetables, meats, poultry and marine produces.

Unit 4: Separation And Mixing Process In Food Industries: Conversion operations. Size reduction and screening of solid smixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

Unit5: Food Biotechnology: Food Biotechnology. Dairy and cereal products. Beverages and food ingredients. High fructosecorn syrup. Single cellprotein.

TEXTBOOK:

1.R.T.Toledo,"Fundamentals of Food Process Engineering", AVI Publishing Co.,NewYork, 1980.

REFERENCES:

1. J.M.Jackson & B.M.Shinn,"Fundamentals of Food Canning Technology", AVI Publishing Co., New York, 1978.
2. J.G.Bernnan,J.R.Butters,N.D.Cowell&A.E.V.Lilley,"Food Engineering Operations", 2^{nd} Edn.,Applied Science,New York, 1976.

Subject **: PGCHE-OPEN 105T**

Lecture : 4 Hours
University : 60 Marks
Duration of Examination: 3 Hours

(BCHE) Elective II-3-Social Corporate Responsibility (Theory)

No. of Credits : 4
College Assessment : 40 Marks

Course objective: To Provide students with a comprehensive understanding of Social Corporate Responsibility, Sustainable Development and sustainability challenges (social, economic and regulatory)

Course Outcome -

After completion of the course students are expected to be able to:
CO1-understand and critically discuss the concepts and topics of

social corporate responsibility as well as business' responsibilityexpose to different approaches in SCR and Sustainability

CO2. understand social approaches of business decisions and get introduced to the SCR and Sustainability

CO3. understand sustainability challenges (social, environmental and economic development) that companies face and how transform these challenges into business opportunities

CO4-. understand various approaches of SCR concept, application of SCR, Sustainability practicesacross different verticals.

CO5-Understand the innovative sustainability solutions that ensures inclusive growth alongwith the growth of the company and society, SCR

UNIT-1:Introduction to SCR -Meaning & Definition of SCR, Importance of SCR, History & evolution of SCR, Theories of SCR, Indian SCR Law – In depth Analysis, benefits of SCR programme, SCR - Global time line, SCR in India.

UNIT-2: Stakeholders & SCR -Who are stakeholder's, The stakeholder approach, Stakeholder and CSR, Stake holders theory perspective, Stakeholder theory in action, Stakeholder identification, Stakeholder salience, Stake holder management, Stakeholder dialogue , Management of stakeholder dialogue

UNIT-3: SCR Planning and Institutionalising-Planning of CSR activities :Responsibility paradigm, SCR Design andImplementation, stakeholder Integration, SCR activities, Bases of evaluation of SCR activities, Measurement of SCR : sustainability indexes, An example of SCR evaluation, SCR in India, SCR initiatives being taken by selected public and private Indian companies

UNIT- 4: Corporate Governance - What is corporate governance, Theories of Corporate governance, Importance of corporate governance, Models and systems of corporate governance, Implementation of corporate governance, Board of Directors, Principals of corporate governance, Corporate governance & SCR

UNIT-5: Corporate sustainability and SCR-What is sustainable development, Corporate sustainability and SCR, Integration of corporate sustainability and SCR, Sustainability Development Goals, SDG compass.

TEXTBOOK:

1.Bharat's Corporate Social Responsibility by KAMAL GARG Edition 2023

REFERENCES:

1. Nirbhay Lumde, Carporate social responsibility in India, first edition, 2023
2. Andrea Giordani, Corporate Social Responsibility, Introbooks ,Jul 2019

Subject :PGCHE 106P(BCHE) **Modeling & Simulation of Chemical Processes (Practical)**

Practical	:4 Hours	No.of Credits	: 2
University	:100 Marks	College Assessment	:100 Marks

Modeling and Simulations should be performed based on but not limited to the following List of examples

1. Dynamics of a Stirred Tank Heater with variable Volume
2. Modeling and Dynamics of a Quadruple Tank System.
3. Decoupled SISO control of the Quadruple Tank System.
4. Multi-variable Control of the Quadruple Tank System.
5. Dynamic Matrix Control of the Stirred Tank System.
6. Experimenton Programmed Adaptive Control System
7. Experiment on Time-delay compensation(Smith-Predictor)
8. Experiment on Inverse Response compensation
9. Experiment on multiple outputs controlled by a single input
10. Experimenton a singleoutput controlled bymultiple input
11. Introduction to process simulators and CFD software-ASPENPLUS,HYSYS.
12. Simulation of steadystateandDynamicprocessesusingASPEN PLUS
13. Simulation of a batch reactor, CSTR, Tubular Reactor, multiphase reactor systems
14. Simulation of a shell and tube heat exchanger
15. Simulation of a condenser
16. Simulation of a pump/compressor
17. Simulation of a fixed bed absorber
18. Simulation of a staged distillation column
19. Simulation of flowin channels and pipes
20. Simulation of flow in sudden expansion/contraction systems
21. Simulation of flow in a squarecavity, cylindrical venturi, slitventuri and orifice plate.
22. Process simulation study (flow sheeting)-Production of hydrogen by stream reforming
23. Process simulation study (flow sheeting)-Production of vinylchloridemonomer flow sheet
24. Process simulation study (flow sheeting)- Production of nitric acid from anhydrous ammonia
25. For the simulation of the above Processes/Process Equipment using Computer Programs or Simulation Packages such as ASPENPLUS/CHEMCAD/HYSYS(UNISIM)/gPROMS etc.can be used.

SECOND SEMESTER M.Tech Chemical Engineering

Subject **:PGCHE201T** (BCHE) **Advanced Separation Processes(Theory)**

Lecture :4 Hours No. of Credits 4

University :60 Marks College Assessment : 40 Marks

Duration of Examination: 3 Hours

Course Objective:

This subject aims to extend your knowledge of basic fluid separation processes to more complex systems commonly encountered in the chemical processing industry. After completing this advanced subject, you are expected to understand the principles of complex fluid separation processes including advanced mass transfer and diffusion theories, equilibrium-based and rate-based methods/models for multi-component absorption, stripping, distillation and extraction, temperature-/pressure-swing adsorption, advanced ion exchange adsorption and chromatographic separation. You will also develop advanced knowledge for design and operation of industrial separation units, the skill of using simulation tools applicable for multicomponent separation, and skill to analyse the energy efficiency, cost-effectiveness and sustainability of the design solutions.

Course outcomes

CO1: Analyze the thermodynamics, advanced mass transfer and diffusion theories underpinning the multi-component separation processes.

CO2: Combine the simulation tools and analysis methods for process flow-sheeting, column dimension calculation, and determination of energy efficiency, cost-effectiveness and sustainability of design solutions for complex separation processes.

CO3: Apply conceptual procedures for the design of multi-component, extractive and/or azeotropic distillation column, temperature-/pressure-swing adsorption column, advanced chromatographic column, and ion-exchange adsorption column.

CO4: Generate experimental skills in operating and analyzing the performance of separation unit operations.

CO5: Appreciate through group-based assignments, an understanding of the design process involving ethical conduct, teamwork spirits, leadership and the need for attention to detail.

Unit 1: Flux Definition, Differential Equations of Mass transfer, Molecular diffusivities, Molecular diffusion,Mass Transfer coefficients

Unit 2: Multicomponent distillation: Bubble point and dew point calculations, Lewis and Matheson calculation, Method of Thiele and Geddes; Azeotropic distillation; Extractive distillation;Molecular distillation; Reactive distillation

Unit3: Azeotropic and extractive fractional distillation: Separation of homogeneous azeotropes, separation of hetero generous azeotropes, quantitative treatment of separation of binary heterogeneous azeotropes, selection of addition agents, selectivity, factors affecting selectivity, methods for prediction, mechanism of relative volatility change, choice of entrainer or solvent, design of an azeotropic distillation process, design of an extractive distillation process, methods of solvent recovery

Unit 4: Membrane separation processes: Fundamentals, mechanism and equilibrium relationships, types and structure of membranes, membrane permeation of liquids and gases, effects ofconcentration, pressure and temperature, dialysis: mechanism, basic idea on dialyser design, industrial application, reverseosmosis, definitions and theory,design considerations, applications,ultra filtration.

Unit 5: Adsorption and Ion Exchange Processes: Adsorption and ion exchange equilibria. Various isotherms. Contact filtration, design of fixed bed adsorber including break through hcurve.

RecommendedBooks:

1. R.E. Lacey, S. Loaeb, Industrial Processing with Membranes, Wiley –Inter Science, NewYork,1972.
2. C.J.King,Separation Processes,TataMcGraw – Hill Publishing Co.,Ltd.,1982.
3. C.J.Geankoplis,Transport ProcessesandUnitOperations,Prentice-Hall of IndiaPvt.Ltd.,NewDelhi, 2000.
4. R.E.Treybal,Mass-Transfer Operations,McGraw-Hill,NewYork,1980.
5. J.D.Seader,E.J.Henley, Separation Process Principles,Wiley,2011.
6. B.K.Dutta,Principles of Mass Transfer and Separation Processes,PHI,2006
7. T.K.Sherwood,R.L. Pigford,C.R.Wilke,MassTransfer,McGraw-Hill,NewYork,1975.
8. H.M.Schoew,New Chemical Engineering Separation Techniques, Interscience Publishers,1972.
9. Osadar,Varid Nakagawa,Membrance Science and Technology, Marcel Dekkar,1992.

Subject :**PGCHE202T** (BCHE) **Advanced Process Dynamics & Control (Theory)**

Lecture :4 Hours No.of Credits 4

University :60 Marks College Assessment : 40 Marks

Duration of Examination:3 Hours

Course objective: To make the students understand basic ideas, challenges, techniques, and applications of process control for controlling various processes.

Course Outcomes: At the end of the Course, the Student will be able to:
CO1: develop the transfer function for a given system to generate response for a given forcing function.
CO2: develop block diagram for a given process
CO3: analyze the stability of a system for different modes of control
CO4: Discuss controller tuning and study the industrial example of SCADA
CO5: explain different advanced control strategies and control valve characteristics

Unit 1: Process Identification and Non-Linear Systems. Introduction and analysis of Non-linercontrol system. Phase plane analysis of second order control system, Analysis of criticalpoints.Method of isoclines for non linear system.

Unit 2: Control of complex processes Process modeling and dynamic response of gas absorber, steam jacket edkettle, heatexchanger, distributed parameter model, non-interacting continuous stirred tank reactors,non-interactingstirred tank heaters.

Unit 3: Feed forward-feedback control configuration. Industrial examples of feedforward-feedback control of heatexchanger, jacketed continuousstirredtank reactorforexothermic andendothermic reactions, stirred tank heater, distillation column, drum boiler, level control,extraction column.

Unit 4: Industrial control system. Control configuration of Supervisory control and data acquisition SCADA, Working control components and network communication of SCADA. Industrial examples of SCADA. Control configuration of distributed control system DCS. Working of Programmable logic controller PLC.Real time monitoring control.

Unit 5: Programmed adaptive control, Gain programmed aptive control.Reference model adaptive control, Inferential control. Industrial examples of adaptive and inferential control.Reaction curve method.

Recommended Books:

1. B.A.Ogunaike,W.H.Ray, Process Dynamics,Modelingand Control,Oxford University Press,NY, 1994
2. B.W.Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall International Series, 1998
3. D.E.Seborg,D.A.Mellichamp, T.F.Edgar, F.J.DoyleIII, Process Dynamicsand Control,3rd Edition, Wiley.
4. G.Stephanopoulos, Chemical Process Control, Prentice-Hall, Englewood Cliffs, NJ,1984
5. T.Marlin, Process Control,2nd Edition, McGraw HillInc,US,2000.
6. R.P.Vyas,Process control and Instrumentation,SeventhEdition,Denett & Co.publication,2015.
7. R.P.Vyas,Measurement and Control,Denett & Co.Publication2010.

Subject **:PGCHE203T** (BCHE) **Advanced Biochemical Engineering(Theory)**

Lecture :4 Hours No.ofCredits 4

University :60 Marks CollegeAssessment : 40 Marks

Duration of Examination: 3 Hours

Course Objective: To demonstrate ability to plan and execute experiments, and analyze and interpret outcomes.

Course outcome: On successful completion of the course student will be able to

CO1 Understand present unit operations together with the fundamental principles for basic methods in production technique for biologically based products.

CO2 Calculate the need for oxygen and oxygen transfer in a biological production process.

CO3 Understand to explain how microorganisms and biochemical processes can be applied in engineered systems and processes.

CO4 Understand an account of measurement and control of parameters in a bioreactor.

CO5 Calculate yield and production rates in a biological production process, and also interpret data.

Unit 1: Enzyme Kinetics: Models for complex enzyme kinetics, modeling of effect of pH and temperature, models for in soluble substrate, models for immobilized enzyme systems, diffusion limitation sinimm obilized enzymesystem, electrostatic and stericeffects.

Unit2: Major metabolic pathways, bioenergetics, Glucose metabolism, metabolism of nitrogenous compounds, respiration, metabolism of hydrocarbons, anaerobic metabolism, autotrophic metabolism.

Unit3: Bioreactors: Sterilization techniques,Modifications of batchand continuous reactors, chemostat with recycle, multistage chemostat, fed-batch operation, perfusion system, activeand passive immobilization of cells, diffusion allimitations in the immobilized system,fermenters.

Unit4: Homogeneous and heterogeneous reactions in bioprocesses:Reaction thermodynamics, growth kinetics with Plasmid instability, The Thiele Modulus and effectiveness factor, diffusion and reactionin waste treatment lagoon.Reactors and choice of reactors.

Unit5: Biological waste water treatment:Microbial participation in natural cycleofmatter, activated sludge process, design and modeling of activated sludge process, Nitrification,anaerobic digestion, mathematical modeling of anaerobic digester, anaerobic denitrification, phosphate removal.

Recommended Books:

1) Michael L. Shuler, Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, PrenticeHall, 2001.
2) J.E.Bailey,D. F.Ollis, Biochemical Engineering Fundamentals,McGraw-Hill,1986.
3) P.M.Doran, Bioprocess EngineeringPrinciples,Academic Press,2nd Edition, 2012.
4) J.M.Lee, Biochemical Engineering,Prentice Hall,EnglewoodCliffs,NewJersey,1992.

Subject	**:PGCHE204T** (BCHE)	**ElectiveIII-**1.**Advance Petroleum Refining (Theory)**	
Lecture	:4 Hours	No. ofCredits	4
University	:60 Marks	CollegeAssessment	: 40 Marks
Duration of Examination: 3 Hours			

CourseObjectives:

To provide the concept of petroleum refining and explain the different methods of petrochemical reactions and their applications. To provide the importance of various refining processes and their applications. To explain the significance petrochemicals productions.

Course Outcomes:

After completion of the course, students will be able to:

CO1:	Understand the basic concepts of Refineries
CO2:	Understand the design of distillation column
CO3:	Understand the design various equipment and rate kinetics of different types of cracking
CO4:	Understand the various mechanism of reaction and related rate kinetics
CO5:	Understand Environmental issues and New Trends in petroleum refinery operations

Unit 1: Introduction to petroleum refinery - General Definitions, Composition of petroleum, laboratory tests, refinery feedstocks and products. Classification of Crude oil, Characterization of crude oil, Composition of crude, Physical properties, Crude oil; analysis and distillation

Unit 2:Design concept of crude oil distillation column design.

Dehydration and desalting of crude, Crude Assay ASTM TBP distillations evaluation of crude oil properties, API gravity various average boiling points and mid percent corves, Evaluation of properties of crude oil and its fractions, Evaluation of crude oil properties and Design of crude oil distillation column.

Unit 3: Thermal and Catalytic cracking, Catalytic Reforming, Hydrotreating and Hydrocracking –

Coking and Thermal process, Delayed coking, Catalytic cracking, Cracking reactions, Zeolite catalysts, Cracking Feedstocks and reactors, Effect of process variables, FCC Cracking, Catalyst coking and regeneration, Design concepts, New Designs for Fluidized-Bed Catalytic Cracking Units. Objective and application of catalytic reforming process reforming catalysts. Reformer feed reforming reactor design continuous and semi regenerative process. Objectives & Hydrocracking Reactions, Hydrocracking feedstocks, Modes of Hydrocracking, Effects of process variables. Hydro treating process and catalysts Reside hydro processing, Effects of process variables, Reactor design concepts.

Unit 4 Isomerization, Alkylation and Polymerization, Lube Oil Manufacturing –

Isomerization process, Reactions, Effects of process variables, Alkylation process, Feedstocks, reactions, products, catalysts and effect of process variables, Polymerization: Objectives, process, Reactions, catalysts and effect of process variables. Lube oil processing: propane de- asphalting Solvent extraction, dewaxing, Additives production from refinery feedstocks.

Unit 5: Environmental issues and New Trends in petroleum refinery operations-

Ecological consideration in petroleum refinery, Waste water treatment, control of air pollution, new trends in refinery, Alternative energy sources, Biodiesel, Hydrogen energy from biomass.

Books Recommended:

1. W.L..Nelson " Petroleum Refining Engineering " Mc Graw- Hill.
2. R.N.Watkins," Petroleum Refinery distillation " Gulf Publishing Co.
3. RobertA Mayers " Hand book of petroleum refining process ".
4. James G Speight " The chemistry and technology of petroleum ".
5. J.H. Gary and G.E. Handwerk " Petrolem Refinery Technologies and economics ".
6. Dr. B.K. Bhaskara Rao, Modern Petroleum Refining Processes (5th Edition)
7. Dr. B.K. Bhaskara Rao, A Text Book on Petrochemicals.
8. Marshall Sitting, Dryden's Outlines of Chemical Technology

Subject	**:PGCHE204T** (BCHE)	**ElectiveIII-2.Nano technology(Theory)**	
Lecture	:4 Hours	No. ofCredits	4
University	:60 Marks	CollegeAssessment	: 40 Marks
Duration of Examination: 3 Hours			

CourseObjectives:

To provide knowledge of the concept and properties of nanomaterials. To provide scientific understanding of nanomaterials and nanotechnology applications in agriculture, health, and environmental conservation.

CourseOutcomes:

After completion of the course, students will be able to:

CO	Co Statement
CO1:	Discover Nanotechnology and Nanoscience history
CO2:	Provide the information of Fabrication of Nanomaterial
CO3:	Analysis and characterization of nanoparticles
CO4:	Develop the nanoparticles growth mechanism
CO5:	Elaborate the various nanoparticles for various applications in different field

Unit 1: Introduction to Nanotechnology:

Nano Scale, history and Scope of Nano Technology., Nanomaterials, Morphology, Enhanced properties at nano scale, Comparison with bulk materials.

Unit 2: Fabrication of Nanomaterials:

Top-Down Approach, Grinding, Planetary milling and Comparison of particles, Bottom-Up Approach, Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sono-chemical Approach, Microwave and Atomization, Gas phase Production Methods: Chemical Vapor Depositions.

Unit 3: Introduction to Instrumentation and characterization:

Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, SEM, TEM, AFM, STM, DLS, Spectroscopy. etc.

Unit 4: Kinetics at Nanoscale:

Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH

Unit 5: Carbon Nanomaterials Synthesis of carbon buckyballs:

List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nano-cones Difference between Chemical Engineering processes and nano-synthesis processes. Applications of Nano Technology. Applications in Chemical Engineering like nano-catalyst, bio analytical tools, nano/micro arrays, nanodevices, lab-on-a-chip.

Books Recommended:

1. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
5. Poole C., and Owens F., Introduction to Nanotechnology, John Wiley, New Jersey, 2003.
6. Singh Nalwa, 10 Volume Enclypedia of Nanoscience and NanoTechnology, 2004.Catherine Brechignac, Philippe Houdy, Marcel Lahmani (Editors)Nanomaterials and Nanochemistry, Springer-Verlag Berlin Heidelberg, 2007.

Subject **:PGCHE204T** (BCHE) **ElectiveIII-**3.**Multiphase Flow(Theory)**

Lecture :4 Hours No. ofCredits 4

University :60 Marks CollegeAssessment : 40 Marks

Duration of Examination: 3 Hours.

Course Objective:

Multiphase flow and heat transfer is an area of interests in fluid dynamics and heat transfer where several different phases co-exist. Although these transport phenomena can be seen our every day-life, for instance, from water boiling in a kitchen and blood streaming in a body to the operation of huge power plants, surprisingly we have little knowledge of multiphase flow since the physical understanding of the phenomena is extremely challenging.

Course Outcomes:

CO1: Describe the most important phenomena and principles of two-phase flow in engineering applications.

CO2: Explain the main points of boiling and condensation, heat transfer, and their enhancement methods.

CO3: Describe the concept boiling crisis (e.g., DNB - departure from nucleate boiling, and dryout) and its modeling.

CO4: Apply the basic two-phase models and flow pattern maps to calculate the pressure drops of two-phase flow at various conditions.

CO5: Apply the models of critical flow and flooding to analyze limiting flow of engineering processes and the learning outcomes to write a scientific review for a topic (to be Identified) in the field of two- phase flow and heat transfer.

Unit1: Two phase flow: Gas/Liquid and Liquid/liquid systems: Flow patterns in pipes, analysis of two phase flow situations

Unit2: Prediction of hold up and pressure drop orvolume fraction, Bubbles izeinpipe flow, Lock chart-Martin elliparameters, Bubble column and its design aspects, Minimum carry over velocity. Hold upratios, pressure drop and transport velocities and their prediction.

Unit3:Flow patterns-identification and classification-flow pattern mapsand transition- momentum and energy balance - homogeneous and separated flow models -correlations for use with homogeneous and separated flow models-void fraction and slip ratio correlations - influence of pressure gradient - empirical treatment of two phase flow - drift flux model -correlationsforbubble, slug and annular flows

Unit4: Introduction to three phase flow, Dynamics of gas-solid liquid contactors (agitated vessels, packed bed, fluid izedbed, pneumatic conveying, bubble column, trickle beds), Flow regimes, pressure drop, holdup, distributions, mass and heat transfer, reactions, Applications of these contactors

Unit5: Measurement techniques in multiphase flow:Conventional and novel measurement techniques for multiphase systems (Laser Doppler anemometry, Particle Image Velocimetry)

RecommendedBooks:

1. R.Clift,M.E.Weber,J.R.Grace,Bubbles,Drops,andParticles,Academic Press,NewYork,1978.
2. Y.T.Shah,Gas-Liquid-Solidreactorsdesign,McGrawHill Inc,1979
3. L.S.Fan,C.Zhu,PrinciplesofGas-solidFlows,Cambridge UniversityPress,1998
4. G. W. Govier, K. Aziz, The Flow of Complex Mixture in Pipes, Van Nostrand Reinhold,NewYork, 1972.

5. G.B.Wallis,OneDimensionalTwoPhaseFlow,McGraw HillBookCo.,NewYork,1969.
6. C.T.Crowe,M.Sommerfeld,Y.Tsuji,MultiphaseFlowswithDropletsandParticles,CRCPress,1998
7. C.Kleinstreuer,Two-phaseFlow: TheoryandApplications,Taylor&Francis,2003
8. M.Rhodes,Introductionto ParticleTechnology,John Wiley&Sons, New York.1998.

Subject **:PGCHE204T** (BCHE) **Elective III-**4.**Fuel Cell Technology (Theory)**

Lecture :4 Hours No. of Credits 4

University : 60 Marks College Assessment:40Marks

Duration of Examination: 3 Hours

Course Objectives: Provide thorough understanding of performance characteristics of fuel cell power plant and its components. Outline the performance and design characteristics and operating issues for various fuel cells. Discuss the design philosophy and challenges to make this power plant economically feasible. The design and analysis emphasis will be on the thermodynamics and electrochemistry. Thus at the successful end of the course, the students will have sufficient knowledge for working in a fuel cell industry or R&D organization.

Course Outcomes:

By the conclusion of this course, each student should

CO1: Apply know-how of thermodynamics, electrochemistry, heat transfer, and fluid mechanics principles to design and analysis of this emerging technology.

CO2: Have thorough understanding of performance behavior, operational issues and challenges for all major types of fuel cells.

CO3: Identify, formulate, and solve problems related to fuel cell technology keeping in mind economic viability.

CO4: Use the techniques, skills, and modern engineering tools necessary for design and analysis of innovative fuel cell systems.

CO5: Understand the impact of this technology in a global and societal context and develop enough skills to design systems or components of fuel cells.

Unit1: Hydrogen Production Methods Production: from fossil fuels, electrolysis, thermal decomposition, photochemical, photocatalytic, hybrid; Hydrogen Storage Methods Storage: Metal hydrides, Metallic alloy hydrides, Carbon nano-tubes; Sea as the source of Deuterium.Introduction and overview of fuel cells technology: low and hight emperature fuel cells.

Unit2: Fuel cell thermodynamics. Fuel cell reaction kinetics: Introduction to electrode kinetics.Exchange current and electrocatalysis, Simplified activation kinetics, Catalyst electrodedesign. Fuel cell thermodynamics - second law analysis of fuel cells, efficiency of fuelcells fuel cell electrochemistry - Nernst equation, Electrochemical kinetics,Butler-Volmerequation

Unit3: Fuel cell types Classification by operating temperature/electrolyte type, Fuel Cell Performance, Activation, Ohmic and Concentration over potential Fuel cell charge andmasstransport. Fuel cell characterization.

Unit4: Fuel cell modeling and system integration:Balance of plant.

Unit5: Safety issues and cost expectation and life cycle analysis of fuel cells. Description of somecommercially available fuel cell stacks, overview on research activities on fuel cells inworld, Research and development relatedto fuel cell development inIndia

RecommendedBooks:

1. R.P.O'Hayre,S.Cha,W.Colella,F.B.Prinz,Fuel CellFundamentals,Wiley,NY,2006.

2. A.J.Bard, L.R.Faulkner,ElectrochemicalMethods,Wiley, N.Y. 2004.

3. S.(Ed)Basu,FuelCellScienceandTechnology,Springer,N.Y.2007.

4. H.Liu,Principlesoffuel cells,Taylor&Francis, N.Y.2006.

Subject	**:PGCHE 205T** (BCHE)	**Research Methodology(Theory)**	
Lecture	:4 Hours	No. ofCredits	4
University	:60 Marks	CollegeAssessment	: 40 Marks
Duration of Examination: 3 Hours			

Course Objective: The course focuses on social science research methods. Methods discussed include interview, content analysis, focus group discussions and surveys.

Course outcomes

By the end of the subject students should be able to:

CO1: Demonstrate the ability to choose methods appropriate to research aims and objectives
CO2: Understand the limitations of particular research methods
CO3: Develop skills in qualitative and quantitative data analysis and presentation
CO4: Develop advanced critical thinking skills
CO5: Demonstrate enhanced writing skills

Unit1:Research Foundation

What is Research, Objectives of Research, Types of Research, Scientific Research, Researchand Theory, Conceptual and theoretical Models, Importance of research methodology inscientificresearch

Unit2:Review of Literature

Need for Reviewing Literature, What to Review and for what purpose, Literature Search Procedure, Sources of Literature, Planning of Reviewwork, Note Taking, Library and documentation

Unit3: Planning of Research

The planning process, Selection of a Problem for Research, Formulation of the SelectedProblems,Hypothesis formation, Measurement,Research Design/Plan

Unit4:Processing of Data and Statistical Analysis of Data

Introduction to Statistical Software, MINITAB, SPSS, Measures of Relationship, SimpleRegression Analysis, Multiple Correlation andRegression, Partial Correlation, MATLABand Neural Network based optimization, Optimization of fuzzy systems, Error Analysis,Results and their discussions

Unit5:Report and Thesis writing

Types of Reports, Planning of Report Writing, Research Report Format, Principles of Writing, Data and Data Analysis Reporting in a Thesis, Use of Endnote, Bibliography, API ,appendix, table, Observations arrangement, Preparation of type script and lay-out of thesis,Useof LATEX Indexing ofJournals,Impact factorandsocial Media for Researchers.

Recommended Books:

1. Research Methodology: Methods and Techniques by C.R.Kothari, New Age International Publishers, ISBN:81-224-1522-9
2. Statistical Methods for Research Workers by Fisher R.A.,Cosmo Publications,New Delhi ISBN:81-307-0128-6
3. Design and Analysis of Experiments by Montogomery D.C.(2001), John Wiley,ISBN:0471260088
4. MINITAB online manual
5. Methodology of Research in Social Sciences by O.R.Krishnaswamy and M.Rangnatham Himalaya publication House, 2005,ISBN: 818488093

THIRD SEMESTER M.Tech Chemical Engineering

Subject :PGCHE 301TOPEN Elective IV-1. Waste to Energy (Theory)

Lecture	:4 Hours	No.of Credits	4
University	:60 Marks	College Assessment	: 40 Marks

Duration of Examination: 3 Hours

Course Objectives- The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. Case studies will be discussed to provide a better understanding of the concepts of "Waste to Energy" in the Indian context

Course Outcomes:

After completion of the course, students will be able to:

CO1: To understand of the concept of Waste to Energy.

CO2: To link legal, technical and management principles for production of energy form waste.

CO3: To learn about the best available technologies for waste to energy.

CO4: To analyze of case studies for understanding success andfailures.

CO5: To facilitate the students in developing skills in the decision making process of waste to energy.

UNIT 1-Introduction : The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source.

UNIT 2 Waste Sources & Characterization : Waste production in different sectors such as domestic, industrial, agriculture, post-consumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria.

UNIT 3 Technologies for Waste to Energy : Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation. Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies.

UNIT 4 Waste to Energy Options : Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversionof wastes to fuelresourcesforother useful energy applications.Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery.Energy Recovery from wastes and optimization of its use, benchmarking and standardization. Energy Analysis.

UNIT 5 : Case Studies– Success/failures of waste to energy Global Best Practices in Waste to energy production distribution and use. Indian Scenario on Waste to Energy production distribution and use in India. Success and Failures of Indian Waste to Energy plants.Role of the Government in promoting 'Waste to Energy'

RecommendedBooks:

1. Marc J Rogoff Dr and Francois Screve, Waste-to-Energy: Technologies and Project Implementation"2011.
2. Naomi B Klinghoffer, Marco J Castaldi, Waste to Energy Conversion Technology (Woodhead Publishing Series in Energy) Paperback – Import, 30 October 2018

3. Marc J. Rogoff and Francois Screve, Waste-to-Energy: Technologies and Project Implementation,31 December 1987

Websites: www.envfor.nic.in, www.cpcb.nic.in, www.mnre.gov.in

Subject :PGCHE 301T OPEN Elective IV-2. Energy Conservation & Planning (Theory)

Lecture	:4 Hours	No.of Credits	4
University	:60 Marks	College Assessment	: 40 Marks

Duration of Examination: 3 Hours

Course Objective: The subject aims to provide the student with the knowledge of existing and upcoming industrial utility and energy management theory that allows the student to have a solid theoretical knowledge and be able in the future to design and development of various energy management technologies. The skill to identify, formulate and solve fields problem in a multi-disciplinary frame individually or as a member of a group

Course Outcomes (COs): After learning this course the students will be able to:

CO1. Understand energy scenario and policy
CO2. Understand the significance and procedure for energy conservation and audit.
CO3. Understand causes and remedies for global energy issues.
CO4. Analyze, calculate and improve the energy efficiency and performance of electrical utilities.
CO5. Analyze, calculate and improve the energy efficiency and performance of mechanical utilities.

Unit 1: Energy Outlook,Energy conservation andits importance, Energy intensive industries

Unit 2: Global industrial energy efficiency benchmarking, Engineering fundamentals related to energy efficiency

Unit3: Principles on energy management, Energy Audit, Detailed thermodynamic an alyses of commonunit operations

Unit 4: Opportunities and techniques/methods for energy conservation in equipment and utility systems in process industries, Process synthesis, Thermo- economics, Energy Management Information Systems (EMIS).

Unit5: Software tools for industrial energy efficiency and savings, Case studies on energy conservation and management in process industries

Recommended Books:

1. W.F.Kenney,Energy Conservationin the Process Industries. Academic PressInc.,1984.
2. Vladimir S. Stepanov, Analysis of Energy Efficiency of Industrial Processes. 1st Edition, Springer-Verlag,1993.
3. Jakob de Swaan Arons, Hedzer van der Kooi, Krishnan Sankaranarayanan, Efficiency and Sustainability in the Energy and Chemical Industries, 1st Edition, Marcel Dekker, Inc., 2004.

Subject **:PGCHE 301T** **OPENElectiveIV-3. Green & Cleaner Technology (Theory)**

Lecture	:4 Hours	No.ofCredits	4
University	:60 Marks	CollegeAssessment	: 40 Marks

Duration of Examination: 3 Hours.

Course Objectives:To provide an ideaon Green Technology with an approach towards the design, manufacturing and use of chemical products to reduce or eliminatethechemical hazards intentionally. Green Technology is a new and rapidly emerging branch of chemistry. The goal of GreenTechnology is to create better and safechemicals while choosing the safest and themost efficient ways to synthesize them. The main goal of Green Technology is to eliminate hazards right at the design stage. The principles of Green Technology demonstratehow chemical production could be achieved without posing hazard to human health and environment.

Course Outcomes On completion of this course, the students will be able to:

CO1. Understand the Principles of Green Technology and Green Engineering:
CO2. Understand the conceptual clarity about Green Synthesis and Catalysis
CO3. Analyze the learning and understand techniques for Green Industrial Processes
CO4. Apply the Concepts of Cleaner Technologies
CO5: Understand the Challengesand Practical Implementation

UNIT1Principles of Green Technology and Green Engineering: To learn tomodify the processes and products to make them green safe and economically acceptableto the society, Concepts of green chemistry and Process intensification.

UNIT2 Green Synthesis and Catalysis: Green oxidation and photochemical reactions, Microwave and Ultrasound assisted reactions, Synthesis of Green Reagents, Green solvents,Green nanotechnologyandIonic liquids.

UNIT3 Green Industrial Processes: Pollution statistics from various industries like polymer, textile,pharmaceutical, dyes, pesticidesandwastewater treatment. A greener approachtowards all these industries.

UNIT4 Concepts of Cleaner Technologies: Cleaner Production (CP), Definition, methodology, Role of CP in Achieving Sustainability, Benefits, Role ofIndustry, Government and Institutions, Environmental Management Hierarchy, Relationof CP and EMS. CP case studies: Ammonical nitrogen recovery from wastewater, Fluorideremoval from wastewater, Reuse of water from sewage treatment plant, Gas quenching process: replacement of oil with nitrogen and Reduction of hydrogen cyanide from process stack. Reuse of liquid industrial waste from several industries.

UNIT5 Challenges and Practical Implementation: Responsibilities andpotentialsof companiesfor action. Green Productivity and emerging technologies. Implementation of the practical applications of Green emerging technologies and sustainable development.Case studies in Green Technology. Green lawscompliance.

Text Books

1. Introduction to Green Chemistry,Matlack A.S. Publisher:Marcel Dekker,Newyork, 2001.
2. Green Chemistry: Theory and Practice, Anastas P.T. and WarnerJ.C.OxfordUniversity Press, 1998.
3. Pollution Prevention: Fundamentals and Practice, BishopP. L.McGraw-Hill, Boston,2000.
4. Cleaner Production Audit Environmental System Reviews, Modak P., Visvanathan C. and Parasnis M. Asian Institute of Technology, Bangkok, 1995.
5.Handbook of Green Chemistry and Technology, Clark J.H. and Macquarrie D.J.Wiley-Blackwell Publishers, 2002

Subject **:PGCHE 302T**(BCHE) **Project Planning and Management(Theory)**

Lecture	:4 Hours	No.ofCredits	4
University	:60 Marks	CollegeAssessment	: 40 Marks

Duration of Examination: 3 Hours

Course Objectives: To make them understand the concepts of Project Management for planning to execution of projects. To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation. To enable them to comprehend the fundamentals of Contract Administration, Costing and Budgeting. Make them capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.

Course Outcomes On completion of this course, the students will be able to:
CO1. Understand project characteristics and various stages of a project.
CO2. Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
CO3. Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
CO4. Apply the risk management plan and analyze the role of stakeholders and understand the contract management, Project Procurement, Service level Agreements and productivity.
CO5: Understand the How Subcontract Administration and Control are practiced in the industry.

Unit1:Basics of Project Management: Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager(PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project ManagementPhilosophy,Project Management Principles

Unit2:Project Identification and Selection: Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, ProjectBreak-even point

Project Planning: Introduction, Project Planning, Need of Project Planning, Project LifeCycle, Roles, Responsibility and Team Work, Project Planning Process, Work BreakdownStructure(WBS)
Organisational Structure and Organisational Issues: Introduction, Concept of Organisational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers,Conflict Resolution, Team

Unit 3:Resources Considerations in Projects: Introduction, Resource Allocation, Scheduling, Project Cost Estimateand Budgets, Cost Forecasts

Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Managementin Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks

Unit4:Project Quality Management and Value Engineering: Introduction, Quality, Quality Concepts,Value Engineering

Project Management Information System: Introduction, Project Management Information System (PMIS), Planning of PMIS, Design of PMIS.

Purchasing and Contracting for Projects: Introduction, Purchase Cycle, Contract Management, Procurement Process

Unit5: Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects

Project Execution and Control: Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control

Project Close-out, Termination and Follow-up: Introduction, Project Close-out, Steps forClosingthe Project, Project Termination, ProjectFollow-up

Project Management Software: Introduction, Advantages of Using Project ManagementSoftware, Common Features Available In Most of the Project Management Software, Project 2000.

ReferenceBooks:

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, by John W. Creswell, 2nd Edition , Sage Publication, 2003
2. Qualitative Inquiry and Research Design: Choosing among Five Approaches, byJohn W.Creswell, 3rd Edition, Sagepublication, 2013.
3. Evaluation: ASystematic Approach, Peter H.Rossi,MarkW.Lipsey, and Howard E.Freeman,7th edition , Sage publications, 2007.
4. Hand book of Practical Program Evaluation, Joseph S.Wholey, Harry P.Hatry, Kathryn E.Newcomer. 4th edition, Wiley, 2015
5. Program Evaluation and Performance Measurement :An Introduction to Practice, James C.McDavidand Laura R.L. Hawthorn,Sage Publication, 2013.
6. Evaluation,CarolH. Weiss,2nd Edition,AB Ebooks, 1997.
7. Case Study Research:Design and Methods, RobertK.Yin,3rd Edition,Sage Publications,2011

Subject	**:PGCHE 303P**(BCHE)	**Project Seminar**	
Practical	:3 Hours	No.of Credits	: 8
University	:100 Marks	College Assessment	:100 Marks

Each student will undertake an independent project seminar. The student is required to select thetopic in consultation with his/her Guide. Student should undertake project concerning Chemical Engineering applications such as design and development, experimental work, industry based problems, generation of new ideas and concept, modification in the existing process/system, development of computer programs, modelling and simulation etc. A preliminary work is to becarried out in this stage of the project. Two neatly typed copies of the Report on the completed work at this stage include comprehensive report on literature survey, design and fabrication of experimental setup and/or development of model, relevant computer programs and the plan for stage II should be submitted at end on the 3rd semester. University and college assessment would be made on the basis of the submitted report and the presentation cum viva-voce examination conducted bythe board of examiners.

FOUTH SEMESTER M.Tech Chemical Engineering

Subject	**:PGCHE 401P**(BCHE)	**Project**	
Practical	:6Hours	No.ofCredits	: 16
University	:200Marks	CollegeAssessment	:200Marks

Project work undertaken in the 3rd semester will be continued and completed at the end of fourthsemester. This stage will include comprehensive report on the work carried out at this stage and relevant portions from project seminar stage, including experimental studies, analysis and/or verification of theoretical model, conclusions. Two neatly typed and bound copies of the reportconsisting of project seminar stage of 3rd semester and project stage from 4th semester combinedtogether along with its soft copy should be submitted at the end of fourth semester. The student are expected to publish at least on enational/international paper based on the project work. The publication/accepted paper for publication shall be included in the report. University and collegeassessment would be made on the basis of the submitted report and the presentation cum viva-voceexaminationconducted bythe board of examiners.

COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

INDUSTRIAL DRIVES & CONTROL

Of

RASHTRASANT TUKDOJI MAHARAJ

NAGPUR UNIVERSITY, NAGPUR

Lokmanya Tilak JankalyanShikshan Sanstha's

PRIYADARSHINI COLLEGE OF ENGINEERING, NAGPUR
(An Autonomous Institute affiliated to RashtrasantTukadoji Maharaj Nagpur University)

SCHEME OF EXAMINATION

I Semester M.Tech.Industrial Drives &Control (IDC) (CBCS)

Sr. No.	Course Code	Course Name	Contact Hours				Marks				Total Marks	ESE Duration
							Theory		Practical			
			L	T	P	Credits	CE	ESE	ECE	ESE		
1	23PID101T	AdvancedPower Electronics	3	0	0	3	40	60	-	-	100	3
2	23PID102T	DCDrives	3	0	0	3	40	60	-	-	100	3
3	23PID103T	Research Methodology andIPR	3	0	0	3	40	60	-	-	100	3
4	23PID11XT	ProgramElective-I	3	0	0	3	40	60	-	-	100	3
5	23PID12XT	ProgramElective–II	3	0	0	3	40	60	-	-	100	3
6	23PID13XA	AuditCourse	2	0	0	-	-	-	-	-	-	-
7	23PID101P	Advanced PowerElectronics Lab.	0	0	2	1	-	-	25	25	50	-
8	23PID102P	DCDrives Lab.	0	0	2	1	-	-	25	25	50	-
		Total	**17**	**0**	**4**	**17**	**200**	**300**	**50**	50	**600**	-

Course Code	Program Elective - I
23PID111T	Analysis of Electrical Machines
23PID112T	Mathematical Modeling of Electrical Machines
23PID113T	EnergyManagement in Electrical System

Course Code	Program Elective – II
23PID121T	Advance Control Theory
23PID122T	Intelligent Control of Drives
23PID123T	Optimization Techniques

CourseCode	AuditCourses
23PID131A	EnglishforResearchPaperWriting
23PID132A	DisasterManagement
23PID133A	ValueEducation

SCHEME OF EXAMINATION

II Semester M. Tech.Industrial Drives & Control (IDC) (CBCS)

Sr. No.	CourseCode	Course Name	Contact Hours				Marks				Total Marks	ESE Duration
							Theory		Practical			
			L	T	P	Credits	CE	ESE	CE	ESE		
1	23PID201T	DrivesSystemDesign	3	0	0	3	40	60	-	-	100	3
2	23PID202T	ACDrives	3	0	0	3	40	60	-	-	100	3
3	23PID203T	Electrical Transportation	3	0	0	3	40	60	-	-	100	3
4	23PID21XT	ProgramElective–III	3	0	0	3	40	60	-	-	100	3
5	23PID22XT	ProgramElective-IV	3	0	0	3	40	60	-	-	100	3
6	23PID23XA	AuditCourse	2	0	0	-	-	-	-	-	-	-
7	23PID202P	ACDrives Lab.	0	0	2	1	-	-	25	25	50	-
8	23PID204P	Computer Aided Design Lab.	0	0	2	1	-	-	25	25	50	-
Total			**17**	**0**	**4**	**17**	**200**	**300**	**50**	**50**	**600**	**-**

CourseCode	ProgramElectiveIII
23PID211T	Design of Synchronous and Asynchronous Machines
23PID212T	Switch Mode Power Converter and Applications
23PID213T	Converter for Renewable Energy Sources

CourseCode	ProgramElectiveIV
23PID221T	Advance Electrical Drives
23PID222T	Digital Control System
23PID223T	Industrial Automation

CourseCode	AuditCourses
23PID231A	Pedagogy Studies
23PID232A	Stress Management by Yoga
23PID233A	Personality Development through Life Enlightenment Skills

SCHEME OF EXAMINATION

III Semester M. Tech.Industrial Drives & Control (IDC) (CBCS)

Sr. No.	Course Code	Course Name	Contact Hours				Marks				Total Marks	ESE Duration
							Theory		Practical			
			L	T	P	Credits	CE	ESE	CE	ESE		
1	23PID31XT	ProgramElective-V	3	0	0	3	40	60		-	100	3
2	23PID33XA	Open Elective	3	0	0	3	40	60	-	-	100	3
3	23PID32XP	Program Elective Lab	0	0	2	1	-	-	25	25	50	-
4	23PID301P	Project-Phase-I	0	0	18	9	-	-	100	-	100	-
		Total	**6**	**0**	**20**	**16**	**80**	**120**	**125**	**25**	**350**	-

CourseCode	ProgramElectiveV
23PID311T	Controllers for Electrical Drives
23PID312T	Special Electric Machines & Drives
23PID313T	Excitation of Synchronous Machines and their control

CourseCode	ProgramElectiveLab
23PID321P	Controllers for Electrical Drives
23PID322P	Special Electric Machines & Drives

CourseCode	OpenElective
23PID331A	Business Analytics
23PID332A	Industrial Safety
23PID333A	Operations Research
23PID334A	Cost Management of Engineering projects
23PID335A	Composite Materials
23PID336A	Waste to Energy.

SCHEME OF EXAMINATION w.e.f. 2023-24 onwards

IV Semester M. Tech.Industrial Drives & Control (IDC) (CBCS)

Sr. No.	Course Code	Course Name	Contact Hours				Marks				Total Marks	ESE Duration
							Theory		Practical			
			L	T	P	Credits	CE	ESE	CE	ESE		
1	23PID401P	Project-Phase-II	0	0	34	17	0	0	200	200	400	-
		Total	**0**	**0**	**34**	**17**	0	0	**200**	**200**	**400**	-

First Semester M.Tech. IDC

CourseCode:23PID101T **Course**:**Advanced Power Electronics**

Credits: 3 **Teaching Scheme: L – T – P :3-0-0**

Course Objective:

1 To overview various power semiconductor devices for power electronic applications.

2 Performance and analysis of low and high Frequency switched power electronic converters for various applications.

3 Selection of drives and powerconverter forparticularapplication.

4 Operation& design of electric motor drives-controlled fed by power electronic converter.

CourseOutcome:

After the completion of this course,the students shall be able to:

1. Select various power semiconductor switches on the basics of their characteristics
2. Utilise various ac-ac converters as per applications performance.
3. Analyse performance of dc-dc converters and its applications.
4. Classify soft switching converters, analyse their performance and applications.
5. Analyse performance of inverters and selection of PWM as per its applications.

Unit-I

Power Semiconductor Devices: Characteristics, protection and industrial applications of power devices.Various pulse width modulation techniques for different converter topologies.

Unit-II

AC-AC Converters: Introduction, single and three-phase ac–ac voltage controllers, Cyclo-converter, Matrix converters application of ac-ac converters.

Unit-III

DC-DC Converters: Introduction, step-down converters-Buck,transformer version of buck converters, step up converters, Buck-Boost converters, application of dc to dc converters

Unit-IV

Resonant and soft switching converters: Introduction, classification, resonant switch-ZC Resonant switch, ZV Resonant switch, Quasi resonant converters, multiresonant converters, load resonant converters and their applications.

Unit-V

DC-AC converters: Introduction, classification, single-phase VSI (Half & Full Bridge), Three-phase VSI with SPWM, SVPWM, Selective harmonic elimination, SPWM with zeros equence signal injection with industrial applications.

TextBooks:

1. “Power electronics handbook by Muhammad Rashid, Academic Press.
2. Modern Power Electronics”by P.C.Sen ,A.H.Wheeler Publishing Co.
3. “Thyristorized Power Controller” by Dubey, Joshi Doradla Sinha PHI Publication

ReferenceBooks:

1. “Power Electronics”Cyril WLander, MHL
2. “Power Electronics”,Ned Mohan,ToraM.Udeland,William P.Riobbins,JohnWiley & sons
3. Related IEEE Papers/NPTEL Lectures.

First Semester M.Tech. IDC

CourseCode:23PID102T **Course:DC Drives**

Credits: 3 **Teaching Scheme: L – T – P : 3-0-0**

Course Objective:

1. Specify the appropriate power circuit on figuration amongst the phase controlled rectifiers and choppers for the speed control of DC motor drives for four-quadrant operation with current limit
2. Design the control circuit and the power circuit for DC-DC converters.
3. Critically compare various options available for the drive circuit requirements

Course Outcome:

After the completion of this course, the students shall be able to:

1. Analyze transient performance of AC and DC machine
2. Analyze dynamic performance of DC motor
3. Obtain transient performance of single phase SCR drives
4. Implement various power factor improvement methods for drives.
5. Analyze transient performance of three phase SCR drives

Unit-I

Transient Analysis of D.C. Motor: Performance & analysis of A.C. & D.C. Commutator machines – Compound wound D.C. motor, Steady state analysis of D.C. shunt motor, D.C. series motor, Transient analysis, Stability of Compound wound D.C.motor, Universal Motor, Separately excited D.C. Generator.

Unit-II

Dynamics of D.C. machine: Separately excited D.C. motor, Series excited D.C. motor, Ward-Leonard System. Machine matrices, system equation,Transient analysis.

Unit-III

Single Phase SCR Drives: One quadrant and two quadrant drive–Continuous current & Discontinuous current mode of operation for separately excited DC motors, Transient performance.

Unit-V

Three Phase SCR Drives: Principle and operation of semiconverter, full-converter and Dual converter drives. Comparison of circulating and non-circulating current dual converter Reversible drives–armature & field current reversal scheme using dual-converters.

Unit-IV

Power Factor Improvement: PF improvement of full converter & Semi-converter drive circuits – phase angle control, Semi converter operation of full converter. Asymmetrical firing, extinction angle control, Symmetrical angle control, PWM control, sequence control of series converter.

Reference Books:

1. Analysis of thyristor power conditioned Motors: S.K.Pillai,Longman Ltd.
2. Control of Electrical Drives: Werner Leonhard, Electric Energy System & Engg., Series Springer Verlag Berlin Heidelberg,NewYork.
3. Electrical Drives: Vedam Subramanian.
4. Electrical Motors Drives (Modeling Analysis and Control) by-R.Krishnan,Practice Hall India.

First Semester M.Tech. IDC

Course Code:23PID111T | **Course:Program Elective – I**

Credits: 3 | **Analysis of Electrical Machines**

Teaching Scheme: L – T – P : 3-0-0

Course Objective:

1 To provide knowledge about fundamentals of magnetic circuits, energy, force and torque.

2 To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.

3 To provide the knowledge of theory of transformation of three phase variables to two phase variables.

4 To analyze the steady state an dynamic state operation of three-phase induction machines using transformation.

5 To analyze the steady state and dynamic state operation of synchronous machines using transformation theory

Course Outcome:

After the completion of this course,the students shall be able to:

1 Apply theory of transformation for machine analysis.

2 Obtain state model of electrical machine including mathematical representation for voltage, toque, impedance matrix and flux linkages.

3 Represent synchronous machines by state model using transformations.

4 Simulate synchronous Determine machine parameters from data sheet for single or infinite bu system.

5 Demonstrate synchronous machines with different simplified linear models.

Unit-I

Theory of transformation: Reference frame, electrical network terminology–meshnetwork – the generalized machine of first kind, impedance matrix, impedance matrix of synchronous machine, the flux linkage and flux density matrix, rotation matrix–electromagnetic torque, performance calculation, elimination of axes, analysis using revolving field theory, transformation from the stationary d-q axes to stationary real axes reference frame.

Unit-II

State Modeling of Electrical Machines: Spring and plunger system – rotational motion –mutually coupled coils – lagrange‟s equation- application of Lagranges Equation– solutionof electro-dynamical Equations.Voltage& Torque equation under acceleration – motionalimpedance matrix ofGeneralized machines, state model of generalized machine,Statemodelof Induction motor,Voltage , Flux Linkages & Torque Equation for 3-phase Induction Motor,Dynamics in the machine variables, Mathematical Models of 3-phase Induction Motor in the arbitrary stationary, rotor & synchronous reference frame.

Unit-III

Synchronous Machines: Per unit system and Normalization, Park's Transformation, Fluxlinkage equations, Voltage & Current equations, Formulation of State –space equations, Equivalent circuit, Sub-transient & Transient inductances and time constants, SimplifiedmodelsofSynchronousmachines.

Unit-IV

Steady state equations and phasor diagram, Single machine, Infinite Bus system, Determination of machine parameters from Manufacturer's data, Analogu eand Digital simulation of Synchronous machines.

Unit-V

Linear Model of Synchronous Machines: Linearization of 1)Generator state space current model 2) Load equation for the one machine problem & 3) Flux linkage model,Simplified linear model & its state space representation

ReferenceBooks:

1. Mukhopadhyay A.K.,Matrix Analysis of Electrical Machines, New Age International,1996.
2. Bimbhra P.S.-,Generalized Theory of Electrical Machines, Khanna Publishers,1975
3. S.K.Sen-,Electric Machinery, Khanna Publishers,1998
4. Anderson P.M.& Fouad A.A.–"Power system control & stability"Galgotia Publications 1981

First Semester M.Tech. IDC

CourseCode:23PID112T
Credits: 3

Course:**Program Elective – I**
Mathematical Modeling of Electrical Machines
Teaching Scheme: L – T – P : 3-0-0

Course Objective:

1 Significance of Electrical Machine Modeling
2 Fundamental of D.C. Motor Modeling
3 Elementary theory of Transformation for reference frame for Induction Motor
4 Fundamental of Synchronous Motor Modeling
5 Performance analysis of Synchronous Motor.

Course Outcome:

After the completion of this course,the students shall be able to:

1 Acquire basic concepts of AC/ DC machine modeling.
2 Justify the dynamic modeling and phase transformation
3 Analyze various methodologies in small signal machine modeling.
4 Represent synchronous machine by mathematical modeling in dq0 reference frame
5 Analyze performance and dynamic modeling of synchronous machines

Unit-I

Basic Concepts of Modeling: Basic Two - pole Machine representation of Commutator machines, 3 phase synchronous machine with and without damper bars and 3 - phase induction machine, Kron's primitive Machine - voltage, current and Torque equations.

Unit-II

DC Machine Modeling: Mathematical model of separately excited D.C motor –Steady State analysis - Transient State analysis - Sudden application of Inertia Load - Transfer function of Separately excited D.C Motor - Mathematical model of D.C Series motor, Shunt motor - Linearization Techniques for small perturbations.

Unit-III

Reference Frame Theory: Real time model of a two phase induction machine-Transformation to obtain constant matrices - three phase to two phase transformation - Power equivalence. Dynamic modeling of three phase Induction Machine Generalized model in arbitrary reference frame.

Unit-IV

Modeling of Synchronous Machine: Synchronous machine inductances – voltage equations in the rotor's dq0 reference frame - electromagnetic torque - current in terms of flux linkages - simulation of three phase synchronous machine- modeling of PM Synchronous motor.

Unit-V

Dynamic Analysis of Synchronous Machine: Dynamic performance of synchronous machine, three -phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria

Text Books:

1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis& control", Pearson Publications, First edition, 2002.
2. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", IEEE Press, Second Edition.

Reference Books:

1.P.S.Bimbra, "Generalized Theory of Electrical Machines" Khanna publications, Fifth edition – 1995

2. Chee Mun Ong –"Dynamic simulation of Electric machinery using MATLAB / Simulink", Prentice Hall of India Publications.

3. Online courses on Modeling of Electrical Machines -http://nptel.ac.in/courses/108106023/

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First Semester M.Tech. IDC

CourseCode:23PID113T **Course:Program Elective – I**

Credits: 3 **Energy Management in Electrical System**

Teaching Scheme: L – T – P : 3-0-0

Course Objective:

1 Necessity of industrial Energy Audit, methodology and various tools and instruments used.

2 Acquire concepts of electrical load management and energy efficiency in electrical systems such as induction motors, transformers etc.

3 Apply concepts of energy efficiency in industrial systems such as pumping system, compressor and fan systems, steam distribution systems, AC systems etc.

Course Outcome:

After the completion of this course, the students shall be able to:

1 Acquire significance of energy management & audit and will be able to prepare energy audit report.

2 Utilise various measurement techniques and instruments for energy audit.

3 Analyze various electrical parameters required for energy management.

4 Determine efficiency of the motor under various conditions and hence understand energy management.

5 Analyse energy conversation concept in industrial applications.

Unit-I

Importance of energy management – overview of energy conservation act (2001), Energy auditing, objectives, methodology, steps in energy management, types of energy audit, preliminary energy audit, detailed energy audit, Energy audit report writing – analysis of past data, Identification of energy conservation opportunities, mass and energy balances, examples, Simple payback period calculation

Unit-II

Potential energy and cost savings from energy conservation measures, barriers to energy efficiency, Need for measurements during energy audit, various measuring instruments used for energy audit, Energy monitoring & targeting.

Unit-III

Electrical Systems: Tariff systems, billing elements, load curve analysis, load management, power factor correction, electrical demand and load factor improvement, load scheduling / shifting, Demand side management (DSM), case study, Energy efficiency in transformers, Case study.

Unit-IV

Electric motors: Motors efficiency, idle running, factors affecting induction motor, performance, estimation of motor loading, efficiency at low loads, numerical problems, high efficiency induction motors, rewound motors Variable speed drives for induction motors, advantages and applications, different types of VFD.

Unit-V

Energy conservation in industrial systems, pumping systems, fans (flow control), compressed air systems, Refrigeration and air conditioning systems Cogeneration, concept and advantages, options (steam/gas turbines/diesel engine based), selection criteria Heat exchanger networking, pinch analysis, basic concept only.

References:

1. Y. P. Abbi, S. Jain, Handbook of Energy audit and environment Management, The Energy and Resource Institute, New Delhi, 2006.
2. Guide Book for energy managers &Auditors, Book-1,2,3,4,Revision 2, Bureau of Energy Efficiency, India, 2005.
3. L. C. Witte, P. S. Schmidt, D. R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington,1988.
4. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
5. T.D. Eastop, D.R. Croft, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
6. A. Chakrabarti, Energy Engineering and Management, PHI Learning, Delhi, 2013.

First Semester M.Tech. IDC

CourseCode:23PID121T **Course:Program Elective – II**

Credits: 3 **Advanced Control Theory**

Teaching Scheme: L – T – P : 3-0-0

Course Objective:

1 Modeling of electromechanicalsystemsbymathematical analysis

2 To Determine Transient and Steady State behavior of systems using standard testsignals.

3 Introduction of linear&non-linear systems for steady state errors, absolute estability & relative stability

4 To Identify and design a control system satisfying requirements.

Course Outcome:

After the completion of this course, the students shall be able to:

1 Develop mathematical models of physical systems and obtain State variable analysis

2 Acquire basics of digital control and determine stability of the system

3 Judge the controllability and suggest the improvement for stability of the system

4 Analyse the stability of the system

5 Design optimal controllers for physical systems including power electronic and power systems.

Unit-I

State Variable Analysis: Diagonalization of state model, Computation of STM by Laplace transform, Cayley Hamilton Theorem and Canonical transformation method, Solution of state equation. Controllability, Observability and state variable feedback.

Unit-II

Digital Control Systems: Models of Digital control Devices, State description of Digital processors and sampled continuous time plants, discretization of digital continuous time state equations, Solution of state difference equation, Stability By Bilinear Transformation& J ury‟sTest.

Unit-III

Controllability and observability tests for digital control systems, Stability of discretetime Systems, Pulse transfer function and its realization, Stability improvement by state feedback, Pole-placement design and state observers.

Unit-IV

LyapunovStabilityAnalysis:Basic concepts, Limit cycles, Stability definitions, Stability Theorems, Lyapunov functions for linear and non-linear systems.

Unit-V

OptimalControl:Parameter optimization techniques, Lagrange parameter techniques, Calculus of variations, Unconstrained and Constrained minimization of functional, Two point boundary value problems, Pontryginsminimum principle, Optimal regulat orandtracking problems, Optimal digital control systems.

ReferenceBooks:

1. M.Gopal.;Digital Control and State Variable Methods; Tata McGraw Hill, NewDelhi, 1997.
2. D.E.Kirk.;Optimal Control Theory;PrenticeHall,1970.
3. M.Gopal.;Digital Control Engineering;Wiley Eastern,1988.
4. B.C.Kuo.;Digital Control System Engineering; Saunders College publishing,1992.
5. Advanced Control System,First Edition M.Rihan

First Semester M.Tech. IDC

CourseCode:23PID122T **Course**:**Program Elective – II**

Credits: 3 **Intelligent Control of Drives**

Teaching Scheme: L – T – P : 3-0-0

CourseObjective:

1 Introduction to Microprocessor types and its programming.

2 Applications of various interfacing circuits required for microprocessor & microcontroller.

3 Programming with Microcontroller

CourseOutcome:
After the completion of this course, the students shall be able to:

1 Acquire the causes, effects and remedies of power quality problems.

2 Design a system component or process as per needs and specifications

3 Write Assembly language program for 8051 Microcontroller to achieve solution to given task

4 To acquire functioning of Signal conditioning using specific circuits/transducers and to measure electrical or non-electrical quantities using processor.

5 Applications of microcontroller in various engineering fields

Unit-I

Review of Microprocessor 8085/8086: Introduction To 16 Bit Microprocessors, 8086/8088 CPU Architecture, Memory Organization, Floating point arithmetic, Bus structure & timings, 8086/8088 Instruction Set.

Unit-II

Microcontroller 8031/8051: Microcontroller: 8051 Architecture/Pin Diagram, Special Function Register (SFR), Internal RAM/ROM, 8051 Instruction Set, Interrupts, AssemblyLanguage Programming and their application, Interfacing to External Memory, Programming Techniques for looping, indexing, counting & bitmanipulation.

Unit-III

Basic I/O Interfacing Concept: Memory mapped I/O programmable peripherals, I/O mapped I/O programmable peripherals, Introduction to PPI8254/8255, Architecture, Modes of operation of 8255, Inter facing of peripheral swith 8255, Introduction to PIC8259, Architecture, Modes of operation of 8259,Interfacing of peripherals with 8259, Interfacing of key board & display, ADC/DAC, USART.

Unit-IV

Interfacing of Microcontroller 8031/8051: Interfacing with ADC/DAC display, interfacing with Keyboard, Interfacing with LCD Display & Stepper Motor with 8251, Power factor improvements, Introduction to DSP processor & its application to power system, Generation of PWM signals using Timer/Counter. Harmonics analysis, FFTetc.

Unit-V

Microcontroller PIC33EP256MC202: Microcontroller: Architecture/Pin Diagram, General Input/output ports, Control Registers for PPS, Interrupts, Oscillator, Timer, Generation of High Speed PWM. Applications to Motor Speed Control, AC-DC, DC-AC Conversion, Battery Charger, UPS, INVERTER, and Power factor Correction.

TextBooks:

1. Hall:Microprocessor & Interfacing:Programming & Hrdware;Mc-GrawHill Books.
2. Gaonkar:Microprocessor Architecture, programming Application with 8085, Penraminternational publishing
3. Bhupendra Singh Chhabra:8086/8088 Microprocessor Architecture Programming, Design & Interfacing, Dhanpat Rai & Sons.
4. Ramakant Gaikwad:Op-amps & LinearIC‟s; Prentice Hall of India
5. KennethJ.Ayala:The 8051 Microcontroller-Architecture, Programming & Application: penraminternational publishing (India)
6. Muhammad Ali Mazidi: The 8051 Microcontroller and Embedded Systems Using Assembly & C: Second Edition- Pearson Publication.
7. Data sheets of dsp IC33EPMC202.

First Semester M.Tech. IDC | **Course:Program Elective – II**
Course Code:23PID123T | **Optimization Techniques**

Credits: 3 | **Teaching Scheme: L – T – P : 3-0-0**

Course Objective:

To enable the student to apply analysis tools in optimization of power systems andpower electronic problems.

Course Outcome:

After the completion of this course,the students shall be able to,

1. Explain and use the basic theoretical principles of optimization and various optimization techniques
2. Develop and select appropriate models corresponding to linear problem descriptions in engineering and solve them
3. Develop and select appropriate models corresponding to non-linear problem descriptions in engineering and solve them
4. Utilise Swarm intelligence for optimization
5. Apply various techniques of optimisation

Unit-I

Introduction to optimization, Statement and Classification of Optimization Problems, Overview of Optimization Techniques, Standard Form of Linear Programming Problems-Definitions and Theorems, Simplex Method-Revised Simplex Method-Duality and Dual Simplex Method-Sensitivity Analysis.

Unit-II

Necessary and Sufficient Conditions-Search Methods(Unrestricted Fibonacci and Golden)-Interpolation Methods (Quadratic, Cubic and Direct Root Method), Direct Search Methods-Random Search-Pattern Search and Rosen Brock's Hill Climbing Method Descent Methods-Steepest Descent, Conjugate Gradient, Quasi Newton and DFE Method

Unit-III

Necessary and Sufficient Conditions-Equality and Inequality Constraints-Kuhn-Tucker Conditions. Gradient Projection Method- Cutting Plane Method-Penalty Function Method (Interior and Exterior). Principle of Optimality-Recurrence Relation-Computation Procedure- Continuous Dynamic Programming.

Unit-IV

Swarm Intelligence: Ant Colony Optimization, Swarm intelligence general characteristics, Ant Colony Optimization: Basic Concepts- The Ant Colony System- Ants' Foraging Behavior and Optimization,- The Max-Min Ant System Minimum Cost Paths, Combinatorial Optimization. Major Characteristics of Ant Colony Search Algorithms- Positive Feedback- Rapid Discovery of Good Solution - Use of Greedy Search and Constructive, Heuristic Information- Ant Colony Optimization Algorithms Applications.

Unit-V

Particle swarm optimization: -Fundamentals- Concepts of PSO-Comparison, with Genetic Algorithm-Application and Implementation. Firefly Algorithm –Basic Concepts-Application in optimization, powerelectronics and power system problems.

Reference Books:

1. R. Fletcher, “Practical Optimization”, Second edition, John Wiley and Sons, New York, 1987.

2. S. S. Rao, “Engineering Optimization-Theory and practice”, fourth edition, Wiley Easter Publications, January 2009. 3. K. V. Mital and C. Mohan, “Optimization Methods in Operations Research and System Analysis”, New age International Publishers, Third edition, 1996.

4. Bazaraa M. S., Sherali H.D. and Shetty C. “Nonlinear Programming Theory and Algorithms”, John Wiley and Sons, New York 1993.

5. Bertsekas D. P., “Constrained Optimization and Lagrange Multiplier Methods”, Academic Press, New York, 1982.Durga Das Basu, “Introduction to the Constitution of India” Prentice Hall EEE, 19th/20th Edn., 2001.

First Semester M.Tech IDC

Course:Research Methodology and IPR

Teaching Scheme: L – T – P : 4-0-0

Course Objectives:

Theobjectiveofthiscourse istoprovide studentswith:

1. An insight into how scientific research is conducted
2. Knowledge of Research Process,Concepts, diversere search task sand equip the mtounder takere search.
3. Understanding the concepts of Data collection, system modeling and reliability.
4. To develop an understanding for the optimization methods in research work.
5. Methods for presentation of research results.

Course Outcomes: By the end of the course, the students shall be able to

1. Understand research problem formulation.
2. Analyze rseach related information
3. Follow research ethics
4. Understand that today"s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of in formation about Intellectual Property promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about,economic growth and social benefits.

Unit-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives ofresearch problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Unit-II

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Unit-III

Effective technical writing, how to write report, Paper Developing a Research Proposal,Formatof research proposal, apresentation and assessment by a review committee

Unit-IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Process of Patentingand Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit-V

Patent Rights: Scope of Patent Rights. Licen sing and transfer of technology. Patent in formation and databases. Geographical Indications., New Developments in IPR:Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Softwareetc. Traditional knowledge Case Studies, IPR and IITs.

Text books:

1. T.Ramappa,“Intellectual PropertyRightsUnderWTO”,S. Chand,2008.

ReferenceBooks:

1. Stuart Melville and Wayne Goddard,“Research methodology: an introduction for science & engineering student.
2. Wayne Goddard and Stuart Melville,“Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition,“Research Methodology:AStep by Step Guide for beginners”
4. Halbert,“Resisting Intellectual Property”,Taylor & Francis Ltd, 2007.

First Semester M.Tech. IDC

Course Code:23PID131A **Audit Course:English for Research Paper Writing**

Teaching Scheme: L – T – P : 2-0-0

Course objectives:

Students will be able to:
1. Underst and that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Underst and the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission.

Course outcomes: Students will be able to

1. Understand & differentiate between literarypiece of writing& Technical Writing.
2. Write technical documents in clear, concise & effective manner
3. Design own style of writing to informor instruct an audience with a specific goalinmind.
4. Will be able to write proposals.
5. Will be able to design, create and write technical manuals.

Unit-I

Planning and Preparation,Word Order, Breaking uplong sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity andVagueness.

Unit-II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

Unit-III

Review of the Literature, Methods, Results, Discussion, Conclusions, TheFinal Check.

Unit-IV

Key skills needed for writing a Title, Abstract, Introduction, Review of the Literature, methods, Results, Discussion, Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

Suggested Studies:

1. Goldbort R(2006)Writing for Science, Yale University Press (availableonGoogleBooks)[40] ModelCurriculumof Engineering & Technology PG Courses [Volume-I]
2. Day R (2006)How toWrite and Publish a Scientific Paper, Cambridge University Press
3. Highman N(1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman‟s book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

First Semester M.Tech. IDC

Course Code:23PID132A **Audit Course:Disaster Management**

Teaching Scheme: L – T – P : 2-0-0

Course Objectives:-Students will be able to:

1. Demonstrate a critical understanding of key concepts in disaster risk reductionandhumanitarian response.
2. Critically evaluate disasterriskr eduction and human itarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance inspecific types of disasters and conflict situations.
4. Critically underst and the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or thecountriestheyworkin.

Course outcomes:

Students will be able to
1.To work as a think tank for the society by providing assistance in policy formulation.
2.Develop ability and understanding of disastermitigation and management.

Unit-I

Introduction-Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters:Difference, Nature,Types and Magnitude.

Unit-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Humanand Animal Life, Destruction of Ecosystem. Natural Disasters:Earthquakes,Volcanisms,Cyclones,Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster:Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks Of Disease And Epidemics,Warand Conflicts.

Unit- III

Disaster Prone Areas in India: Study of Seismic Zones; Areas Proneto Floods And Droughts, Landslides And Avalanches; Areas Prone to Cyclonic and Coastal Hazards With Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

Unit-IV

Disaster Preparedness and Management: Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluationof Risk: Application of Remote Sensing, DataFrom Meteorological and other Agencies, Media Reports: Governmental And Community Preparedness.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies""'New Royal book Company. Model Curriculum of Engineering & Technology PG Courses[Volume-I]
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, NewDelhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt.Ltd.,New Delhi.

First Semester M.Tech. IDC

Course Code:23PID133A **Audit Course:Value Education**

Teaching Scheme: L – T – P : 2-0-0

Course Objectives:

1. To Understand value of education and self-development
2. To Imbibe good values in students
3. To beaware of importance of character

Course outcomes:

By the end of the course, the students shall be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality.

Unit-I

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moralandnon-moralvaluation.Standards and principles, Value judgements

Unit-II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truth fulness, Cleanliness.Honesty, Humanity.Power of faith, National Unity.Patriotism.Love for nature, Discipline

Unit-III

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Loveand Kindness. Avoid fault Thinking. Free fro manger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth.Aware of self-destructive habits.Associationand Cooperation.Doing best for saving nature

Unit-IV

Character and Competence–Holybooks vs Blindfaith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women.Allreligions and samemessage.Mind your Mind,Self-control.Honesty,Studying effectively

Suggested reading

1. Chakroborty,S.K.“Values and Ethics for organizations Theory and practice”,Oxford University Press, New Delhi
2. Open Verification Methodology Cookbook, Mark Glasser, Springer, 2009
3. Principles of Functional Verification,Andreas S.Meyer, Elsevier Science,2004
4. Assertion-Based Design, 2nd Edition, Harry D.Foster, Adam C.Krolnik, David J.Lacey, Kluwer Academic Publishers,2004.

SYLLABUS OF SEMESTER I, M.TECH.(IDC)

Course Code: PGIDC1 03/3T **Course:Micro and Smart Grid**

L:3Hrs. **P:0 Hrs.** **Perweek Credits: 3**

Course Objectives:

1. To underst and fundamental concepts of Microgrids, its Power Electronics Interface, protection and islanding issues
2. To understand various Power quality issues in Microgrid and introduction to smart grid technologies
3. To understand Renewable Energy and its storage options for smart grid technologies.To understand smart grid measurement & communication Technology

Course Outcomes:

1. After the completion of this course,the students shall be able to:
2. Microgrid concepts, Power Electronics interface in AC & DC microgrids, Communication infrastructure, modes of operation and control, Protection and is landing issues,etc
3. Power quality issues in microgrid slikemodeling and stability analysis, regulatory standards and economics and basic smart grid concepts
4. Load and generation Power flow analysis, economic dispatch and unit commitment problems and various verticals of smart grid
5. Smart grid communication and measurement technologies like Phasor Measurement Unit(PMU), Smartmeters, Wide Area Monitoring system (WAMS)etc
6. Penetration of Renewable Energy Sources in smart grid and associate dissues and their applications in Electric vehicles etc

UnitI

MICRO GRIDS : Concept and definition of microgrid, microgrid drivers and benefits, reviewof sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islandedmode, Active and reactive power control, protection issues, anti-islanding schemes: passive,active and communication based techniques

UnitII

POWER QUALITY ISSUES IN MICROGRIDS : Power quality issues in microgrids- Modelingand Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids.

UnitIII

INTRODUCTION TO SMART GRID : Basics of Power Systems: Load and Generation PowerFlow Analysis, Economic Dispatch and Unit Commitment Problems, Smart Grid: Definition,Applications,Government and Industry, Standardization, Functions of Smart Grid Components-Wholesaleenergymarketinsmart grid-smart vehicles in smart grid.

UnitIV

SMART GRID COMMUNICATIONS AND MEASUREMENT TECHNOLOGY :

Communication and Measurement - Monitoring, Phasor Measurement Unit (PMU), SmartMeters, Wide area monitoring systems (WAMS)- Advanced metering infrastructure- GIS andGoogle Mapping Tools,IP-based Systems ,Network Architectures

UNITV

RENEWABLE ENERGY AND STORAGE: Renewable Energy Resources-Sustainable EnergyOptions for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues- Electric Vehicles and Plug-in Hybrids-PHEVTechnology-Environmental Implications-StorageTechnologies-Grid integration issues of renewable energy sources.

Textbooks/References:

1. James Momoh,“Smart Grid:Fundamentals of designand analysis”,JohnWiley & sonsInc, IEEEpress 2012.

2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama,“SmartGrid: Technology and Applications”,John Wiley&sonsinc,2012.

3. Fereidoon P.Sioshansi,“Smart Grid:Integrating Renewable, Distributed &EfficientEnergy”, Academic Press, 2012.

4. ClarkW.Gellings,“The smart grid:Enabling energy efficiency and emandresponse”,FairmontPressInc,2009.

SYLLABUS OF SEMESTER I, M.TECH.(IDC)

Course Code:PGIDC104/2T **Course:Artificial Intelligence**

L:3Hrs. **P:0 Hrs.** **Per week Credits:3**

Course Objectives:

1. To learn various types of algorithms use fulinArtificial Intelligence(AI).
2. To convey the ideas in AI research and programming language related to emerging technology.
3. To understand the concepts of machine learning, probabilistic reasoning, robotics, computer vision,and natural language processing.
4. To understand the numerous applications and huge possibilities in the field of AIthatgo beyond the normal human imagination.

Course Outcomes:

1. After the completion of this course,the students shall be able to:
2. Design and implement key components of intelligent agents and experts ystems.
3. To apply knowledge representation techniques and problem solving strategies to common AI applications.
4. Apply and integrate various artificialin telligence techniques in intelligent system
5. Development as well as understand the importance of maintaining intelligent systems.Buildrule-basedand other knowledge-intensive problem solvers.

Unit01:

Introduction to Artificial Neural Network: Organization of the Brain, Biological Neuron,Biological and Artificial Neuron Models, Historical Developments.Essentials of Artificial Neural Networks: Artificial Neuron Model, operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures

Unit02:

ClassificationTaxonomy of ANN: Connectivity,Neural Dynamics(ActivationandSynaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules.Perceptron Models: Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem. Multilayer feed forward NeuralNetworks

Unit03:

Memory: Associative Memory, Bi-directional Associative Memory (BAM) Architecture, BAMTraining Algorithms: Storage and Recall Algorithm, BAM Energy Function, Self-Organizing Maps(SOM) and Adaptive Resonance Theory(ART).

Unit04:

Introduction to Fuzzy Logicsystem: Fuzzy versus crisp, fuzzysets: membership function, Basic fuzzyset operations, properties of fuzzysets, fuzzyrelations. Fuzzy Control, Predicatelogic (Interpretation of predicatelogic formula,Inference in predicate logic), fuzzylogic (Fuzzy quantifiers, fuzzy Inference), fuzzy rule based system, defuzzification methods

Unit05:

Introduction to other intelligent tools: Introduction to Genetic Algorithm: biologicalbackground, GA operators, selection, encoding, crossover, mutation, chromosome. Expert System: software architecture, rule base system.

TextBooks:

1. Simon Haykin,“Neural Networks: A Comprehensive Foundation”,2nd Edition, Pearson Education
2. S.Rajsekaram,G.A.VijayalaxmiPai,“Neural Networks,Fuzzy Logic & Genetic Algorithms Synthesis & Applications”,Practice HallIndia
3. James A. Anderson,“An Introduction to Neural Networks”,Practice Hall India Publication
4. Mohamed H.Hassoun,“Fundamentals of Artificial Neural Network”,Practice HallIndia
5.

Reference books:

1. KelvinWaruicke, Arthur Ekwlle,RajAgarwal,“AI Techniques in Power System”,IEELondonU.K.

2. S.N.Sivanandam,S.Sumathi,S.N.Deepa,“Introduction to Neural Network Using MATLAB 6.0”,Tata McGraw Hill

3. Jacek Zurada,“Introduction to Artificial Neural Network”,Jaico Publishing House India

SYLLABUS OF SEMESTER I, M.TECH.(IDC)

Course Code: PGIDC104/3T Course:Utilization of Electrical Energy

L:3Hrs. P:0 Hrs. Per week Credits:3

Course Objective:

1. To understand the Illumination –Design of lighting scheme-sources of light.
2. To understand the Drives-Suitability for different applications
3. To understand Electric Heating and Welding –Different methods.

Course Outcome:

1. To select their electric drive system based on application and availability of power source.
2. Apply power electronics technology in efficient utilization of electrical heating
3. Apply power electronics technology in efficient utilization of electrical welding
4. Create lighting system using illumination fundamentals and various illumination Technologies.
5. Analyze effective utilization of Power Electronic technologies in Electrical Traction.

UNIT-I

ELECTRIC DRIVES: Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, Particular applications of electric drives, Types of industrial loads, continuous,Intermittent and variable loads, load Equalization.

UNIT-II

ELECTRIC HEATING: Advantages and methods of electric heating, resistance heating, induction heating and dielectric heating.

UNIT-III

ELECTRIC WELDING: Electric welding, resistance and arc welding,electric welding equipment,comparison between A.C.and D.C. Welding**.**

UNIT-IV ILLUMINATION FUNDAMENTALS & VARIOUS ILLUMINATION METHODS:

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Discharge lamps, MV and SV lamps – comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and floodighting.

UNIT-V

ELECTRIC TRACTION: System of electric traction and trackel ectrification. Review ofexisting electric traction systems in India. Special features of traction motor, methods ofelectric braking-plugging rheostatic braking and regenerative braking, Mechanics of trainmovement. Speed-time curves for different services – trapezoidal and quadrilateral speedtime curves. Calculations of tractive effort, power,specific energy consumption for givenrun, effect of varying acceleration and braking retardation, adhesive weight and braking retardation adhesive weight and coefficient of adhesion**.**

TEXTBOOKS:

1. J.B. Gupta,"Utilization of Electric Power and Electric Traction", Kataria & Sonspublishers, Delhi, IX Edtion, 2004.

2. C.L.Wadhwa,"Generation,Distributionand Utilization of electrical Energy",New Age International(P) Limited Publishers,3rdEdition,2010.

REFERENCES:

1. N.V.Suryanarayana,"Utilization of Electrical Power including Electric drives and Electrictraction",New Age International(P)Limited Publishers,1stEdition,1994.
2. E. OpenShawTaylor,"Utilization of Electric Energy", Orient Longman,1st Edition,1937.

COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

COMPUTER SCIENCE ENGINEERING

Of

RASHTRASANT TUKDOJI MAHARAJ

NAGPUR UNIVERSITY, NAGPUR

Master of Technology (Computer Science & Engineering)

Semester I

Sl. No	Subject Code	Subject	Teaching Scheme				Schemeof Examination (Marks)			Duration of Exam. (Hours)	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS101T	Advanced Data Structures and Algorithms	3	1		4	60	40	100	3	50
2.	23PCS102T	Object Oriented Software Engineering	3	1		4	60	40	100	3	50
3.	23PCS103T	Advanced SComputer Architecture	3	1		4	60	40	100	3	50
4.	23PCS104T	ProgramElective-I	3			3	60	40	100	3	50
5.	23PCS105T	ProgramElective-II	3			3	60	40	100	3	50
6.	23PCS101P	LaboratoryI [AdvancedDataStructures and Algorithms]			2	1	25	25	50	2	25
7	23PCS102P	LaboratoryII [Object Oriented Software Engineering]			2	1	25	25	50	2	25
Total Marks							350	250	**600**		
Load of the semester						22	**Total credits in the semester**				**20**

Program Electives:PEI:

1. **[23PCS111T]Software Requirements & Estimation**
2. **[23PCS112T]Cryptographic Foundation**
3. **[23PCS113T]AIand Expert Sytems**

Program Electives: PEII:

1. **[23PCS121T]Embedded System**
2. **[23PCS122T]Modelling and Simulation**
3. **[23PCS123T]Data Science and Visualization**

Master of Technology (Computer Science & Engineering)

Semester II

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks)			Duration of Exam.	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS201T	Advanced Database Systems	3			3	60	40	100	3	50
2.	23PCS202T	Advances in Operating System	3			3	60	40	100	3	50
3.	23PCS203T	HighPerformance Networks	3			3	60	40	100	3	50
4.	23PCS204T	ProgramElective-III	3			3	60	40	100	3	50
5.	23PCS205T	ProgramElective-IV	3			3	60	40	100	3	50
6.	23PCS206T	Foundation Course I Research Methodology and IPR	2			2	60	40	100	3	50
7	23PCS201P	Laboratory III [Advanced Database Systems]			2	1	25	25	50	2	25
8	23PCS202P	Laboratory IV [Advancesin Operating System]			2	1	25	25	50	2	25
Total Marks							360	290	**650**		
Load of the semester						21	**Total credits in the semester**				**19**

Program Electives : PEIII:

1. **[23PCS231T]Natural Language Processing**
2. **[23PCS232T]Web Analytics and Intelligence**
3. **[23PCS233T]Cyber Crime Investigations and Cyber Forensics**

Program Electives: PE IV:

1. **[23PCS241T]Social Network Analysis**
2. **[23PCS242T]Computational Intelligence**
3. **[23PCS243T]Real Time Systems**

Master of Technology(Computer Science & Engineering)

Semester III

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks)			Duration of Exam. (Hours)	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS301T	ElectiveV[Open]	3			3	60	40	100	3	50
2.	23PCS302T	Foundation Course II Project planning and Management	2			2	60	40	100	3	50
3.	23PCS303P	ProjectandSeminar			16	8		200	200	-	100
Total Marks							120	280	400		
Load of the semester						**21**	**Total credits in the semester**				**13**

Open Elective V [OPEN]:

[23PCS351T] Fundamentals of Cyber Security
[23PCS352T] Multimedia
[23PCS353T] ERP

SemesterIV

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks)			Duration of Exam. (Hours)	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS401P	Industrial Project			32	16	200	200	400	-	200
Total Marks							200	200	400		
Load of the semester						**32**	**Total credits in the semester**				**16**

Master of Technology(Computer Science & Engineering) Syllabus : Semester I

23PCS101T	Advanced Data Structures and Algorithms	L	T/P	C
		3	1	4

Course Objectives:

4. To introduce and practice advanced algorithms and programming techniques necessary for developing sophisticated computer application programs
5. Togetaccustomedwithvariousprogrammingconstructssuchasdivide-and-conquer, backtracking, and dynamic programming.
6. To learn new techniques for solving specific problems more efficiently and for analyzingspace and time requirements.

Course Outcome:

At the end of this course:

1. Students are familiar with algorithmic techniques such as brute force, greedy, and divideand conquer.
2. Student can apply advanced abstract data type (ADT) and data structures in solving real world problems.
3. Effectively combine fundamental data structures and algorithmic techniques in building a complete algorithmic solution to a given problem
4. Canpracticeadvancedalgorithmsandprogrammingtechniquesnecessaryfordeveloping sophisticated computer application programs

UNITI

Review of order rotation & growth of functions, recurrences, probability distributions, Average case analysis of algorithms, Basic data structures such as stacks, queues, linked lists, and applications.

UNITII

Direct access tables and hash tables, hash functions and relates analysis, Binary Search treesand Operations, AVL Trees and balancing operations, R B Trees, properties, operations.

UNITIII

B – Trees – definition – properties, operations, Graph algorithms, MST single source all pair shortest paths,maximal independent sets, coloring vertex cover, introduction to perfect graphs.

UNITIV

Quick sort randomized version, searching in linear time, Algorithmic paradigms Greedy Strategy, Dynamic programming, Backtracking, Branch-and-Bound, Randomized algorithms.

Text Books

H.S.Wilf,Algorithms andcomplexity, Prenticehall.
T.H.Cormen, C.E.Leiserson,R.L.Rivest,Introductionto Algorithms,Prenticehall.
K.VishwanathanIyer,Lecturenotesforclassroomuse.

References:

1. MarkAllenWeiss(SecondEdition)“DataStructuresandAlgorithmAnalysisinC”,Pearson
2. RobertL.KruseBruceP.Leung“DataStructuresandProgramDesigninC(Second Edition)” ,

Master of Technology (Computer Science & Engineering)

Syllabus:Semester I

23PCS102T	Object Oriented Software Engineering	L	T/P	C
		3	1	4

Course Objectives:

This course will develop students'knowledge in/on:

1. Fundamentals of software engineering and UnifiedModeling Language
2. Requirement selicitationand analysis
3. System design concepts and activities
4. Mapping model tocodeand test the system

Course Outcomes:

On completion of this course,students will be able to…

1. Illustrate the importance of software engineering
2. Develop the software requirements specification document
3. Design the work flow of the object oriented software system
4. Build the system using selected reusable design patterns

UNITI

Introduction to Software Engineering: Software engineering failures, Software engineering concepts, Software engineering development activities, Managing software development Modeling with Unified Modeling Languages: Modeling concepts, A deeper view into UML Project Organization and Communication: A rocket example, Project organization concepts, Project communication concepts, Organizational activities

UNITII

Requirements Elicitation: Usability examples, Requirements elicitation concepts, Requirements elicitation activities, Managing requirements elicitation Analysis: An optical illusion, Analysis concepts, Analysis activities - from use cases to objects, Managing analysis

UNITIII

System Design - Decomposing the System: A floor plan example, System design concepts, System design activities - from objects to subsystems System Design -Addressing design goals: A redundancy example, UML deployment diagrams, Managing system design

UNITIV

Object Design - Reusing Pattern Solutions: Bloopers, Reuse concepts - Solution objects, Inheritance and design patterns; Reuse activities - Selecting design patterns and components, Managing reuse Object Design - Specifying Interfaces: A railroad example, Interface specification concepts, Interface specification activities, Managing object design Mapping Models to Code: A book example, Mapping concepts, Mapping activities, Managing implementation Testing: Testing the space shuttle, Testing concepts, Testing activities, Managing testing

Text Book:

1. Bernd Bruegge,Allen H.Dutoit,Object Oriented Software Engineering UsingUML,Patterns and Java, 3rd ed., United States of America: Pearson Education, 2010.

ReferenceBooks:

1. Timothy C.Lethbridge, Robert Laganiere, Object Oriented Software Engineering Practical Software Development using UML & Java, 1st. ed.,New York: TMH, 2004.
2. GradyBooch,James Rambaugh, IvarJacobson, The Unified Modeling Languageuser guide, 1st. ed., India: Pearson education, 2005.

Master of Technology(Computer Science & Engineering) Syllabus : Semester I

23PCS103T	Advanced Computer Architecture	L	T/P	C
		3	1	4

Course Objectives:

1. The objective of this course is to analyze the parallelism, identify the conditions of parallelism, and study different parallel interconnection systems.
2. It also focuses on identifying the pipeline hazards, gain in-depth knowledge of architecture and learn parallel processing and its applications to solve workloads.

Course Outcomes:

1. Analyzethe parallelism.
2. Identify the conditions of parallelism.and study different parallel interconnection systems.
3. Gainin-depth knowledge of architecture.
4. Understanding pipelined and non-pipelined processing

UNIT I

Flynn's classification: SISD, SIMD, MISD, MIMD, Parallel Processing: Definition, Theory of Parallelism. Parallel Computer Models, Parallelism in Uni-processor computers, Implicit Parallelism vs. explicit parallelism, Levels of parallelism. Soft ware Parallelism, Hardware Parallelism, Amdahl's law, Overview of RISC and CISC architecture, System Performance attributes of parallel Computers.

UNIT II

Pipelining: Linear pipe line processor, Asynchronous and Synchronous models, speed up, Efficiency, Throughput, Pipelining in MIPS architecture, Non linear pipe line processor, Instruction pipeline, Arithmetic pipeline. Conditions of Parallelism: Data and Resource Dependencies, Control Dependence, Resource dependence, Bernstein's condition, Hardware and software parallelism, pipeline hazards and their Resolution Mechanisms like data forwarding, Delayed Branch, Branch Prediction, Dynamic Branch Prediction(Two state machine, four state machine), loop unrolling, dynamic scheduling, Software pipelining.

UNIT III

Loosely coupled and tightly coupled system, Parallel Interconnection Systems: Static and Dynamic Networks, Linear Array, Ring, Star, Tree, Mesh, Systolic Array, Chordal ring, Completely connected network, Cube connected cycles, Torus, K-ary-n cube, Barrel shifter, single stage interconnection network, Multistage Interconnection Networks, Control Structure, Node degree, diameter, Bisection width, symmetric, functionality, Network Latency, Bandwidth, Scalability, Data routing functions:- Permutation, Perfect shuffle exchange, Hypercube Routing function.

UNIT IV

Memoryhierarchy, CacheDesignIssues, Memory Interleaving, Introductiontomulticores,grid and cluster, Case studies on some commercial processors like Pentium, Power PC etc.

Text Books:

1. Advanced Computer Architecture,by KaiHwang McGraw Hill.
2. Computer Architecture–Aquantitative approach ByJ.LHennessyand D.A.Patterson, Morgan Kaufmann

ReferenceBook:.Introduction to Parallel Computing, 2nd Edition, Pearson Educationby Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar.

Master of Technology (Computer Science & Engineering) Syllabus : Semester I

23PCS111T	Software Requirements & Estimation[PEI]	L	T/P	C
		3	1	4

Course Objectives:

1. Understand the good practices for requirements engineering.
2. Understand Requirement selicitation,elicitation techniques,
3. Understand analysis models, Software quality attributes.
4. Understand software estimation, sizeestimation ,
5. Understand Effort, Schedule and Cost Estimation.

Course Outcomes:

At the end of the course the student will be able to:

1. Gain knowledge about software equirements and analyze requirement elicitation techniques and prototyping.
2. Gain knowledge about requirement management, their principles and practices.
3. Estimating the software interms of size,cost,effort and schedule.
4. Expose Industrial resources

UNIT I

Introduction to software life cycle, Management activities in a software project, Requirements engineering: Requirements Elicitation, Requirement Elicitation techniques, Requirement Analysis,Requirement Analysis Models, Requirement Documentation, Requirement Management

UNIT II

Size Estimation: Function Point Analysis from DFD's, ER diagram, Function Point Analysisfrom Use Case Diagram & Class Diagram, Mask II FPA, LOC estimation, Conversion betweensize measures

UNIT III

Effort,schedule & costestimation:Estimationfactors,COCOMO-II,Estimationby Analogy, Validating Software Estimates Tools: Software Estimation Tools

UNIT IV

Industry Resources; IFPUG, UQAM-SEMRL,COSMIC,IEEE,Two latest Research papers tobe covered

Text Books:

1. Kishore,Swapna,“SoftwareRequirementsandEstimation”,TataMcGrawHill,2001

Reference Books:

1. NormanE.Fenton,“Software Metrics:A Rigorousand Practical Approach”, International Thomson Computer Press, 1996.
2. B. Henderson-Sellers, “Object-Oriented Metrics, Measures of Complexity”, Prentice Hall, 1996.

Master of Technology (Computer Science & Engineering) Syllabus : Semester I

23PCS112T	Cryptographic Foundation[PEI]	L	T/P	C
		3	1	4

Course Objectives:

1. Build a solid mathematical basis to understand foundations of cryptography
2. Formally understand the notions related to security authentication and privacy.
3. Understand security concepts, Ethicsin Cryptography.
4. Understand security threats, and the security services and mechanisms to counter them
5. Comprehend and apply relevant cryptographic techniques
6. Comprehend security services and mechanisms in the network protocol stack
7. Comprehend and apply authentication services and mechanisms

Course Outcomes:

Student should be able to:

1. Apply knowledge of computing and mathematics for developing efficient security algorithms.
2. Identify security threats and determine effort stocounter them
3. Write code for relevant cryptographical gorithms.
4. Determine firewall requirements, and configure firewall.
5. Evaluate cryptographic primitives and their implementations for correctness,efficiency, and security.

UNITI

Introduction to Security: Definition, Goal and Challengaes, OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Techniques, Model for Network Security, Mathematics of Cryptography: Integer Arithmetic, Modular rithmatic, Matrices, Linear Congruence, Algebraic Structures: Group, Ring, Field, Galois Field, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Stream and Block Cipher, Steganography.

UNIT II

Modern Symmetric Key Ciphers: Modern Block Ciphers, Modern Stream Ciphers, Data Encryption Standard (DES): DES Structure, DES Analysis, Multiple DES, Security of DES, AdvancedEncryptionStandard(AES),AESTransformationfunctions,AnalysisofAES,Useof Modern Block Ciphers: ECB, CBC, CFB, OFB, CTR, Use of Stream Ciphers: RC4, Key Management, Key Generation.

UNIT III

Number Theory: Prime Numbers, Fermat’s and Euler’s Theorems, Testing of Primality, Shinese Remainder Theorem, Exponentiation and Logarithm, RSA Algorithm, Elgamal Cryptosystem, Elliptic Curve Cryptography, Diffe-Hellman Key Exchange.

UNIT IV

Message Integrity and Message authentication: Application of Cryptographic Hash Functions, Two Simple Hash functions, Requirements and security, Secure Hash Algorithm (SHA), Message Authentication Requirements, Message authentication functions, Message Authentication Codes(MAC), SecurityofMAC,DigitalSignature,Digital Signature Standards.

Text Books:

1. B. A.Forouzan,Cryptography & Network Security,McGraw Hill,SpecialIndian Edition, 2007.
2. W.Stallings,Cryptography and Network Security,PearsonEducation,3rdEd,2006.

References:

1. R.E.Smith,Internet Cryptography,AWL.
2. A.J.Menezes,Handbook of Applied Cryptography,CRCPress.
3. J.Hershey, Cryptography Demystified,McGrawHill.
4. J.Knudsen, Java Cryptography, O'Reilly.

Master of Technology(Computer Science & Engineering) Syllabus : Semester I

23PCS113T	Artificial Intelligence and Expert Systems[PEI]	L	T/P	C
		3	1	4

Course objectives:

1. To impart knowledge about Artificial Intelligence.
2. To give understanding of the main abstractions and reasoning for intelligent systems.
3. To enable the students to understand the basic principles of Artificial Intelligence in various applications.

Course outcomes:

Student should be able to:

1. Solve basic AI based problems.
2. Define the concept of Artificial Intelligence.
3. Apply AI techniquestoreal-world problems to develop intelligent systems.
4. Select appropriately from arrange of techniques when implementing intelligent systems.

UNIT 1:

Introduction: Overview of AI problems, AI problems as NP, NP-Complete and NP Hard problems.Strong and weak,neat and scruffy, symbolicandsub-symbolic, knowledge-basedand data-driven AI.Search Strategies:Problemspaces (states,goalsandoperators), problem solving By search, Heuristics and informed search,Minmax Search,Alpha-betapruning.Constraint Satisfaction (back tracking and local search methods).

UNIT II:

Knowledge representation and reasoning: propositional and predicate logic, Resolution and theorem proving, Temporal and spatial reasoning. Probabilistic reasoning, Bayes theorem. Totally-ordered and partially-ordered Planning. Goal stack planning, Nonlinear planning, Hierarchical planning. Learning: Learning from example, Learning by advice, Explanation based learning, Learning in problem solving, Classification, Inductive learning, Naive Bayesian Classifier, decision trees.

UNIT III:

Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Textclassification.Information retrieval.Agents:Definitionofagents, Agentarchitectures(e.g., reactive, layered, cognitive), Multi-agent systems- Collaborating agents, Competitive agents, Swarm systems and biologically inspired models.

UNIT IV:

Intelligent Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition. Key Application Areas: Expert system, decision support systems,Speech and vision,Naturallanguage processing,Information Retrieval, Semantic Web.

TextbooksandReferences:

1. Artificial Intelligence by Elaine Rich, Kevin Knight and Shivashankar B Nair, Tata McGraw Hill.2.IntroductiontoArtificial IntelligenceandExpert SystemsbyDanW. Patterson,Pearson Education.
3. Artificial Intelligence: A Modern Approach by S. Russell and P. Norvig, Prentice Hall.

Master of Technology(Computer Science & Engineering)

Syllabus:SemesterI

23PCS121T	Embedded Systems[PEII]	L	T/P	C
		3	1	4

Course Objective:

An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, health and safety, manufacturability, and sustainability.

Course Outcomes:

1. Knowledge and understanding of fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware
2. A wide competence from different areas of echnology, especially from computer engineering, embedded intelligent systems and mechatronics.
3. Deep state-of-the-art theoretical knowledge in the areas of real time systems, embedded processors, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software co-design of embedded systems.
4. Understanding and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.

UNIT I

Introduction: Embedded system, Features of Embedded Systems, Design Metrics, Embeded System Design flow, Processor in the system, Other hardware units, Software embedded into a system, Exemplary embedded systems, Embedded System-on-chip (SOC) and in VLSI circuit. Devices and Device Drivers: Serial communication using the ‘I2C’, ‘CAN’ Parallel communication between the networked I/O multiple devices using the ISA, PCI, PCI-X Device drivers,Interruptservicing(Handling)mechanism.Process or selection or anembedded system, Memory selection for an embedded system, Inter process communication.

UNIT II

Real Time Operating System: Types of Real-time tasks, Task Periodicity, Task Scheduling, Classification of Scheduling algorithms, Clock driven scheduling, Event driven scheduling, Features of RTOS, Commercial RTOS, Windows CE, LynxOS, VxWorks, Introduction to microc/OS-IICase Studies ofProgramming with RTOS: Casestudyofan embeddedsystem for a smart card.

UNIT III

Hardware and Software Co-design: Embedded system project management, Embedded system design and co-design issues in system development process, Design cycle in the development phase for an embedded system

UNIT IV

Low power Embedded system Design: Sources of Power Dissipation, Dynamic power dissipation, Static power dissipation, Power reduction techniques, System level power management.

Text Books:

1. Embedded Systems-Architecture, Programming and Design–RajKamal,TMH
2. Embedded system design–Santanu Chattopadhyay,PHI

References:

1. Hardware Software Co-design of Embedded Systems–Ralf Niemann, Kluwer Academic.
2. Design Principles of Distributed Embedded Applications–Hermann Kopetz, kluwer Academic.
3. Embedded Real-Time Systems Programming–SriramV .Iyerand Pankaj Gupta,TMH.

Master of Technology (Computer Science & Engineering) Syllabus : Semester I

23PCS122T	Modelling and Simulation[PEII]	L	T/P	C
		3	1	4

Course Objectives:

1. Fundamentals of creating mathematical models of physical systems and implementation on computers to analyse the system.
2. The different mathematical approaches to modelling that are covered in the course can be characterized into differential and difference equation based models, probability based a model which includes stochastic differential equations, cellular automata and event based approaches, and matrix based models.

Course Outcomes:

1. Tocreatearelevantmodelforamultitudeofproblemsfromscienceandengineering,by extracting the necessary and relevant information regarding the problem.
2. Beabletodefinethedifferentmodellingtermsbyanalysingthesystemorthedatathatis present.
3. They would be able to implement the model on the computer and from the results check for the validity of the model and correctness of the assumptions present in the model.

UNIT I

Introduction: System Concepts, System boundaries and environment, continuous and discrete systems, system modeling, Type of Models, Modeling Methodology, Model validation, Principles & Nature of Compute rmodeling and simulation, Stepsin Simulation Study, Pitfalls in Simulation,WhentouseSimulation?,PhysicalandInteractiveSimulation,RealTimeSimulation, Simulation and Analytical Methods, Areas of Application.

UNITII

Continuous & Discrete: Analog vs. Digital Simulation, Continuous simulation vs. Numerical Integration; Time Flow Mechanism, Concepts of simulation of continuous and discrete system with the help of live examples- Pure Pursuit Problem, Inventory Problem, Chemical Rector; Generation of random numbers,Monte Carlo Computation vs Stochastic Simulation, Generation of non-uniformly distributed random numbers, Discrete Probability Functions, Cumulative Distribution Function, Measures of Probability Function-Central Tendency & Dispersion, Generation of Poisson and Erlang variates.

UNIT III

Simulators for the live systems: Simulation of awater reservoir system, Simulation of a hypothetical Computer. Simulation of queuing Systems: Basic concepts of queuing theory, Simulation of single-server, two server and general queuing systems, Simulation in Inventory Control systems : Elements of inventory theory, inventory models, simulators for complex Inventory systems.

UNIT IV

Design and Evaluation of Simulation Experiments: Length of simulationrun, variance reduction techniques.Experiment layout and Validation.Simulation Languages: Continuous and discrete simulation languages, Block-Structured continuous simulation languages, Expression based languages, discrete system simulation languages: GPSS, SIMSCRIPT, SIMULA, Factors in selection of discrete system simulation languages.

Text Books:

1. Gordon G.:System Simulation",Prentice-Hall of India Pvt.Ltd. New Delhi1993.
2. Narsingh Deo: System Simulation with Digital Computer:,PHI NewDelhi,1993

Reference Books:

1. Neelamkavil Frances: "Computer Simulation and modelling, John Wiley & Sons,NewYork 1987,
2. Payne,JamesA.:"Introduction to Simulation:Programming Techniques and Methods of Analysis, McGraw-Hill International Editions, Computer Science Services, New York(1998).
3. ReitmanJulian:"ComputerSimulationExperiments",Wiley-Interscience,1971.

Master of Technology(Computer Science & Engineering)

Syllabus:Semester I

23PCS123T	Data Science and Visualization[PEII]	L	T/P	C
		3	1	4

Course Objectives:

1. To know the fundamental concepts of data science and analytics
2. To learn various techniques formining data streams
3. To learn event modeling for different applications.
4. To know about Hadoop and Map Reduce procedure

Course Outcomes: Upon the completion of the course the student should be able to:

1. Work with big data platform and its analysis techniques.
2. Design efficient algorithms formining the data from large volumes.
3. Model a framework for Human Activity Recognition
4. Development with cloud data bases

UNIT I

INTRODUCTION TO DATA SCIENCE – Applications - Data Science Process – Exploratory Data analysis – Collection of data – Graphical presentation of data – Classification of data – Storage and retrieval of data – Big data – Challenges of Conventional Systems - Web Data – Evolution Of Analytic Scalability - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II

DATAANALYSIS:Correlation–Regression–Probability–ConditionalProbability–Random Variables – Analysis using Mean, Median, Mode, Standard Deviation, Skewness, Kurtosis- Regression Modeling - Multivariate Analysis - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods - Analysis of Time Series: Linear Systems Analysis - Nonlinear Dynamics –

UNIT III

DATA MINING TECHNIQUES: Rule Induction - Neural Networks: Learning and Generalization - Competitive Learning - Principal Component Analysis and Neural Networks - Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees - Stochastic Search Methods- Neuro-Fuzzy Modeling – Association rule mining – Clustering – Outlier Analysis – Sequential Pattern Mining – Temporal mining – Spatial mining – Web mining

UNIT IV

FRAMEWORKS AND VISUALIZATION: Map Reduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases –Cloud databases - S3- Hadoop Distributed File Systems –Visualizations - Visual Data Analysis Techniques - Interaction Techniques – Social Network Analysis – Collective Inferencing – Egonets - Systems and Applications.

Text/Reference Books:

1. Michael Berthold,David J.Hand,“Intelligent Data Analysis”,Springer,2007.
2. Anand Rajaraman and Jeffrey David Ullman,“Mining of Massive Datasets”,Cambridge University Press, 2012.
3. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, 2012.
4. Jiawei Han,MichelineKamber“Data Mining Conceptsand Techniques”,Second Edition, Elsevier, Reprinted 2008.
5. Rachel Schutt,Cathy O'Neil,“Doing Data Science”,O'Reilly Publishers,2013.
6. Foster Provost,TomFawcet,“Data Science for Business”,O'Reilly Publishers,2013.
7. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications“, Wiley Publishers, 2014.
8. S. N. Sivanandam, S. N Deepa, “Introduction to Neural Networks Using Matlab 6.0”, TataMcGraw- Hill Education, 2006.

Master of Technology (Computer Science & Engineering) Syllabus : Semester I

23PCS101P	Advanced Data Structures And Algorithms Lab	L	T/P	C
			2	1

Course Objectives:

1. The fundamental design, analysis,and implementation of basic data structures.
2. Basic concepts in the specification and analysis of programs.
3. Principles for good program design,especially the uses of data abstraction.
4. Sample Problems on Data structures:

Programs:

1. Write Java programs that use both recursive and non-recursive functions for implementing the following searching methods: a) Linear search b) Binary search
2. Write Java programs to implement the following using arrays and linkedlistsa) ListADT
3. Write Java programs to implement the following using an array.a)Stack ADTb) Queue ADT
4. Write a Java program that reads an infix expression and converts the expression to postfixform. (Use stack ADT).
5. Writea Java program to implement circular queue ADT using an array.
6. Write a Java program that uses both a stack and a queue to test whether the given string is a palindrome or not.
7. Write Java programs to implement the following using a singly linked list. a) Stack ADT b) Queue ADT
8. Write Java programs to implement the deque (double ended queue) ADT using a) Array b) Singly linked list c) Doubly linked list.
9. Write a Java program to implement priority queue ADT.
10. Write a Java program to perform the following operations:a) Construct abinary search tree of elements. b) Search for a key element in the above binary search tree. c) Delete an element from the above binary search tree.
11. Write a Java program to implement all the functions of adictionary (ADT) using Hashing.
12. Write a Java program to implement Dijkstra’s algorithm for Single source shortest path proble
13. Write Java programs that use recursive and non-recursive functions to traverse the given binary tree in a) Preorder b) Inorder c) Postorder
14. WriteJavaprogramsfortheimplementationofbfsanddfsforagivengraph.
15. Write Java programs for implementing the following sorting methods: a) Bubble sort d) Merge sort g) Binary tree sort b) Insertion sort e) Heap sort c) Quick sort f) Radix sort
16. Write a Java program to perform the following operations: a) Insertion into a B-tree b) Searching in a B-tree
17. Write a Java program that implements Kruskal’s algorithm to generate minimum cost spanning tree.

ReferenceBooks:

1. Data Structures and Algorithms in java, 3rd edition, A.Drozdek,Cengage Learning.
2. Data Structures with Java, J.R.Hubbard, 2nd edition,Schaum’s Outlines,TMH.
3. Data Structures and algorithmsin Java, 2nd Edition,R.Lafore, Pearson Education.
4. Data Structures using Java,D.S.Malikand P.S.Nair,Cengage Learning.
5. Data structures, Algorithms and Applications in java, 2nd Edition,S.Sahani, Universities Press.
6. Design and Analysis of Algorithms,P.H.Dave and H.B.Dave,Pearson education.

Master of Technology (Computer Science & Engineering) Syllabus : Semester I

23PCS102P	Object Oriented Software Engineering Lab	L	T/P	C
			2	1

Course Outcomes:

After completion of the course, the student will be able to:

1. Analyzes of tware project using Microsoft project management tool
2. Design a software system using unified modeling approach
3. Apply Win-runner, QTP and selenium tool sinsoftware testing
4. Apply Test director and open source testing tools fortest management

List of Experiments:

Experiment-I

1. Project scheduling using Microsoft project management tool
2. Project estimation using Microsoft project management tool

Experiment-II Construct Use case and class diagrams for the following

1. Online shopping
2. Banking system
3. Cabdispatching system

Experiment-III Construct Collaboration and Sequence diagrams for the following

1. Librarian issues books to student
2. Mobile phone

Experiment-IV Construct Activity and State chart diagrams for the following.

1. ATM transaction
2. Ticket machine
3. Credit card processing

Experiment-V

Casestudy:Developclass diagram of Unifiedlibrary applicationand modelitindifferent views i.e.logicview, component view,deployment view,data based esignand perform forward & reverse Engineering List of Experiments on Testing

Experiment-VI

Manual testing:Take any system(e.g.ATMsystem) and study its system specifications and report the various bugs

Experiment-VII

Study of Win Runner testing tool and its implementation

1. Win Runner testing process and Winrunner user interface
2. How Win Runner identifies GUI(Graphical User Interface) objects in an application and describes the two modes for organizing GUI map files
3. How to record at estscript and explains the basics of Test Script Language(TSL)
4. How to synchronize a test when the application responds slowly
5. How to creat eatest that checks GUI objects and compare the behavior of GUI objects in

different versions of the sample application

6. How to create and run at est that checks bitmapsin your application and run the teston different versions of the sample application and examine any differences, pixel by pixel
7. How to create Data-driven tests which supports toruna single test on several sets of data from a data table
8. How to read and check text found in GUI objects and bitmaps

9. How to create a batch test that automatically runs the tests
10. How to update the GUI object descriptions which in turn supports test scripts as the application changes

Experiment-VIII

Apply Selenium testing tool implementation on real time applications placement portal

Experiment-IX

Study of any bugtracking tool(e.g.Bugzilla,BugBit)

Experiment-X

Study of any test management tool(e.g.TestDirector)

Experiment-XI

Study of any open source-testing tool(e.g.TestLink)

Experiment-XII

Take a miniproject(e.g.University admission, Placementportal) and executeit. During thelife cycle of the mini project create the various testing documents

Reference Books:

1. Meilir Page-Jones, Fundamentals of Object Oriented Design in UML, 1st ed. Noida: Pearson Education, 2000.
2. Dr. K.V.K.K. Prasad, Software Testing Tools: Covering WinRunner, Silk Test, Load Runner, J Meter and Test Director with case studies, 1st ed., New Delhi: Dreamtech Press, 2004.
3. Pascal Roques,Modeling Software Systems Using UML2 ,1st ed.,New Delhi:Wiley-India, 2009.
4. Mark Priestley, Practical Object-Oriented Design with UML, 2nd ed., New Delhi: TATA McGraw Hill , 2009.

Gandharba Swain, Object Oriented Analysis & Design Through Unified Modeling Language, 1st ed., New Delhi : Lakshmi Publications Pvt. Ltd, 20

23PCS201T	Advanced Database Systems	L	T/P	C
		3	1	4

Course Objectives:

1. To review the concepts of data base architecture, scheme and data models.
2. Revisiting the theory of normalization and various normal forms.
3. Develop proficiency in query processing and optimization.
4. To provide students with knowledge of data base transaction processing, concurrency control and recovery from database failure.
5. To develop competence in students for designing and implementing a database for any real life application.

Course Outcome:

1. Compare and evaluate alternative data base architectures and models in different application contexts.
2. Apply normalization steps in data base design for minimizing redundancyand data anomalies.
3. Understanding of transaction management,concurrency control and how they affect database integrity and consistency.
4. Employ the conceptual and relational models to design large data base systems.

UNIT I:

Review of Basic Database Concepts

Data Models, Schema and Instances, Three-Level Schema Architecture & Data Independence, E-R Modelling: Specialization, Generalization, Aggregation, Functional Dependencies, Decomposition, Concept of Normalization and Normal Forms

UNIT II:

Query Processing and Optimization

Basic Steps inprocessing anSQL Query, Catalog Information for Cost Estimation, Measures of Query Cost, Selection and Join Operations, Query Optimization: Overview, Transformation of Relational Expressions by Equivalence Rules.

UNIT III:

Transaction Management and Concurrency Control

Transaction concept, Transaction state, Implementation of Atomicity and durability, Concurrent executions, Serializability, Concurrency Control Schemes: Lock-based, Timestamp based, Validation based protocol, Multiple granularity, Multiversion schemes, Deadlock handling, Recovery System.

UNIT IV:

Advanced Topics Data Mining,

Data Warehousing, Parallel Databases, Distributed Databases,Mobile Databases, Multimedia Databases, Spatial database, Temporal databases.

Text Book:

1. Ramez Elmasri, ShamkantB.Navathe, Fundamentals of Database Systems, 6thEdition, Pearson Education India.

References Books:

1. Silberschatz,Korth,andSudarshan,"Data base system Concepts,4/e”,Tata-Mc-Graw Hill.
2. Bipin C.Desai:Introduction to Data Base Systems,Galgotia Publications.
3. C.JDate,“Introduction to database Systems,7/e”,Pearson Education India

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS202T	Advances in Operating System	L	T/P	C
		3	1	4

Course Objectives:

1. At the end of the course, the student will have become exposed to classic and current operating systems literature, gained the experience of conducting research in the area of operating systems,developedstate-of-the-art research projects that lead to Publishable results.
2. The course will be instrumental to familiarizeand build the confidence in the students to develop the knowledge of design and develop mobile operating system based knowledge and application on it.

Course Outcomes

After completion of course,students would be conversant with:

1. Concepts of some of the advanced topics in operating system design, issues.
2. Knowledge involved inmemory,concurrency,andfilemanagement techniques
3. Familiar with some advanced topics and emerging type of operating system design concepts.
4. Ability to design and analyze mobile OS based applications and to customize kernel tuning.

UNIT I:

Concurrent Execution: threads, event systems,async/sync I/O,Parallelism, Ordering, and Races, Dynamic Data Race Detector for Multi-Threaded Programs, Discussions of synchronization with an emphasis on monitors, On Optimistic Methods for Concurrency Control, Concurrency Control and Recovery, Communication using lightweight remote procedure call (RPC)

UNIT II:

Memory Management: virtual memory, NUMA machines, memory allocators – Hoard Scalable Memory Allocator, Memory Resource Management in VMware, Global Memory Management in Cluster machines Scalability: Multicore processing, locking, lock-free data structures, The Scalable Commutativity Rule: Designing Scalable Software for Multicore Processorsetc.

UNIT III:

OS Architecture:The structure and design of an operating system, OS Architecture and Extensibility: SPIN and the Exo-kernel, OS architecture for scalable multicore systems: Multi-kernelMobile OS Architecture: Android, iOS

UNIT IV:

Virtualization: Machine virtualization, binary instrumentation, VMware design etc. File Systems and Disk: file system interfaces, networked file systems, AFS, The Design and Implementation of a Log-Structured File System, File system extensibility, non-disk file systems,

Text Book:

1. Advanced Concepts in Operating Systems:Distributed, Database,and Multiprocessor Operating Systems by Mukesh Singhal, Niranjan Shivaratri, 2017, McGraw Hill
2. There is no specific textbook for this course. The course is based on a collection of journaland conference papers

Reference Books:

1. Modern Operating Systems,Tanenbaum
2. Operating Systems:AModern Perspective,Gary Nutt,
3. Advanced Operating Systems,by Silberschatz,1999
4. Advanced Programming in the Unix Environment by W.Richard Stevens,Addison Wesley, 1993
5. Unix Network Programming: Networking APIs: Sockets and XTI (Volume1) byW. Richard Stevens.

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS203T	High Performance Networks	L	T/P	C
		3	1	4

Course Objectives:

1. To study high performance networks
2. To reinforcean understanding of LAN technologies which have lead to high speed LANs
3. To understand ATM technology
4. To introduce high speed switching concepts
5. To consider Quality of Service and congestion control issues
6. To look at related protocols such as multicast protocols

Course Outcomes:

After successful completion of the course, students should be able to:

1. Solve the challenges of High Speed Networks and its related performance.
2. Communicate effectively the principles usedin High Performance computing.
3. Explain the basics of high speed networking technologies and to demonstrate the knowledge of network planning and optimization
4. Describe the key components and technologies involved in building the state of art network design applications, concepts to optimize performance of high-speed networks
5. Design and configure networks to support aspecified set of applications

UNIT I:

The Motivation for Internetworking: Need for Speed and Quality of Service; History of Networking and Internet; Advanced TCP/IP and ATM; Internet Architecture; Interconnection through IP Routers; TCP Services; TCP format and connection management; UDP format and UDP Services; Encapsulation in IP; IP header format; IP Services; IP addressing; Classful and Classless addressing; Subnetting and Supernetting; CIDR; IPv6 overview

UNIT II:

Congestion Control and Quality of Service: Data traffic; Network performance; Effects of Congestion; Congestion Control; Congestion control in TCP and Frame Relay; Link-LevelFlow and Error Control; TCP flow control. Quality of Service: Flow Characteristics, Flow Classes; Techniques to improve QoS; Traffic Engineering; Integrated Services; Differentiated Services; QoS in Frame Relay and ATM; Protocols for QoS Support: Resource Reservation- RSVP; Multiprotocol Label Switching; RealTime Transport Protocol;

UNIT III:

High Speed Networks: Packet Switching Networks; Frame Relay Networks; Asynchronous Transfer Mode (ATM); ATM protocol Architecture; ATM logical connections; ATM cells; ATMServicecategories;ATMAdaptationLayer.OpticalNetworks:SONETnetworks;

SONET architecture; High-Speed LANs: The Emergence of High-Speed LANs; Bridged and Switched Ethernet; Fast Ethernet; Gigabit Ethernet.

UNIT IV:

Internet Routing: Interior and Exterior gateway Routing Protocols; Routers and core routers; RIP; OSPF; BGP; IDRP; Multicast Routing; MOSPF; Routing in Ad Hoc Networks. Error and Control Messages: ICMP; Error reporting vs Error Correction; ICMP message format and Delivery; Types of messages; IGMP; Address Resolution (ARP); BOOTP; DHCP; Application layer protocols: Remote Logging; File Transfer and Access; Comparison of SMTP and HTTP; Comparison of IMAP and POP.

Text Books:

1. William Stallings,“High-Speed Networks and Internets, Performance and Quality of Service”, Pearson Education.
2. Douglas E.Comer,“Internet working with TCP/IPVolume–I,Principles, Protocols, and Architectures”, Fourth Edition, Pearson Education.
3. George Coulouris,Jean Dollimore,Tim Kindberg,“Distributed Systems-Concepts and Design”, Pearson Education.

Reference Books:

1. B.Muthukumaran,“Introduction to High Performance Networks”,Vijay Nicole Imprints.
2. Wayne Tomasi,“Introduction to Data Communications and Networking”,Pearson Education.
3. James F. Kurose, Keith W.Ross, “Computer Networking, ATop-Down Approach Featuring the Internet”, Pearson Education.
4. AndrewS.Tanenbaum,“ComputerNetworks”,Pearson Education.
5. Behrouz A. Forouzan, “Data Communications and Networking”, Fourth Edition, McGraw Hill.
6. Mahbub Hassan, Raj Jain, “High Performance TCP/IP Networking, Concepts, Issues, and Solutions”, Pearson Education. 7. Andrew S. Tanenbaum, Marten Van Steen, “Distributed Systems-Principles & Paradigms”, Pearson Education

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS231T	Natural Language Processing[PEIII]	L	T/P	C
		3		3

Course Objectives:

1. Teach students the leading trends and systems in natural language processing.
2. Make them understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the above mentioned concepts.
3. Teach the mtorecognize the significance of pragmatics fornatural language understanding.
4. Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Outcomes:

After completion of the course, the student will be able to:

1. Get the idea about origin and fundamentals of NLP with Morphology concepts.
2. Learn the need of machine translation and understand the process of it.
3. Understand about lexical analysis,Wordnet theory,speech recognition and their concepts.
4. Understand the use of NLP in Sentiment analysis and information retrieval.
5. Learn the Implementation of NLP using various tools and techniques and implementation of key algorithms using NLP.

UNIT I

Introduction: Origin of Natural Language Processing (NLP), Challenges of NLP, NLP Applications,ProcessingIndianLanguages.WordsandWordFormsMorphologyfundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields, Scope Ambiguity and Attachment Ambiguity resolution.

UNIT II

Machine Translation: Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, Rule Based Machine Translation, Knowledge Based MT System, Statistical Machine Translation, UNL Based Machine Translation, Translation involving Indian Languages.

UNIT III

Meaning: Lexical Knowledge Networks, WorldNet Theory; Indian Language; Word Nets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multi linguality; Metaphors. Speech Recognition: Signal processing and analysis method,Articulation and acoustics, Phonology and phonetic transcription, Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

UNIT IV

Other Applications: Sentiment Analysis; Text Entailment; Question Answering in Multilingual Setting; NLP in Information Retrieval, Cross Lingual IR. Laboratory Work: To implement Natural language concepts and Computational linguistics concepts using popular tools and technologies. To implement key algorithms used in Natural Language Processing.

Text Books:

Siddiquiand Tiwari U.S.,Natural Language Processing and Information Retrieval,Oxford University Press
AllenJ.,Natural Language understanding, Benjamin/Cunnings,(1987).

Reference Books:

Jensen K.,Heidorn G.E.,Richardson S.D.,Natural Language Processing: ThePLNLP Approach, Springer (2013).
Roach P.,Phonetics, Oxford University Press (2012)

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS232T	Web Analytics and Intelligence[PEIII]	L	T/P	C
		3		3

Course Objective:

To Assess that how website visitors view and interact with a site's pages and features, and business intelligence, which would allow using data on customer purchasing patterns, demographics, and demanding trends to make effective strategic decisions.

Course Outcomes:

At the end of course student shall be able to:

1. Characterize the webdata as visitor content type.
2. Understand to apply the conversion metrics offline as well as online web.
3. Collect the data of different kinds: weblogs,web beacons and stream data.
4. Create packets and to perform the packet sniffing, identification of unique page.
5. Apply different metrics to counthits, views, bounce and to generate different kinds of reports

UNIT I

Introduction: Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics;Categories:Offsiteweb,Onsite web;Webanalyticsplatform,Webanalyticsevolution, Needforwebanalytics,Advantages,Limitations.DataCollection:ClickstreamData:Weblogs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISPbased measurement, Search Engine data.

UNIT II

Qualitative Analysis: Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys:Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys. Web Analytic fundamentals: Capturing data: Web logs or JavaScript's tags, Separate data servingand data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool,Understanding click stream data quality,Identifying unique page definition,Using cookies, Link coding issues.

UNIT III

Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI. Relevant Technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

UNIT IV

WebAnalytics 2.0:Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Text Books:

1. Clifton B.,Advanced Web Metrics with Google Analytics,Wiley Publishing,Inc.2nd.
2. Kaushik A.,Web Analytics 2.0,The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed.

Reference Book:

SterneJ.,Web Metrics:Proven methods formeasuring web site success, John Wiley and Sons

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS233T	Cyber Crime Investigations and Cyber Forensics [PE III]	L	T/P	C
		3		3

Course Objectives:

1. To understand the basics of Cyber Crimes and Cyber Forensics
2. To understand how to examine digital evidences such as the data acquisition, identification analysis.
3. To explore techniques for conducting the forensic examinationon different digital devices.

Course Outcomes:

At the end of course student shall be able to:

1. Understand the fundamentals of Cyber Crime and analyze the nature and effect of cybercrimes in society.
2. Understand Cyber Crime Investigation Process.
3. Apply the Investigation processes to various operating systems and its applications
4. Demonstrate and explore various Cyberforensic Toolsand apply it to digtal devices.

UNIT I

Introduction :Introduction to Cyber World, Types of cyber-attacks, Cyber Crime and Digital Fraud,Cyber-attacks andcybersecurity,Informationwarfareandcyberterrorism,Overviewof Types of computer forensics i.e. Media Forensics, Network forensics (internet forensics), Machine forensic, Email forensic (e-mail tracing and investigations)

UNIT II

Under Standing Computer Investigations : Preparing a Computer Investigations, Taking a systematic approach, Understanding Data recovery workstations and software, Conducting an Investigation, Completing the case., Processing Crime and Incident Response: Identifying Digital evidences, Collecting evidence, Preparing for a search, Seizing and Storing Digital evidences, Digital Hashing.

UNIT III

Windows and DOS systems based Investigations: File Systems, Examining File systems, Disk Encryption, Windows registry, startup tasks, Linux Boot processes and File systems, Digital signature and time stamping, cryptography, cell phone and mobile device forensics, Email investigations, Network Forensics, SQL Injections, Steganography.

UNIT IV

Computer Forensics Tools and Software: Helix, DTsearch, S-tools, Camouflage, Recovery of Deleted files in windows and Unix , Hardware forensic tools like Port scanning and vulnerability assessment tools like Nmap , Netscanetc . Password recovery e.g. Passware, Mobile forensic tools , DOS file systems and Forensic tools, Password encryption analyzer

Text Books:

1. Computer Forensics and Investigations, 2nd edition,Nelson,Phillips,Enfinger, Steuart, Cenage Learning 2008
2. Incident Response & Computer Forensics.Mandia,k.,Prosise,c.,Pepe,m.2ndedition. Tata-McGraw Hill, 2003.

Reference Books:

1. Digital Evidence and Computer Crime, 2nd Edition , Eoghan Casey , academic Press File System Forensic Analysis by Brian Carrier , addition Wesley
2. Windows Forensic Analysis DVD Toolkit (Bookwith DVD-ROM), Harlan Carvey, syngress Publication
3. EnCE: The Official En Case Certified Examiner Study Guide, 2nd Edition ,Steve Bunting , sybex Publication

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS241T	Social Network Analysis [PEIV]	L	T/P	C
		3	1	4

Course Objective:

The objective of this course is to provide students with an understanding of basic concepts in Social Network Analysis and explain its importance. The basic object of social lnetwork analysisis to study and analyse the different network structure when the actors are interacting each otherina real world.

Course Outcomes:

At the end of course student shall be able to:

1. Understand the concepts Social Network and its analysis.
2. Understand the community structure and cohesiveness of different subgroups.
3. Understand the cascade in gproperties of different networks.
4. Do analysis of decentralize online social networks and understand different link analysis forw ebmining.

UNIT I

Limitations of current Web - Development of Semantic Web-Emergence of the Social Web- Social Network analysis: Development of Social Network Analysis -Key concepts andmeasures in Network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis. Types of networks, Tools for visualizing network data, review of graph theory basics.

UNIT II

Structural properties of networks: Notions of centrality, cohesiveness of subgroups: clique, n-cliques, n-clans, n-clubs, k-flexes and k-cores. Roles and positions, structural equivalence, regular equivalence, automorphic equivalence, equitable partitions, stochastic blockmodels and community structure in networks.

UNIT III

Cascading properties of networks: Information/influence diffusion on networks, maximizing influence spread, power law and heavy tail distributions, preferential attachment models, small world phenomenon

UNIT IV

Mining Graphs: Community and cluster detection: Extracting evolution of Web Community from a Series of Webarchive- Detecting communities in social networks-Definition of community-Evaluating communities- Methods for community detection and mining, Applications of community mining algorithms -Tools for detecting communities social network infrastructures and communities Decentralized online social networks-Multi Relational characterization of dynamic social network communities, random walks, spectral methods, link analysis for webmining: pagerank, weighted page rank and hyper-link in duced topic search (HITS) algorithms.

Text Books:

1. Stanley Wasserman, Katherine Faust. Social network analysis: methods and applications.Cambridge University Press, 1994.
2. PeterMika,"Social Networks and the Semantic Web",First Edition,Springer2007.

Reference Books:

1. Peter R.Monge,Noshir S.Contractor, Theories of communication networks.Oxford University Press, 2003.
2. DuncanWatts.Six degrees:the science of a connected age.Norton, 2004.

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS242T	ComputationalIntelligence[PEIV]	L	T/P	C
		3	1	4

Course Objectives:

1. Tounderstand, analyze andapplytheconcepts of neural network,neuro-modelling,several neural network paradigms.
2. To understand, analyze and apply the concepts of fuzzy logic, knowledge representation using fuzzy logic, approximation reasoning, fuzzy inference system, fuzzy logic controland other machine intelligent application of fuzzy logic.
3. To understand, analyze and apply the concept of evolutionary computing paradigm known as genetic algorithm to engineering optimization problems.
4. Tounderstand, analyze and apply the concept of hybrid algorithms in different engineering application.

Course Outcomes:

At the end of course student shall be able to:

1. Know about the basic concept of computational intelligence and also their use in some real life situation.
2. Solve the problems using neural network techniques.
3. Find the solution using different fuzzy logic techniques.
4. Use genetic algorithms for different modeling.

UNIT I

Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks, perception model, feed forward neural network, Back propagation, Adaline, Widrow-Hoff's Adaline model, Madaline, Unsupervised learning neural network: Hopfield neural network, Competitive learning, self- organizing feature map, Reinforcement learning: Q-learning, Temporal difference learning.

UNIT II

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, membership functions, Fuzzy set theory and operations, Extension principle of fuzzy set, fuzzy inference, Fuzzy implications, fuzzy relation, fuzzy reasoning , fuzzy c-means clustering , fuzzy inference Engine on VLSI architecture, Defuzzification techniques

UNIT III

Fundamentals of genetic algorithms: Encoding, Fitness functions, Reproduction Genetic Modeling : Cross cover, Inversion and deletion, Mutation operator, Bit-wise operators, Bitwise operators used in GA. Convergence of Genetic algorithm. GA as an alternative to back propagation, Applications of GA in navigational planning of robots , Particle swarm optimisation,ant-colony optimisation,Bee colony optimisation.

UNITIV

Hybrid Systems: Neuro-fuzzysynergism,weakly coupledNeuro-fuzzy system,Tightlycoupled Neuro-Fuzzy System, fuzzy-GA synergism, Neuro-GA, Adaptation of neural learningalgorithm using GA

Text Books:

1. Computational Intelligence Principles, Techniques and Applications, Amit Konar, Springer publication.
2. Neural Networks,Fuzzy Logic, and Genetic Algorithm (synthesis and Application) S.Rajasekaran, G.A.Vijayalakshmi Pai,PHI
3. Principles of Soft Computing S.N.Sivanandam & S.N.Deepa,Wiley-India Edition

Reference Books:

1. Neuro Fuzzy and Soft Computing,J.S.R.JANG,C.T. Sun,E.Mitzutani, PHI
2. Soft-computing,D.K.Pratihar, Alpha Science

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS243T	**Real Time Systems[PEIV]**	**L**	**T/P**	**C**
		3	1	4

Course Objectives:

1. To study issues related to the design and analysis of systems with real-time constraints.
2. To learn the features of Real time OS.
3. To learn about computer control and hardware requirements for Real time systems.
4. To study the methods of developing Real time applications.
5. To study the difference between different Real time system development methodologies.

Course Outcomes:

At the end of course student shall be able to:

1. Understand classifications of Real time systems.
2. Comprehend Real-time programming environments
3. Schedule jobs in Real time systems
4. Develop real time systems.

UNIT I

Introductiontoreal–time computing

Elements of Control System – Structure of a real–time system – Classification of Real-time Systems, Time Constraints, Classification of Programs, Concepts of Computer Control: Introduction, Sequence Control, Loop Control, Supervisory Control, Centralized Computer Control, Hierarchical Systems. Hardware Requirements for Real-Time Applications Introduction – General Purpose Computer – Single Chip Microcomputers and Microcontrollers – Specialized Processors – Process-Related Interfaces – Data Transfer Techniques – Communications – Standard Interface.

UNIT II

Languages for Real-Time Applications Introduction – Syntax Layout and Readability – Declaration and Initialization of Variables and Constants – Modularity and Variables – Compilation of Modular Programs – Data types – Control Structures – Exception Handling – Low-level facilities – Co–routines – Interrupts and Device Handling – Concurrency –Real- Time Support–Overview of Real-Time Languages.

UNIT III

Real Time Operating Systems

Introduction – Real-Time Multi-Tasking OS – Scheduling Strategies – Priority Structures – TaskManagement –SchedulerandReal-TimeClockInterruptHandler–MemoryManagement – Code Sharing – Resource Control Task Co-Operation and Communication – Mutual Exclusion.

UNIT IV

RTS Development Methodologies Introduction – Yourdon Methodology – Ward and Mellor Method – Hately and Pirbhai Method.

Text Books:

Stuart Bennet,“Real–Time Computer Control”,2^{nd} Edn.,Pearson Education, 2008.

ReferenceBooks:

Rajib Mall,"Real–Time Systems:Theory and Practice",1stedition, Pearson Education,2012

Master of Technology (Computer Science & Engineering) Syllabus : Semester II

23PCS206T	Foundation Course I: Research Methodology	L	T/P	C
		3		3

Course Objectives:

1. Identify and discuss the role and importance of research in thesocialsciences.
2. Identify and discuss theissues andconcepts salientto theresearch process.
3. Identify and discuss the complex issues in herent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Course Outcomes:

At the end of course student shall be able to:

1. Explain key research concepts and issues
2. Read,comprehend,and explain researcharticles in their a cademic discipline.
3. Demonstratethe ability to choose methods appropriate to research aims and objectives
4. Understand the limitations of particular research methods

UNIT I

IntroductiontoResearch Methodology

Meaning of research, objectives of research, meaning of research, motivation in research, types of research, scope of educational research, characteristics and prerequisites of educational research, types of educational research, research approaches, significance of research, research methods versus methodology, research and scientific method, importance of knowing how research is done, research process, criteria of good research, necessity of defining the problem.

UNIT II

TechniquesforResearchMethodology

Defining research problems, hypothesis formulation, developing a research plan, research design, features of a good design, different research designs, and important concepts related to research design, methods for data collection.

UNIT III

DataAnalysisandStatistical Techniques

Data and their analyses, quantitative methods and techniques, Measure of central tendency, measures of variation, frequency distribution, analysis of variance methods, identifying the distribution with data, parameter estimation, Goodness-of-Fit tests-Chi-Square test, K-S Goodness-of-Fit test, Correlation analysis, Regression analysis, time series and forecasting, Introduction to discriminate analysis, factor analysis, cluster analysis, conjoint analysis. Sampling methods, test of hypothesis

UNIT IV

AlgorithmicResearchandSimulation

Algorithmic research problems, types of algorithmic research, types of solution procedure, steps of development of algorithm, steps of algorithmic research, design of experiments, stepsofmodeling, operationsresearchmodels,applicationofmodels.Needforsimulation, types of simulation, simulation language, fitting the problem to simulation study, simulation models, output analysis.

Text Books and Reference Books:

1. Research Methodologies,R.Panneerselvam, Prentice Hall, 2007.
2. Researchin Education,BestJohn V.and JamesVKahn,Wiley eastern, 2005.
3. ElementsofEducationalResearch,Sukhia, S.P.,P.V.Mehrotra,andR.N. Mehrotra, PHI publication, 2003.
4. Methodology of Research Education,K.Setia,EEE publication,2004.
5. Research methodology, Methodsand Techniques, Kothari,C.R., 2000.

23PCS201P	Advanced Database Systems Lab	L	T/P	C
			2	1

Course Objective:

This lab work will enhance database handling, data manipulation and data processing skills through SQL & PL/SQL, which will help them in developing data centric computer applications.

Course Outcomes:

At the end of course student shall be able to:

1. Understand the fundamentals of relational database systems including: data models, database architectures and ER features.
2. Evaluate and a doptthe different normalization techniques.
3. Assess the basic issuesof transaction processing and concurrency control.
4. Understand the roles that data bases play in organizations and familiarize with basic database storage, file organization, database accessing techniques.

Experiments on the following topics are expected to be covered:

5. Familiarization of the MySQL database–creation and manipulation of tables.
6. Analyze a given situation, develop an ER model and convert the ER model to Relationalmodel.
7. Implement the database using MySQL and manipulate the tabl esusing SQL commands.
8. Lab Course Project: Course project to picselection, developing an ER modeland converting ER model to a Scheme diagram
9. Developing a data flow diagram for the problem specification.
10. Implementation of front end pages.
11. Implementation of serversidepages and verifying the normalization
12. Testing the constraints and project
13. Submission and evaluation of project

Text Books/Reference Books:

1. Elmasr, Navathe, ‘Fundamentals of Database Systems’,4th ed., Pearson Education
2. Reghu Ramakrishnan, Databse Management Systems, McGrawHill

23PCS202P	Advancesin Operating Systems Lab	L	T/P	C
			2	1

Course Objectives:

1. To study the characteristics of OS for Multiprocessor and Multicomputer.
2. To learn theissues related to designing OS.
3. To learn the latest trends in building Mobile OS.

Course Outcomes:

At the end of course student shall be able to:

1. Knowledge about advanced concept sinOS
2. Ability to developOS for distributed systems
3. Ability to develop modules form obile devices

Followings are some of the areas where experiments need to be conducted under the Advances in Operating Systems lab:

1. Synchronization,communication and scheduling in parallel systems
2. Distributed systems and their communication mechanisms
3. Failures and recovery management
4. System support for Internet-scale computing
5. Research positionin Multi-O Senvironment (LinuxOS, MacOS,Symbian and other mobile applications)
6. There search group might be funded by Intel,Nutanix, semiconductor research consortium
7. Research positions may include Operating System Developr (Kernel/Algorithm/Memory)

Text Book:

M Singhal and NG Shivaratri, Advanced Conceptsin Operating Systems,TataMcGraw Hill Inc, 2001

Reference Books:

1. ASTanenbaum, Distributed Operating Systems,Pearson Education Asia,2001
2. Source Wikipedia, Mobile Operating Systems,General BooksLLC,2010

Master of Technology (Computer Science & Engineering) Syllabus : Semester III

23PCS351T	Fundamentals of Cyber Security[OE]	L	T/P	C
		3		3

Course Objectives:

1. Understand various block cipher and stream ciphe rmodels
2. Describe the principles of public key cryptosystems, hash functions and digital signature
3. To get a firm knowledge on Cyber Security Essentials

Course Outcomes:

At the end of course student shall be able to:

1. Implement basic security algorithms required by any computing system
2. Analyze the vulnerabilities in any computing system and hence be able to design a security solution
3. Analyze the possible security attacks in complex real time systems and their effective counter measures
4. Enumerate various governing bodies of cyber laws
5. Impart various privacy policies foran organization

UNIT I

PUBLIC KEY CRYPTOGRAPHY AND HASH ALGORITHMS:

Principles of public key cryptosystems. The RSA algorithm-Key management, Diffie-Hellman Key exchange- Hash functions-Hash Algorithms (MD5, Secure Hash Algorithm)

UNIT II

FUNDAMENTALS OF CYBER SECURITY:

How Hackers Cover Their Tracks- Fraud Techniques- Threat Infrastructure- Techniques toGain a Foothold (Shellcode, SQL Injection, Malicious PDF Files)- Misdirection, Reconnaissance, and Disruption Methods

UNIT III

PLANNING FOR CYBER SECURITY:

Privacy Concepts -Privacy Principles and Policies -Authentication and Privacy - Data Mining - Privacy on the Web - Email Security - Privacy Impacts of Emerging Technologies

UNITIV

CYBER SECURITY MANAGEMENT:

Security Planning - Business Continuity Planning - Handling Incidents - Risk Analysis - Dealingwith Disaster – Legal Issues –Protectingprograms andData – Information andthe law – Rights of Employees and Employers - Emerging Technologies - The Internet of Things - Cyber Warfare

Text Books and References:

1. William Stallings, “Cryptography and Network Security”, Pearson Education, 6th Edition, 2013.
2. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition , Pearson Education , 2015.
3. Graham,J.Howard,R.,Olson,R.,Cyber Security Essentials,CRCPress,2011.
4. GeorgeK. Kostopoulous,Cyber Space and Cyber Security, CRC Press, 2013.

Master of Technology (Computer Science & Engineering) Syllabus : Semester III

23PCS352T	Multimedia[OE]	L	T/P	C
		3		3

Course Objectives:

1. To introduce various aspects of multimedia components like Images, audio, sound and computer graphics.
2. Students will gain knowledge and express their creativity which will also arouse students' interest in the course and further motivate them towards developing their career in the area of multimedia and internet applications

Course Outcomes:

At the end of course student shall be able to:

1. To Critically and analyze the key components of multimedia technologies including text, graphics, voice, video and animation and the broad principles associated with multimedia concepts used in computer graphics.
2. Create vector and typographic designs and apply masking effect to images and Create ananimation using the tools panel.
3. Design animage using imageediting tools and apply effectively.Create animated sequence with titles applying the principles of animation.
4. Apply acquired knowledge in the field of multimedia for the good cause like advertisement in practice and independently continue to expand knowledge in this field.

UNIT I

INTRODUCTION: Multimedia- Definitions, Use of Multimedia, Introduction To Making Multimedia: The Stages of a Multimedia Project, Need, Creativity, Organization, Communication. Text-About Fonts and Faces, Cases, Serif Versus Sans Serif, Using Text in Multimedia, Computers and Text, Font editing and design tools, Hypermedia and Hypertext. Designing for the World Wide Web-Developing for the Web, Text for the Web, Images for the Web, Sound for the Web, Animation for the Web.

UNIT II

IMAGES: Images: Making Still Images, Bitmaps, Vector Drawing, 3-D Drawing and Rendering,Color, UnderstandingNatural Light andColor, Computerized Color,Color Palettes, Image File Formats.

UNIT III

IMAGE EDITING: Image Editing software: selection tools, working with layers, masks and channels, correcting and enhancing photographs, typographic design and vector drawing, working with 3D images, producing files for the web.

UNIT IV

ANIMATION: Animation-Principles of Animation, Animation by Computer, Animation Techniques, Animation File Formats, Making Animations that Work, a Rolling Ball, a Bouncing Ball, Creating an Animated Scene; Installing and using animation software (Flash or Blender), adding animation, tweening, morphing; Interactive navigation-working with sound and video.

Textbook:

TayVaughan, Multimedia:Makingit Work (SeventhEdition)(2010).McGraw Hill Professional.

References/Books:

1. Student friendly video lecturer spertaining to this course are available at http://spoken-tutorial.org
2. .Juan Manuel Ferreyra, GIMP2.6 cook book,2011.
3. Roland Hess, Blender Foundation

Master of Technology (Computer Science & Engineering) Syllabus : Semester III

23PCS353T	Enterprise Resource Planning[OE]	L	T/P	C
		3		3

Course Objectives:

1. Communicate the relevance and evolution of modern Enterprise applications.
2. Convey an understanding of the basic concepts of Process Mapping and Business Process Reengineering in an ERP context.
3. Explain the ERP Life cycle challenges and success factors.
4. Inform the latest trends in Enterprise Applications.
5. Guide the configuration of the business processes in open source ERP and SAP.

Course Outcomes:

At the end ofcourse student shall be able to:

1. Identify the relevance and evolution of modern Enterprise applications.
2. Examine the basic concepts of Process Mapping and Business Process Reengineering in an ERP context.
3. Identify the ERP Life cycle challenges and success factors.
4. Build and configure business process in open source ERP.

UNIT I

ERP Introduction, Technology & Functional Modules

Introduction, Evolution from MRP to ERP, Need for an ERP, Essentials, Advantages and Risks: ERP Architecture, System Landscape, RDBMS, Configuration, Customisation: Functional Modules of ERP; Manufacturing/SCM, Sales & Distribution, HR, Finance; CRM, SRM.

UNIT II

Business Process Redesign and Mapping

Business Function & Processes, Cross Functional Processes, Functional departments in a Business, Business Process Reengineering, Process mapping.

UNIT III

ERPL ife Cycle: Selection an Implementation

Pre-implementation tasks/Readiness for ERP, Requirements definition/analysis, Cost Benefit Analysis/ERP Costs, ERP Life Cycle: Package Selection, ERP Transition Strategies,ERP Implementation Strategies, methodologiesand challenges, ERP implementation lifecycle, Vendors and Consultants, Training & Education, Data Migration, Post Implementation activities, Success & Failure factors of ERP implementation, Testing and Users, Operation & Maintenance of an ERP system, Measurement of the performance of ERP system.

UNIT IV

ERP Market and Trends

ERP Market Share Analysis, Popular ERP Package Vendors, Cloud based ERP, Mobility, Business Intelligence and Analytics, Geographic Information systems (GIS), OLAP, Security Systems for

ERP, Enterprise Application Integration, ERP and e-Business, Open Source ERP, Introduction to ERP packages such as SAP, Odoo, ERP Sim.

Text Books:

1. Brad ford, Marianne.Modern Erp:Select, Implement and Use Today’sAdvanced Business Systems. Morrisville, NC: Lulu, 2015. Print.
2. Leon, Alexis. Enterprise Resource Planning.(Fourth Edition) New Delhi: McGraw-Hill Education (India) Pte Ltd, 2019. Print.

References:

1. Monk, Ellen & Wagner, Bret.Concepts in Enterprise Resource Planning (3rdEdition), 2011.
2. Leon, Alexis.ERPDemystified.,2014. Print.
3. Ray, Rajesh. Enterprise Resource Planning-Text & Cases.McGraw-HillEducation(India) Pte Ltd, 2011. Print.
4. K. Ganesh & Sanjay Mohapatra & S. P. Anbuudayasankar & P. Sivakumar, "Enterprise Resource Planning,"Management for Professionals, Springer,edition127, number978-3-319-05927-3, August. 2014.

23PCS302T	Foundation Course II: Project Planning and Management	L	T/P	C
		3		3

Course Objectives:

This course is aimed at introducing the primary important concepts of project management related to managing software development projects. They will also get familiar with the different activities involved in Software Project Management. Further, they will also come to know how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget.

Course Outcomes:

At the end ofcourse student shall be able to:

1. Identify the different project contexts and suggest an appropriate management strategy.
2. Practice the role of professional ethicsin successful software development.
3. Identify and describe the key phases of project management.
4. Determine an appropriate project management approach through an evaluation of the business context and scope of the project.

UNIT I

SOFTWARE MANAGEMENT & ECONOMICS: The Waterfall Model, Conventional software Management Performance; Evolution of Software Economics - Software economics, Pragmatic software cost estimation, Reducing software product size, Improving software processes.

UNIT II

THE OLD AND THE NEW WAY OF PROJECT MANAGEMENT: Improving team effectiveness, Improving automation through software environment, Achievingrequired quality; Peer inspections – A pragmatic view, The principles of conventional software engineering, Principles of modern software management, Transitioning to an iterative process.

UNIT III

SOFTWARE MANAGEMENT PROCESS FRAME WORK: Life cycle phases, The artifact sets, Management artifacts, Engineering artifacts, Pragmatic artifacts; Model Based Software Architectures - A management perspective and A technical perspective.

UNIT IV

PROJECT ORGANIZATION AND PLANNING: Work breakdown structures, Planning guidelines, Thecost and scheduleestimating process, Theiteration planning process, Pragmatic planning, Line-of-Business organizations, Project organizations, Evolution of organizations; Process automation - Automation building blocks, The project environment.

Text Book:

Walker Royce,“Software Project Management”, 1stEdition, Pearson Education,2006.

References Books:

1. Bob Hughes and Mike Cotterell,“Software Project Management”,3rd Edition, Tata McGraw Hill Edition, 2005.
2. Joel Henry,“Software Project Management”,1st Edition, Pearson Education, 2006.
3. Pankaj Jalote,“Software Project Management in practice”,1st Edition, Pearson Education, 2005.

23PCS303P	**Project and Seminar**	**L**	**T/P**	**C**
			16	8

For Project with Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Project with code and Seminar, there will beinternal evaluation as well as external evaluation of 100 marks each. A candidate has to secure a minimum of 50% of marks to be declared successful.

Master of Technology (Computer Science & Engineering) Syllabus: Semester IV

Sl. No	Subject Code	Subject	Teaching Scheme				Scheme of Examination (Marks)			Duration of Exam. (Hours)	Minimum Passing Marks
			L	T	P	Total Credits	EE	CA	Total Marks		
1.	23PCS401P	Industrial Project			32	16	200	200	400	-	200
Total Marks							200	200	400		
Load of the semester						**32**	**Total credits in the**				**16**

The Dissertation/Project internal evaluation will be done by the Committee on the basis of seminar, viva-voce and the dissertation report submitted by the candidate out of 200 marks.

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COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

STRUCTURAL ENGINEERING

Of

RASHTRASANT TUKDOJI MAHARAJ

NAGPUR UNIVERSITY, NAGPUR

Annexure III

Curriculum and Syllabus of Post Graduate Course (Structural Engineering):

SCHEME OF EXAMINATION

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Sr. No.	Course Code	Course Category	BOS/ Dept	Course Name	Contact Hours				Marks				Total Marks	ESE Duration
									Theory		Practical			
					L	T	P	Credits	CE	ESE	CE	ESE		
1	24PSE101T	PCC	CV	Advanced Concrete Structure Design	4	0	0	4	40	60	--	--	100	3 Hours
2	24 PSE101 P	PCC	CV	Lab: Advanced Concrete Structure Design	0	0	2	1			25	25	50	
3	24 PSE102 T	PCC	CV	Substructure and Foundation Design	4	0	0	4	40	60	--	--	100	3 Hours
4	24PSE103T	PCC	CV	Pre-stressed Concrete Structures	4	0	0	4	40	60	--	--	100	3 Hours
5	24PSE104T	PCC	CV	Matrix Analysis of Structures	4	0	0	4	40	60	--	--	100	3 Hours
6	24PSE104P	PCC	CV	Lab: Matrix Analysis of Structures	0	0	2	1			25	25	50	
7	24PSE11XT	PEC	CV	Program Elective-I	4	0	0	4	40	60	--	--	100	3 Hours
					20	**0**	**4**	**22**	**200**	**300**	**50**	**50**	**600**	

Course Code	**Program Elective-I**
24PSE111T	Structural Instrumentation and Rehabilitation of Structures
24PSE112T	Advanced Concrete Technology and Admixtures
24PSE113T	Finite Element Method

SCHEME OF EXAMINATION

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Sr. No.	Course Code	Course Category	BOS / Dept	Course	Contact Hours				Marks				Total Marks	ESE Duration
									Theory		Practical			
					L	T	P	Credits	CI	ESE	C	ESE		
1	24PSE201T	PCC	CV	Structural Dynamics	3	0	0	3	40	60	--	--	100	3 Hours
2	24PSE201P	PCC	CV	Lab: Structural Dynamics	0	0	2	1			25	25	50	
3	24PSE202T	PCC	CV	Design of Bridges and Retaining Structures	4	0	0	4	40	60	--	--	100	3 Hours
5	24PSE203T	PCC	CV	Advanced Design of Steel Structures	4	0	0	4	40	60	--	--	100	3 Hours
7	24PSE204T	PCC	CV	Research Methodology and IPR	2	0	0	2	20	30	--	--	50	2 Hours
8	24PSE21XT	PEC	CV	Program Elective-II	4	0	0	4	40	60	--	--	100	3 Hours
9	24PSE22XT	PEC	CV	Program Elective-III	4	0	0	4	40	60	--	--	100	3 Hours
					21	**0**	**2**	**22**	**220**	**330**	**25**	**25**	**600**	

Course Code	**Program Elective-II**
24PSE211T	Analysis and Design of Special Structures
24PSE212T	Fabrication and Erection of Structures
24PSE213T	Green Building and Sustainable Practices
	Program Elective-III
24PSE221T	Analysis and Design of Industrial Buildings
24PSE222T	Introduction to Earthquake Engineering
24PSE223T	Theory of Plates and Shells

SCHEME OF EXAMINATION

THIRD SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Sr. No.	Course Code	Course Category	BOS/ Dept	Course	Contact Hours				Marks				Total Marks	ESE Duration
									Theory		Practical			
					L	T	P	Credits	CE	ESE	CE	ESE		
1	24PSE301P	PCC	CV	Dissertation Phase-I	0	0	12	6	--	--	100	100	200	
2	24PSE31XT	PEC	CV	Program Elective IV	3	0	0	3	40	60	--	--	100	3 Hours
3	24PSE32XT	PEC	CV	Program Elective V	3	0	0	3	40	60	--	--	100	3 Hours
					6	**0**	**12**	**12**	**80**	**120**	**100**	**100**	**400**	

Course Code	ProgramElective-IV
24PSE311T	Design of Multi storied Buildings
24PSE312T	Theory of elasticity and elastic stability
24PSE313T	Smart Structures & Applications
	ProgramElective -V
24PSE321T	Wind effects on structures
24PSE322T	Composite structures
24PSE323T	Structural Instrumentation

SCHEME OF EXAMINATION

FOURTH SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Sr. No.	Course Code	Course Category	BOS/ Dept	Course	Contact Hours				Marks				Total Marks	ESE Duration
									Theory		Practical			
					L	T	P	Credits	CE	ESE	CE	ESE		
1	24PSE401P	PCC	CV	Dissertation	--	--	32	16	--	--	200	200	400	
					--	**--**	**32**	**16**	**--**	**--**	**200**	**200**	**400**	

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

CourseTitle: Advanced Concrete Structures Design **Course Code:** 24PSE101T

Teaching Scheme:L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1. To discuss the different design approaches for a RCC Frame structure and its application.
2. To understand the concept of flat slab
3. To design and analyze Elevated and Ground water tank.
4. To learn the design and detailing of staircase
5. To explain the concept and design of special structure shear wall

Course Outcomes: At the end of the course, the student will be able to

1. Analyze and design portal frame.
2. Design the Flat slab.
3. Designing and detailing of Elevated and Ground water tank.
4. Explain and adopt the different methods for Staircase design.
5. Understand the Classification of shear walls design principles.

Course Content	
Unit I	Introduction to IS Code, Concept of Analysis and design, Approximate analysis, Analysis and design of portal frame.
Unit II	Design of Flat slabs according to IS method, Shear in Flat Slabs, Equivalent frame method.
Unit III	Design of Elevated and Ground water tank - Circular, Rectangular
Unit IV	Design and detailing of staircase
Unit V	Introduction and Classification of shear walls, design principles, Design and detailing of Concrete walls.

Sr. No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Bhavikatti S. S., Advanced R. C. C. Design Volume-II, New age international publisher, New Delhi, Ist edition - 2006
2	Krishna Raju N, Advanced R. C. C. Design, CSB Publisher and Distributor, New Delhi, 2nd edition-2005
3	Ramaswamy, G.S, Design of Concrete Shells, Krieger Publ. Co., 1984
4	Advanced Reinforced Concrete Design, by P.C. Varghese Prentice Hall India Limited
5	Design of reinforced concrete structure by Ramamrutham

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Advanced Concrete Structures Design **Course Code:** 24PSE101P

Teaching Scheme:L-T-P: 0-0-2 **Total Credits: 1**

List of Experiment- Based on software

1. Minimum Five Designs / Experiments based on above syllabus.
2. Minimum two site visit based on above syllabus.

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

CourseTitle: Substructure and Foundation design **Course Code:** 24PSE102T

Teaching Scheme:L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1. To understand soil structure interaction and soil classification.

2. To design of raft foundation and combined footing.

3. To explain the concept of ground improvement technique

4. To discuss and design of machine foundation.

5. To Analyse and design of pile foundation.

Course Outcomes: At the end of the course, the student will be able to

1. Identify the type of foundations to be used for various site conditions
2. Analyze and design different types of foundation structures.
3. Understand the various ground improvements method.
4. Design machine foundation
5. Design of pile foundation.

Unit I	Introduction to soil structure interaction, Soil classification, Geotechnical design parameters, factors affecting settlement, control of excessive settlements. Design of isolated footings including eccentric load.
Unit II	Design raft foundation and combined footing.
Unit III	Ground improvements: Various methods, sand drains, stone columns, stabilization, grouting, reinforced earth, geotextiles, diaphragm walls, Reinforced earth retaining walls, skin walls.
Unit IV	Introduction to machine foundations, design and its practical considerations for construction IS code of practice.
Unit V	Analysis and design of pile foundation.

Suggested Self Readings

Sr. No	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Sawmi Saran, ― Analysis and Design of Substructures‖, , Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2	Kurain N. P,‖ Design of foundation systems- Principles and Practice‖, Narosa Publishing house, New Delhi, 2005.
3	Poulose H.G. and Davis E.H.,‖ Pile foundation Analysis and Design‖, John-Wiley Sons, NY, 1980.
4	Karuna Moy Ghosh , ―Foundation Design in practice‖, PHI Learning Pvt. Ltd, New Delhi 2012
5	P. C. Varghese, ―Design of Reinforced Concrete Foundations‖, PHI Learning Pvt. Ltd., New Delhi, 2009.

References Books

1. J. E. Bowles, ―Foundation Analysis and Design‖, Tata McGraw Hill New York
2. Kurain N.P,‖ Modern Foundations: Introduction to Advance Techniques‖, Tata McGraw Hill, 1982
3. Winterkorn H.F. and Fang H.Y. Ed., ―Foundation Engineering Hand Book‖, Van-Nostrand Reynold, 1975
4. Bowles J.E., ―Foundation Analysis and Design‖ (4th Ed.), Mc.Graw –Hill, NY, 1996
5. Sreenivasalu&Varadarajan, ―Handbook of Machine Foundations‖, Tata McGraw Hill
6. Hetenyi, M. ―Beam on Elastic Foundation‖, University of Michigan Press, 1946.
7. Swami Saran, ―Soil Dynamics and machine Foundations‖, Galgotia Publications (P)Ltd, New Delhi, 1999.

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Prestressed Concrete Structures **Course Code:** 24PSE103T

Teaching Scheme:L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1. To understand the basic aspects of prestressed concrete fundamentals including pre and post tensioning process
2. To analyse and design of prestressed concrete flexural members
3. To analyse and design of prestressed concrete slab and beam
4. To learn about various designs of pre-stressed elements
5. To understand the pre-stressed elements

Course Outcomes: At the end of the course, the student will be able to

1. Explain the principle, types and systems of prestressing and analyze the deflections.
2. Determine the flexural strength and design the flexural members, end blocks.
3. Design the tension and compression members and apply it for design of piles.
4. Analyze the statically indeterminate structures and design the continuous beam.
5. Analyze the Composite construction of Pre- stressed and in- situ concrete.

Unit I	**INTRODUCTION:** Development of prestressed concrete –Advantages and Disadvantages of PSC over RCC –General principles of pre-stressing-pre tensioning and post tensioning, code provisions –Materials used in PSC-high strength concrete –High tension steel-Different types /methods/systems of prestressing
Unit II	**Design Principles**: Design of flexural members, Design for Shear, bond and torsion. Design of End blocks and their importance, Design of tension members, application in the design of prestressed pipes and prestressed concrete cylindrical water tanks, design of concrete flat plates.
Unit III	Design of compression members with and without flexure, its application in the design piles.
Unit IV	Application of prestressing in continuous beams, concept of linear transformation, concordant cable profile and cap cables.
Unit V	Composite beams, analysis and design, ultimate strength, their applications. Partial prestressing, its advantages and applications.

Suggested Self Readings

Sr. No.	Suggested Text Books/Reference Books
1	Prestressed Concrete by Krishna Raju, Tata McGraw Hill Publishing Co.
2	Fundamentals of Prestressed Concrete by N.C.Sinha & S.K.Roy S.Chand & Co.
3	T.Y.Lin, Design of Prestressed Concrete Structures, John Wiley and Sons, Inc.
4	Evans, R.H. and Bennett, E.W., Prestressed Concrete, Champman and Hall, London. MTCSE30
5	Prestressed Concrete by S. Ramamrutham, Dhanpati Rai Pubilicartions.
6	Prestressed concrete design by Praveen Nagarajan, Pearson Pubilications.

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

CourseTitle: Matrix Analysis of Structures **Course Code:** 24PSE104T

Teaching Scheme:L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1. To make students to learn principles of Structural Analysis.

2. To Solve plane frame and space frames by matrix method

3. To evaluate the force in truss.

4. To develop stiffness matrix for Grid

5. To analyse special effect structure

Course Outcomes: At the end of the course, the student will be able to -

1. Understand the fundamental concepts and modern methods of Structural analysis.

2. Analyze Global stiffness matrix and load vectors for plane frame and space frames

3. Develop member stiffness matrix for Plane Truss, Space Truss

4. Perform Stiffness method for Grid elements

5. Recognize special effects on behaviour of structures

Unit I	Introduction of matrix methods of analysis – Static and kinematic indeterminacy – Degree of freedom– Structure idealization- stiffness and flexibility methods – Suitability: Element stiffness matrix for truss element, beam element and tensional element- Element force - displacement equations. Analysis of Beam by Stiffness Method.
Unit II	Analysis of Plane Frame, Space Frame by Stiffness Method
Unit III	Analysis of Plane Truss, Space Truss by Stiffness Method
Unit IV	Stiffness method for Grid elements – development of stiffness matrix – coordinate
Unit V	Analysis for member loading (self, Temperature & Imposed) Inclined supports, Lack of Fit, Initial joint displacements.

Sr. No.	Suggested Text Books/Reference Books
1	Matrix Method of Structural Analysis, Gere, W. and Weaver; J. M., 3rd Edition, Van Nostrand Reinhold; New York; 1990
2	Matrix Method of Structural Analysis, Meghre A.S.& Deshmukh S.K. ; 1st edition, Charotar publishing house, Anand, 2003
3	Matrix Method of Structural Analysis, Kanchi, M. B., 2nd Edition; John Willey & Sons, 1999
4	Matrix Methods of Structural Analysis, Godbole P., Sonparote R., Dhote S., PHI Learning Pvt. Ltd. 2014

Reference Books

1 Matrix Analysis of Structural Dynamics, Cheng, F.Y., M. Dekke; NY 2000

2 Finite Element Procedures, Bathe, K.J., 2nd Edition Springer,; 2002

3 Concepts and Applications of Finite Element Analysis, Cook, R.D. et. al, John Willey &Sons; NY 1995

4 Introduction to Matrix Method of Structural Analysis, Martin; H.C., McGraw Hill Book Co. 1966

5 Introduction to Finite Elements in Engineering, Chandrapatla T.R., Belegundu A., D. Prentice Hall India,1991

6 Matrix Analysis of Structures SI Version, Kassimali A., Cengage Learning, 2011

7 Matrix Methods of Structural Analysis: Livesley R. K. Pergamon International Library of Science,

Technology, Engineering and Social Studies, Elsevier, 2013

8 Matrix Structure Analysis. McGuire W. Gallaghar R. H. & Zimian R. D., John Willey Publication

9 Theory of Matrix Structural Analysis, Przemieniecki J. S., Dover Publication Inc. New York

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

CourseTitle: Matrix Analysis of Structures **Course Code:** 24PSE104P

Teaching Scheme:L-T-P: 0-0-2 **Total Credits: 1**

Experiments based on Software (Any six)

1. Analyze a continuous beam with maximum three degree of Kinematic Indeterminacy.
2. Analyze a continuous beam with sinking of support with maximum three degree of Kinematic Indeterminacy.
3. Analyze a plane truss with maximum three degree of Kinematic Indeterminacy.
4. Analyze a space truss with maximum three degree of Kinematic Indeterminacy.
5. Analyze a plane frame with maximum three degree of Kinematic Indeterminacy.
6. Analyze a space frame with maximum three degree of Kinematic Indeterminacy
7. Analyze a plane grid.
8. Analyze a multi storied frame structure.

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Structural Instrumentation and Reh. of Struct. **Course Code:** 24PSE111T

Teaching Scheme:L-T-P: 3-0-0 **Total Credits: 4**

Course Objectives:

1.To describe Strain Gauges, its classification, working principle and its construction.

2. To understand the dynamic strain measurement

3. To identify structural defects and deterioration mechanisms

4. To familiarize students with the Indian codes/Standards for proof load / non-destructive testing

5. To demonstrate the Techniques for rehabilitation

Course Outcomes: At the end of the course, the student will be able to

1. Illustrate Transducers, its classification, working principle and construction

2. Understand the dynamic strain measurement

3. Identify cracks in buildings: causes and remedial measures

4. Demonstrate the knowledge of Indian codes/Standards for non-destructive / design impose load testing

5. Demonstrate the Techniques for rehabilitation / strengthening of RC, Steel and Masonry structures

Unit I	Study of various transducers, Principle of their working, displacement, velocity, acceleration etc, strain gauge & piezoelectric type of transducers. Strain gauge, classification, electrical resistance strain gauges, working Principle, types and construction, materials, strain gauge circuits, rosette analysis
Unit II	Indicating and recording devices, static & dynamic strain measurement, data acquisition and processing systems, load strain behaviour.
Unit III	Corrosion of steel, Theory and prevention. Cracks in buildings: causes and remedial measures, Factor affecting health of structure causes of distress, regular maintenance, various measures, structural safety in alteration

Unit IV	Non-destructive testing of concrete, steel structures, Various NDT tests, codal provisions, Proof Load testing.
Unit V	Techniques for Rehabilitation of RC, Steel and Masonry structures

Suggested Self Readings

Sr. No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Singh, Sadhu; Experimental Stress Analysis, Khanna Publishers.
2	R.T.Allen and S.C.Edwards, “Repair of Concrete Structures”, Blakie and Sons, UK, 1987.
3	Dension Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, U.K. 1991.
4	Soisson, H.E.; Instrumentation in Industry; John Willey & Sons; NY; 1975
5	Boomfield, J.P.; Corrosion of Steel in Concrete; E& FN SPON; 1997
6	Ganesan, T.P.; Model Analysis of Structures; University Press; 2000
7	IS: 13935; Repair and Seismic Strengthening of Bulidings- Guidelines; Bureau of Indian Standard; New Delhi; 1993
8	SP: 25; Causes and Prevention of Cracks in Buildings; Bureau of Indian Standard; NewDelhi; 1984

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Advanced Concrete Tech. and Admixtures **Course Code:** 24PSE112T

Teaching Scheme:L-T-P: 3-0-0 **Total Credits: 4**

CourseObjectives:

1. To study the material properties and its specification.

2. To study admixtures and its suitability.

3. To discuss concrete mix proportioning.

4. To provide knowledge about special concrete.

5. To explain different concreting methods.

Course Outcomes: At the end of the course, the student will be able to -

1. Understand the fundamental concepts material properties.

2. To Recognize benefit of Mineral admixtures.

3. To apply methods of concrete mix proportioning.

4. Develop special concrete

5. Explain special concreting methods

Unit I	MATERIALS AND PROPERTIES: I S specifications for materials and testing of concrete making materials, Properties, Grading, Methods of combining aggregates, Properties of fresh and hardened concrete, Variability of concrete strength, Elasticity, creep and shrinkage of concrete, Durability and factors affecting durability, behavior of concrete under aggressive environmental conditions including temperature.
Unit II	ADMIXTURES: Different types of admixtures for improving properties of concrete such as strength, workability, durability etc. Necessity & benefit of Mineral admixtures, Suitability in different conditions.
Unit III	CONCRETE MIX PROPORTIONING: Principles of concrete mix

	proportioning, Methods of concrete mix proportioning (with and without admixtures), Trial mixes, Testing of concrete mixes.
Unit IV	SPECIAL CONCRETE: Light weight concrete, Fly ash concrete, Fibre reinforced concrete, Polymer Concrete, High performance concrete, Self compacting concrete, Concrete containing Silica Fumes, Concrete containing GGBS, No fines concrete, Reactive powder concrete. concrete for 3D Printing
Unit V	CONCRETING METHODS: Process of manufacturing of concrete, Methods of transportation, placing and curing - Extreme weather concreting, special concreting methods, Vacuum dewatering - underwater concrete, special from work.

Sr. No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Neville A.M., Properties of Concrete, Pearson Education. 2. Shetty M.S., Concrete Technology, S.Chand and Company Ltd., Delhi
2	Ramachandran V.S., Concrete Admixtures Handbook, Standard Publishers Distributors, Delhi. 2. Proceedings of recent seminars / workshops / conferences and Papers from relevant National and International Journals.

FIRST SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Finite Element Merthod **Course Code:** 24PSE113T

Teaching Scheme:L-T-P: 3-0-0 **Total Credits: 4**

Course Objectives:

1. Understand the purposes and uses of the finite element analysis
2. Discuss shape function and application of FEM to bar and beam
3. To explain FEM to 2D problems
4. To learn Isoperimetric elements
5. Introduction to standard FEM software

Course Outcomes: At the end of the course, the student will be able to –

1. Explain basic concepts of finite element method.
2. Apply concepts of FEM for derivation of element equations.
3. Analyze civil engineering problems by finite element method.
4. Application of FEM to 2D problems
5. Explain mathematical modelling and solution techniques in FEM

Unit I	Introduction to Finite element method, Applications, Introduction to Rayleigh Ritz Method for bar and beam analysis, Stress strain relationship, strain displacement relationship, Equilibrium equations.
Unit II	Shape functions, Formulation of stiffness matrices and load vectors, Assembling, Application of FEM to bar and beam Problems.
Unit III	Application of FEM to 2D problems: Triangular and Rectangular element formulation using Cartesian Coordinates, Application to two-dimensional stress analysis.
Unit IV	Isoparametric elements, Natural coordinates, Application to 1D and 2D Problems. Application of FEM to 2D problems: Triangular and Rectangular element formulation using Cartesian Coordinates,
Unit V	Numerical integration, Modelling and storage techniques, Introduction to standard FEM software

Suggested Self Readings

Sr. No.	Suggested Text Books/Reference Books
1	Zienkiewicz,O.C.&Taylor,R. L.,"FiniteElementMethod",Vol-I, II& III;Elsevier,2000.
2	Hughes,T.R.J.,"FiniteElementMethod",DoverPublication,2000.
3	Bathe,K.J.,"FiniteElementProcedures",Pringor; 2ndEdition,2002.
4	Reddy,J.N.,"FiniteElementMethod",JohnWilley&Sons,1982.
5	Buchanan,G.R,"FiniteElementAnalysis",McGrawHillPubl.;NY,1995.

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Structural Dynamics **Course Code:** 24PSE201T

Teaching Scheme: L-T-P: 3-0-2 **Total Credits: 3**

Course Objectives:

1. To make student aware about principles of Structural Dynamics
2. To implement principles of single-degree freedom systems.
3. To know about Free vibrations and analytical methods.
4. To get the knowledge of Dynamic analysis
5. To aware about vibration due to earthquake

Course Outcomes: At the end of the course, the student will be able to

1. Understand the principles of Structural Dynamics.
2. Summarize the Solution techniques of single-degree freedom systems.
3. Design and develop analytical methods.
4. Summarize the Solution techniques for dynamics analysis
5. Understand the concepts of earthquake vibrations.

Course Content	
Unit I	Introduction to dynamic problems in civil engineering, codal provisions, concept of degrees of freedom, D'Alembert's principle, principle of virtual displacement and energy principles, fundamentals of rigid/deformable body, measurement of damping, analysis of undamped and viscosity damped single degree freedom systems.
Unit II	Response of single-degree-of-freedom systems to harmonics including support motion and transmissibility. Duhamel integral, principle of vibration-measuring instruments – seismometer and accelerometer.
Unit III	Free vibrations of lumped mass degree freedom systems, shear buildings orthogonality criteria, Rayleigh's method.
Unit IV	Dynamic analysis of systems with distributed properties, approximate design method, transformation factors.
Unit V	Introduction to vibration due to earthquake, Deterministic Earthquake Response: Systems on Rigid Foundations: Types of Earthquake Excitations, Translational Excitations SDOF Elastic Systems, Translational Excitations, Linear Static Method – Analysis for obtaining response of multi storeyes RC Building.

Sr. No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Dynamics of Structures – Theory and Application to Earthquake Engineering"- 2nd ed., Anil K. Chopra, Pearson Education.
2	Vibration Problems in Engineering Timoshenko, S, Van-Nostrand Co
3	Structural Dynamics- Mario Paz: CBS publishers.
4	Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (india)
5	Structural Dynamics by Roy. R. Craig John willy & fours. I.S: 1893 (Part 1) - 2016, "Code of practice for Earthquake resistant design of Structures"
6	Theory of vibrations by W.T. Thomson CBS Publishers and Distributors.

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Structural Dynamics (LAB) **Course Code:** 24PSE201P

Teaching Scheme: L-T-P: 3-0-2 **Total Credits: 1**

Course Objectives & Outcomes:

1. Apply appropriate tools to design and conduct experiments.

2. Select and apply appropriate techniques.

Experiments to be performed (Minimum 07 experiment to be performed)

1. To Examine various Instruments used in structural dynamics lab
2. To determine the response of Single degree of freedom system and to find out the natural frequency
3. To determine natural frequency and drawing mode shapes of a three-degree freedom shear building model.
4. To determine the soil Liquefaction
5. To determine earthquake induced waves in a rectangular water tank.
6. To calculate the lateral force in water tank due to earthquake when water tank is empty and water tank is full by IS 1893-2016
7. To calculate Horizontal Seismic forces at all levels of the building using IS 1893-2016 (Part-I)
8. Evaluation of damping at Resonance
9. Dynamics of vibration absorber
10. Dynamics of one span and two span beams.
11. Estimation of damping coefficient of single degree of freedom system.

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Design of Bridges and Retaining Structures **Course Code:** 24PSE202T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1.To know the basics of RC bridge design.

2.To know the IRC and its recommendations.

3.To implement IRC Loading in bridge designing.

4. To study earth retaining structures.

5.To understand the design concept of retaining structures**.**

Course Outcomes: At the end of the course, the student will be able to

1.Identify the types of bridges and Bearings.

2. Understand applicability of IRC codes related to bridges.

3. Analyze and design deck slab bridges.

4. Implement various codal provisions for earth retaining structures.

5. Design earth retaining structures

	Course Content
Unit I	Introduction of RC bridge superstructure and design parameters, choice of type of bridges. Hydraulic Design: Importance of Hydraulic Factors in Bridge Design. Bridge bearings.
Unit II	Introduction to IRC: Loads, Analysis of IRC Loads, Impact factors, other loads to be considered in Bridge Design. IRC recommendations. Design of bridge with Class AA track vehicles.
Unit III	Design reinforced concrete deck slab bridge. (Class AA wheel vehicles, Class A & B)
Unit IV	Introduction of earth retaining structures and IS code recommendations
Unit V	Design of earth retaining structures.

Sr.No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Chen, W.F. and Duan, L, “Bridge Engineering Handbook”, CRC Press, 1999.
2	Fintel, M., “Handbook of Concrete Engineering” 2nd Edition, CBS Publishers Delhi, 1986.
3	Jagdeesh R. and Jairam M., ― Design of bridges‖, PHI Publication New Delhi, 2nd edition
4	N. Krishna Raju, Design of bridges, Oxford & IBH publishing Co. Ltd., New Delhi.
5	D. Johnson Victor, Essentials of bridge engineering, Oxford & IBH publishing Co. Ltd., New Delhi.
6	Hambly, E.C., Bridge deck behaviour, Chapman and Hall, London
7	O’Brien E.J. and Keogh D.L., Bridge deck analysis, E& FN Spon, New York
8	IRC: 5 -1970, Standard specifications and code of practice for road bridges, Sections I to V, Indian Roads .Congress, New Delhi.
9	IRC 006, Standard Specifications and Code of Practice for Road Bridges, Section II – Loads and Stresses.(Fourth Revision), 2014.

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Advanced Design of Steel Structures **Course Code:** 24PSE203T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1.To classify the structures and analyse the frame for wind loads.

2.To understand fatigue and the factors that influence it.

3.To know about composite sections

4.To Analysis of Plate Girder.

5.Understand the design concept of structural steel roof truss

Course Outcomes: At the end of the course, the student will be able to

1.Perform wind load analysis for frames.

2. design the welded connections and to give exposure to fatigue.

3.Design the Steel- Concrete Composite sections.

4.Design the Plate Girder

5.Design the Truss for Roof.

	Course Content
Unit I	Stability and Plate Buckling, Classification of structures-wind load analysis. Beam-column Connections/Semi Rigid Connections 4 hours Throat and Root Stresses in Fillet Welds – Seated Connections Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections
Unit II	Types of fatigue leading and failure- Fatigue test, endurance limit- S-N diagram-Various failure relations- Factors influencing fatigue strength- Influence of stress concentration on fatigue test

	Types of cross sections - Local buckling and lateral buckling - Design of compression and tension members
Unit III	Design of Steel - Concrete Composite Sections Design of beam – columns- composite slabs
Unit IV	Design of Plate Girder
Unit V	Design truss for Roof

Sr. No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Duggal.S.K., (2014), Limit State Design of Steel Structures, Tata McGraw-Hill Education, New Delhi.
2	Bhavikatti. S.S., (2012), Design of Steel Structures, I.K. International Publishing House Pvt. Ltd. New Delhi.
3	S Ramamrutham Design of steel structure- Dhanpat rai publication
4	IS 800 General Construction in Steel — Codeof Practice
5	IS 11384 Code of practice for composite construction in structural steel and concrete

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Research Methodology and IPR **Course Code:** 24PSE204T

Teaching Scheme: L-T-P: 2-0-0 **Total Credits: 2**

Course Objectives:

1.To understand the research problem

2.To know the literature studies, plagiarism and ethics

3.To analyse the nature of intellectual property rights and new developments

4.To know the patent rights

Course Outcomes: At the end of the course, the student will be able to

1.Understand research problem formulation.

2.Analyse research related information.

3.Explain various forms of the intellectual property, its relevance and business impact.

4.Understand that IPR protection provides an incentive to inventors for further research work.

Course Content	
Unit I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.
Unit II	Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write reports, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee
Unit III	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit IV	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Sr. No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
Text Books	
1	Research Methodology. Methods & Technique: Kothari. C.R.
2	Research Methodology, S.S Vinod Chandra, S Anand Hareendran, Pearson
3	Intellectual Property – Copyrights, Trademarks, and Patents by Richard Stim, Cengage Learning
4	Research Methodology a step-by-step guide for beginners: Ranjit Kumar SAGE Publications Ltd 3rd Edition, 2011
Reference Books	
1	Practical Research: planning and Design (8th Edition) – Paul D. Leedy and Jeanne E. Ormrod.
2	A Hand Book of Education Research – NCTE
3	Methodology of Education Research – K.S. Sidhu.
4	Tests, Measurements and Research methodsin Behavioural Sciences- A.K. Singh
5	Statistical Methods- Y.P. Agarwal.
6	Methods of Statistical Ananlysis- P.S Grewal.
7	Fundamentals of Statistics – S.C. Gupta, V.K. Kapoor
8	Intellectual Property Rights by Deborah E. Bouchoux, Cengage Learning.
9	Managing Intellectual Property – The Strategic Imperative, Vinod V.Sople, 2nd Edition, PHI Learning Private Limited.

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Analysis and Design of Special Structures (Program Elective-II)

Course Code: 24PSE211T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1.To aware about IS recommendation for Special Structures

2.To know the design concept of underground water tank

3.To understand the design concept of Intz Water Tank

4.To recognize the design concept of shell

5.To understand the design concept of Bunkers & silos

Course Outcomes: At the end of the course, the student will be able to

1.Apply the codal provisions for design of special Structures.

2.Examine structural behaviour and design of RC underground water tank

3. Evaluate the reinforcement of various structural components of Intz Water Tank

4. Evaluate the reinforcement of shell

5. Design Bunkers & silos

Course Content	
Unit I	Introduction and IS recommendation for Special Structures
Unit II	Design RC Water Tanks: Design & detailing of Underground water tank .
Unit III	Design Intz Water Tank
Unit IV	Design shells.
Unit V	Design Bunkers & silos.

Sr.No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Dr. B.C.Punamia, A.K. Jain; RCC Designs; Laxmi Publication
2	S.N.Sinha ; Reinforced Concrete Design, Tata McGrawhill
3	A.K.Jain; Design of Concrete Structures, Nemchand Publication
4	IS: 456-2000 Indian Standard code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi.
5	IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, Bureau of Indian Standards, New Delhi
6	Shah and Kurvey; Limit State theory & Design of Reinforced Concrete

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Fabrication and Erection of Structures (Program Elective-II)

Course Code: 24PSE212T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1. To learn about the properties of rolled steel sections.

2. To know about fabrication drawing.

3. To get knowledge about various erection process.

4. To make students aware about various tools used in erection of steel structures.

5. To impart knowledge, quality control and safety.

Course Outcomes: At the end of the course, the student will be able to

1. Achieve knowledge of properties of rolled steel sections.

2.Interpreted the fabrication drawing.

3.Understand the various erection methods.

4.Summarize the Solution techniques in the erection process.

5.explain Code provisions for inspection and safety.

	Course Content
Unit I	**GENERAL-** Various shape, size and properties of rolled steel sections, tubes and hollow rectangular sections: Chemical composition, physical properties and weldability of various types of structures steel, their suitability for various purposes.Various operations like interpretation of drawings, shop-floor operations, fastenings, assembling, finishing and shipping, sub -assemblies and main assemblies.
Unit II	**FABRICATION DRAWINGS-**Structural connections, their classification, symbols for their representation, layout of an industrial building, preparation of fabrication drawing and detailing for columns, trusses, beams and cladding, detailing of truss-joints, column bases, beam to beam and column to beam connection (Seated and framed).

Unit III	**ERECTION PROCESS**-Principle of erection, Erection organisation, Preparation and reading of erection drawing, Assembly marks, common types of structures to be erected, erection of tackle and falsework equipment for lifting and rigging, Code provisions for erection. Methods of erection, levelling and alignment, setting out and grouting, allowable tolerances for plumbing, levelling and alignment.
Unit IV	**TOOLS FOR ERECTION**- Miscellaneous small tools for erection like drifts, shakles and grips, erection of shed type buildings, portal frames, multi-storeyed buildings, prefabricated tanks, towers and chimneys.
Unit V	**INSPECTION, QUALITY CONTROL AND SAFETY**- Code provisions for tolerances and deviations, Inspection of welds, radiographic and ultrasonic techniques, Various stages of inspection, Quality control departments, methods of rectification of defects. Accidents and their causes, Various unsafe acts and precautions for their prevention, Rules for safety for cranes, winches, etc. Safety during electrical operations and while using X-ray equipment, Maintenance of erected structures, surface treatment against corrosion, etc.

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Hass, A.M. Precast Concrete Design and Applications, Applied Science Publishers, 1983.
2	Promyslolw, V Design and Erection of Reinforced Concrete Structures, MIR Publishers, Moscow 1980.
3	Structural Steel Fabrication and Erection – S.K. Saxena and R.B. Asthane (Somaiya Publications, 172, Mumbai Marathi Granth, Sangrahalaya Marg, Dadar, Bombay-14)
4	Guide Book for Fabrication and Erection of Steel Structures, Institute for Steel Development and Growth, Kolkata
5	Shivagunde R.B. and Asthana R.B., Structural Steel Drafting and Detailing, Somaiya Publications, New Delhi.
6	Steel Designer’s Manual: Edited by Graham W. Owens & Peter R. Knowles, 5 th Edition, Blakwell Scientific Publications, London.

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Green Building and Sustainable Practices (Program Elective-II)

Course Code: 24PSE213T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1. To impart knowledge of the principles and practices of the green buildings.
2. To know the importance of sustainable use of natural resources and energy.
3. To understand the principles of effective energy and resources management in buildings.
4. To bring awareness of the basic criteria in the green building rating systems.
5. To understand the methodologies to reduce, recycle and reuse towards sustainability

Course Outcomes: At the end of the course, the student will be able to

1. Define sustainability and a green building, along with its features and benefits.
2. Describe the criteria used for site selection and water efficiency methods.
3. Explain the energy efficiency terms and methods used in green building practices.
4. Select materials for sustainable built environment & adopt waste management methods.
5. Describe the methods used to maintain indoor environmental quality.

	Course Content
Unit I	**Introduction to Green Buildings:** Concept of green buildings, Concept of sustainability, typical features of green buildings, benefits of green buildings towards sustainable development. Introduction to High performance building; integrated design process of high-performance building; Green project requirements and strategies. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.
Unit II	**Green Building Materials and Indoor Environment Quality:** Introduction; Low emitting materials; Building and material reuse; Construction waste management; Regional materials; Life cycle cost assessment of building materials and products; Factors affecting indoor environment quality; Ventilation and filtration; Building materials and finishes- Emittance level; Indoor Environment quality best practice.

Unit III	**Energy Efficiency**: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy: Energy efficient building envelopes, Solar Heat Gain Coefficient, U-Values for facade materials, efficient lighting technologies, energy efficient and BEE rated appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of NET ZERO buildings.
Unit IV	**Building materials**: Methods to reduce embodied energy in building materials: (a) Local building materials. (b) Natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks. (c) Materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) Reuse of waste and salvaged materials. Waste Management: Handling of construction & demolition waste materials, separation of household waste, handling e-waste, on-site and off-site organic waste management.
Unit V	**Indoor Environmental Quality**: Day lighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Sam Kubba, "Hand book of Green building Design and construction", Elsevier Architecture Press.
2	Abe Kruger and Carl Seville, "Green building: principals and practice in residential construction", Cengage Learning.
3	**IGBC** Green New building rating system (Version 3.0), March 2015
4	GRIHA Manual Volume-1: Introduction to National Rating System by Ministry of New and Renewable Energy, Government of India and the energy and resource institute, New Delhi
5	Kibert, C. "Sustainable Construction: Green Building Design and Delivery", John Wiley & Sons, 2005
6	Non-Conventional Energy Resource by G. D. Rai, Khanna Publishers.
7	Alternative building materials and technologies by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
8	Sustainable Building Design Manual, Vol.1 and 2, TERI, New Delhi, 2004.
9	Mike Montoya, Green Building Fundamentals, Pearson, USA, 2010
10	Regina Leffers, Sustainable Construction and Design, Pearson / Prentice Hall, USA

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Analysis and Design of Industrial Buildings (Program Elective-III)

Course Code: 24PSE221T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1.To learn the codal provision for planning of industrial structure.

2.To understand the design concept of Single & Multi- Bay Industrial Structure.

3.To make aware about design criteria of foundation for industrial structures.

4. To Analyze and design the concept of Chimneys.

5. ToUnderstand the design concept of Cooling Towers

Course Outcomes: At the end of the course, the student will be able to

1. Understand codal provision for planning of industrial structures.
2. Design of Single & Multi-bay Industrial Structures in Concrete & Steel
3. Design the Foundation for Industrial Structures
4. Design Chimney
5. Design Cooling Tower.

Course Content	
Unit I	**Planning of Industrial Structures.** Introduction and planning of Industrial Structures. IS code recommendations, general aspects, civil engineering aspects.
Unit II	Design of Single & Multi-bay Industrial Structures in Concrete & Steel.
Unit III	**Foundation for Industrial Structures:** Machine foundations, general requirement, Design criteria, Design of block foundation for vertical compression, vibration isolation.
Unit IV	**Chimneys:**Introduction, classification of industrial chimneys structures and IS code recommendations . Design of Chimneys.
Unit V	**Cooling Tower:** Introduction, basic components and functions of components, parameters performance of a cooling tower.Mechanism of Heat TransferDesign of Cooling Tower.

Sr.No	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Duggal.S.K., (2014), Limit State Design of Steel Structures, Tata McGraw-Hill Education, New Delhi.
2	Bhavikatti. S.S., (2012), Design of Steel Structures, I.K. International Publishing House Pvt. Ltd. New Delhi.
3	Advanced Reinforced Concrete Design, By N. Krishna Raju (CBS Publishers & Distributors).
4	IS 800 General Construction in Steel — Codeof Practice
5	Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, Industrial Buildings: A Design Manual, Birkhauser Publishers, 2004.
6	B.C. Punmia, A.K. Jain “Design of Steel Structures”, Laxmi Publications, New Delhi.
7	Santhakumar A.R. and Murthy S.S., Transmission Line Structures, Tata McGraw Hill, 1992

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Introduction to Earthquake Engineering (Program Elective-III)

Course Code: 24PSE222T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1.To aware about the fundamentals of earthquake engineering.

2. To study the sources of earthquakes.

3. To aware about the I.S. codes and philosophy in earthquake design.

4. To know the behavior of RC structures under earthquake.

5. To learn about Earthquake Load Analysis on Structure.

Course Outcomes: At the end of the course, the student will be able to

1. Understand the fundamentals of earthquake engineering.

2. Evaluate causes and sources of earthquakes.

3. Apply I.S. codes and philosophy in earthquake design.

4. Analyse the behavior of RC structures.

5. Performearthquake Load Analysis on Structure.

	Course Content
Unit I	**Introduction to Earthquake** Origin of earthquake, Engineering geology of earthquakes, faults, Propagation of earthquake waves, quantification of earthquake (magnitude, & intensity of earthquake), Measurement of earthquake (accelerograph, accelerogram recording and analysis of earthquake records), determination of magnitude, epicenter distances, Seismicity of the world.
Unit II	**Sources of Earthquake** Causes or sources of earthquake damage, damage due to ground failure, History of past Earthquakes, generation of response spectrum from available earthquake records, Earthquake design spectrum and inelastic spectrum. Evolution of seismic risk.
Unit III	**Design philosophy and study of IS code** Concepts of earthquake resistance design, Design philosophy, and four virtues of

	earthquake resistance design (stiffness, strength, ductility and configuration). Introduction to capacity design concept, Study of IS: 1893, Study of IS: 13920 for analysis and ductile design of RCC structures.
Unit IV	**Behavior of RC Structures During Earthquake and Earthquake Resistant Features of Structure:** Load Transfer Path, Strength Hierarchy, Reversal of Stresses, Importance of Beam Column Joints, Importance of Stiffness and Ductility (Capacity Design Concept) in Structures, Effect of Short Column, Effect of Soft Storey, Improper Detailing, Effect of Masonry Infill Walls, Effect of Eccentricity, Effect of Pounding, Effect of Floating Columns, Effect of Flexibility and Effects of Setbacks, Earthquake Resistant Features of RC Structures.
Unit V	**Earthquake Load Analysis on Structures:** Introduction to methods of Earthquake Load Analysis (Linear Static, Linear Dynamic, Non Linear Static, Non Linear Dynamic) Analysis of Structure by Linear Static Method (Seismic Coefficient Method) Analysis of Structure by Linear Dynamic Method (Random Response Method)

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Kramer, S.L, “Geotechnical Earthquake Engineering”, Prentice Hall, New Jersey, 1996.
2	Arya A. S., “Introduction to earthquake engineering structures”.
3	Chopra A. K., Dynamics of Structures, Theory & Application to Earthquake Engineering, 2nd Edition., Pearson Education (Singapore) Pvt. Ltd, New Delhi, 1995
4	Pankaj Agrawal and Manish Shrikhande, “Earthquake resistant Design of Structures”, Prentice Hall of India Pvt, Ltd. Publications, 2006
5	S. K. Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press Publications 2007
6	IS 1893:2002, Criteria for Earthquake Resistant Design of Structures Bureau of Indian StandardsBureauof Indian Standards 2002
7	IS 13920: 1993, Ductile Detailing of Reinforced Concrete Structures subjected toSeismic forces - Code of practice,Bureau of Indian StandardsBureauof Indian Standards1993
8	Newmark,N.M. & Hall, W.J., “Earthquake Spectra & Design , Earthquake Design Criteria”, Earthquake Engineering Research Institute,Oakland, California, USA, 1982

SECOND SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title:Theory of Plates and Shells (Program Elective-III)

Course Code: 24PSE223T

Teaching Scheme: L-T-P: 4-0-0 **Total Credits: 4**

Course Objectives:

1.To get the knowledge of various boundary conditions for thin rectangular and circular plates.

2. To examine the Navier's solution for Simply supported plates under different loadings.

3. To know about the finite difference method to plate problem.

4. To assess the Membrane theory of cylindrical shells with different directrix

5. To study bending theory of cylindrical shells

Course Outcomes: At the end of the course, the student will be able to

1. Understand various boundary conditions with reference to thin rectangular and circular plates

2. Analyze the Navier's solution for Simply supported plates under different loadings

3. Apply finite difference method to plate problem

4. Evaluate the Membrane theory of cylindrical shells with different directrix

5. Apply Bending theory of cylindrical shells

	Course Content
Unit I	Governing differential equations for various plates: Development of governing differential equations by Kirchoff's theory with reference to thin rectangular plates with various boundary conditions. Symmetrical bending of laterally loaded circular plates with different boundary conditions.
Unit II	Navier's solution:Study of Simply supported plates under different loadings. Navier's solution. Introduction to Levis solution.
Unit III	Finite difference method: Application of finite difference method to plate problem.
Unit IV	Membrane theory of cylindrical shells: Classification of Shells. Membrane theory of cylindrical shells with different directrix such as circular, cycloidal, catenary,

	and parabolic.
Unit V	Bending theory of cylindrical shells: Bending theory of cylindrical shells, Finster walder, Schorer's, and D-K-J theory.

Sr.No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Timoshenko S.P and Krieger S.W, Theory of Plates and Shells, 2nd Edition, McGraw-Hill Book Company, New Delhi, 1970.
2	Chadrashekhara K, Theory of Plates, 1st Edition, Universities Press (India) Ltd, Hyderabad, 2001.
3	Ramaswamy, G.S, Design of Concrete Shells, Krieger Publ. Co., 1984
4	Ramachandran S., Thin Shells (Theory and Problems) 1 st Edition, Universities Press (India) Ltd, Hyderabad
5	Philipee G Ciarlet, Mathematical elasticity Vol.II: Theory of plates, 1st Edition, Elsevier Science B V, 1997

THIRD SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Design of Multi storied Buildings(Program Elective-IV)

Course Code: 24PSE311T

Teaching Scheme: L-T-P: 3-0-0 **Total Credits: 3**

Course Objectives:

1. To know the fundamentals of earthquake and wind load as per Indian standards.
2. To understand the behaviour of shear walls for earthquake forces.
3. To get the knowledge of various design principles and techniques for a design of high-rise building.
4. To study Ductility concept in earthquake resistant design of RCC buildings
5. To understand analysis and design concept of multi-storeyed buildings.

Course Outcomes: At the end of the course, the student will be able to

1. Apply the fundamental concept and analyse Earthquake and wind load as per Indian standards.
2. Analyze and design shear wall for earthquake forces.
3. Apply technical design principles and techniques for a design of high-rise building.
4. Implement various codal provisions for ductility design of RCC Structures
5. Design of multi-storeyed buildings.

	Course Content
Unit I	**Earthquake and Wind Load Analysis on Structures as per Indian Standards:** Structural Systems and concepts. Loading: Gravity, wind and earthquake loading. Earthquake load and wind load Analysis of multi -storied buildings as per Indian Standards
Unit II	**Analysis and Design of Shear wall:** Introduction to Frame – shear wall buildings, Mathematical modeling of buildings with different Structural systems. Analysis & Design of shear walled buildings with ductile detailing as per IS 13920-2016.
Unit III	**Special aspects in multi-storey buildings:** Special aspects in multi-Story buildings like effect of torsion, flexible first storey, P- delta effect, Soil – Structure Interaction on building response, drift limitations.
Unit IV	**Ductility considerations in earthquake resistant design of RCC buildings:** Ductility

	of reinforced members subjected to flexure. Design of braced columns using Indian Standards, Design of Beam - Column joints for ductile behaviours as per IS code provisions.
Unit V	**Analysis of multi-storeyed buildings with bracings & infills:** Analysis and Design of multi-storeyed buildings with bracings & masonry infills.

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Agrawal &Shrikhande, Design of Earthquake Resistant Structures, 3 rd 2006, Prentice – Hall of India Pvt. Ltd
2	Paulay, T. & Prestiley M.J.N., Seismic design of R C & Masonry Buildings, 2nd 1999, John Willey & Sons
3	Asadour H. Hadjian, Basic Elements of Earthquake Engineering, 2015, Wiley
4	S.K.Duggal, "Earthquake Resistant Design of Structures." 2004
5	C.V.R. Murty, Earthquake Tips, 2005, NICEE, IITK
6	Robin K. McGuire, Seismic Hazard and Risk Analysis, 2004, Earthquake Engineering Research Institute;First edition
7	Roberto Villaverde, Fundamental Concepts of Earthquake Engineering, 2009, CRC Press
8	FarzadNaeim, Handbook on Seismic Analysis and Design of Structures, Kluwer Academic Publisher, 2001
9	Booth, E., Concrete Structures in Earthquake Regions, Longman Higher Education, 1994

THIRD SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Theory of Elasticity and Elastic Stability (Program Elective-IV)

Course Code: 24PSE312T

Teaching Scheme: L-T-P: 3-0-0 **Total Credits: 3**

Course Objectives:

1. To acquire the knowledge of fundamental methods of elasticity.
2. To understand the concept of three-Dimensional Stress Analysis
3. To aware about bending and torsional effect on various structural elements
4. To get the knowledge of beam-column analysis.
5. To know the concept of elastic buckling of columns

Course Outcomes: At the end of the course, the student will be able to

1. Demonstrate the knowledge of fundamental methods of elasticity for 2-D stress analysis
2. Analyze bending and torsional problems and apprise various theories to solve 3-D problems
3. Apply the bending and torsional effect on various structural elements
4. Explain beam-column using the concept of elastic stability.
5. Apply energy method for elastic buckling of columns

	Course Content
Unit I	Two-Dimensional Stress Analysis: Introduction to Two-Dimensional Stress Analysis, Types of forces, Components of stresses and strains, Stress strain relation, Plane stress and plane strain, Strain at a point, Differential equation of equilibrium, Boundary conditions and compatibility equations (rectangular coordinates), Airy's stress function.
Unit II	Three-Dimensional Stress Analysis: Introduction to Three-Dimensional Stress Analysis, Components of stress, Principal stresses, Stress invariants, Maximum shearing stress, Differential equation of equilibrium, Boundary conditions and compatibility equations.
Unit III	Bending of cantilever: Bending of cantilever of narrow rectangular section loaded at end, bending of simply supported beam with uniform load, torsion of non-circular and elliptical cross section.
Unit IV	Analysis of beam columns: Differential equation for beam columns with concentrated loads, continuous lateral loads and couples for simply supported ends, Application of

	trigonometric series, Lateral buckling of Beams columns.
Unit V	Elastic buckling of columns**:** Energy method for elastic buckling of columns, Approximate method, Buckling of Columns on elastic foundation, Columns with intermediate compressive forces and distributed axial load, Columns with varying cross section. Buckling of built-up columns

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Timoshenko, S.P. and Goodier, J.N., Theory of Elasticity, 3rd Edition, Mc-Graw Hill Book Company, New Delhi, 1963
2	Timoshenko, S.P. and Gere J. M., Theory of Elastic Stability, 2nd Edition, Mc-Graw Hill Book Company, New Delhi,1963
3	Asadour H. Hadjian, Basic Elements of Earthquake Engineering, 2015, Wiley
4	Srinath, L.S., Advanced Mechanics of Solids India, 2nd Edition, Tata Mc-Graw Hill Book Company, 2003.
5	Mikhait Filonenkoborodich, Theory of Elasticity, 1st Edition, University press of pacific, 2003
6	Ameen, M., Computational Elasticity—Theory of Elasticity, Finite and Boundary Element Methods, 1stEdition, Narosa publication, 2007

THIRD SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Smart Structures & Applications (Program Elective-IV)

Course Code: 24PSE313T

Teaching Scheme: L-T-P: 3-0-0 **Total Credits: 3**

Course Objectives:

1. To get the knowledge of smart materials.
2. To aware about Actuators and Sensors
3. To know about Structural Health Monitoring
4. To aware about Base Isolation
5. To study various types of Vibration Control Techniques.

Course Outcomes: At the end of the course, the student will be able to

1.Understand characteristics and behavior of smart materials.

2. Apply the knowledge of actuators and sensors in mitigation techniques.

3. Explain the overall structural health monitoring.

4. Examine the various methods and techniques of Base Isolation

5. Demonstrate the various types of Vibration Control Techniques.

	Course Content
Unit I	**Smart Materials:** Introduction to smart structures, application, smart systems – Components of smart systems, different types of smart materials – characteristics and behavior of smart materials – modeling of smart materials.
Unit II	**Actuators and Sensors:** Introduction of sensors and actuators., features and -characteristics of sensors-types of sensors and actuators electronic, thermal and hydraulic type actuators, characteristics of sensors and actuators.
Unit III	**Structural Health Monitoring:** Overview of structural health monitoring, Types of structural health monitoring,smart SHM application to new and existing buildings,Advantages and limitations.
Unit IV	**Base Isolation:** Theory of Base Isolation ,Principle of base isolation, Methods, Techniques

Unit V	**Vibration Controlled Techniques:** Energy dissipation devices; introduction, Methods, principals Dampers,purpose,Types of energy dissipation devices; Metallic yield dampers, friction dampers, viscoelastic dampers, tuned mass dampers.

Sr.No.	Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.
1	Srinivasan, A.V. and Michael McFarland, D., Smart Structures: Analysis and Design, Cambridge University Press, 2000.
2	Yoseph Bar Cohen, Smart Structures and Materials 2003, The International Society for Optical Engineering 2003.
3	Brian Culshaw, Smart Structures and Materials, Artech House, Boston, 1996.
4	M.V. Gandhi and B.S. thompson, Smart Materials and Structures, Chapman and Hall 1992
5	Damodarasamy and Kavitha," Basics of structural Dyanamics and Aseismic design, Phi Publisher, New Delhi.

THIRD SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Wind Effect on Structures(Program Elective-V)

Course Code: 24PSE321T

Teaching Scheme: L-T-P: 3-0-0 **Total Credits: 3**

Course Objectives:

1. To introduce concept of wind flow
2. To aware about the IS **– 875 (Part III)**
3. To get the knowledge about dynamic wind effects
4. To introduce philosophy of wind tunnels
5. To explore various case studies on structures

Course Outcomes: At the end of the course, the student will be able to

1.Acquire knowledge of IS - 875(Part 3)

2. Understand about the IS **– 875 (Part III)**

3. Analyze dynamic wind loads

4. Understand wind tunnels and various aspects of wind flow

5. Summarize wind effects on various structures

	Course Content
Unit I	Wind Characteristics: Variation of wind velocity, atmospheric circulations – pressure gradient force, coriolis force, frictionless wind balance, geostrophic flow, boundary layer. Extra ordinary winds – Foehn,Bora, Cyclones, Tornadoes etc.,
Unit II	**Study of IS – 875 (Part III):** Static wind effects and building codes with particular reference to IS 875(Part-III), wind speed map of India, introduction to the proposed revisions of IS 875 (Part III).
Unit III	Dynamic wind effects: Wind induced vibrations, flow around bluff bodies, along wind and across wind response, flutter, galloping, vortex shedding, locking, ovalling; analysis of dynamic wind loads, codal provisions – gust factor, dynamic response factor; vibration control and structural monitoring; exposure to perturbation method, averaging technique.
Unit IV	Wind tunnel testing: Open circuit and closed-circuit wind tunnels, rigid and

	aeroelastic models, wind tunnel measurements and instruments along with site visit.
Unit V	Case studies: Buildings, parking sheds, workshop building, multistory building, water tanks, towers, chimneys, bridges.

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	EmilSimiu and R. H. Scanlan, “Wind Effects on Structures – An Introduction to Wind Engineering”, John Wiley and Sons, New York, 986.
2	C. Scruton, “An Introduction to Wind Effects on Structures”, Oxford University Press, Oxford,UK, 1981.
3	Peter Sachs, “Wind Forces in Engineering”, Pergamon Press. Oxford UK, 1972.
4	Lawson T. V., “Wind Effects on Buildings”, Applied Science Publishers, London, UK, 1980.
5	Cook, N. J., “The designer’s guide to wind loading of building structures. Part 1 Background,damage survey, wind data and structural classification. Building Research Establishment”, Butterworths, U. K., 1985.
6	6. Cook, N. J., “Designer’s guide to wind loading of building structures. Part 2: Static structures. Building Research Establishment”, Butterworths, U. K., 1990.
7	Simiu, E., Scanlan, R. H., “Wind Effects on Structures: fundamentals and applications to design”,3rd Edition, John Wiley & Sons, New York, 1996.
8	Dyrbye, C., Hansen, S. O., “Wind loads on structures”, John Wiley, New York, 1997.
9	Holmes, J. D., “Wind loading on Structures”, Spon Press, London, U. K., 2001.

THIRD SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Composite Structures (Program Elective-V) **Course Code:** 24PSE322T

Teaching Scheme: L-T-P: 3-0-0 **Total Credits: 3**

Course Objectives:

1.To get the knowledge of composite materials.

2.To aware about the elastic behavior of lamina.

3.To know about stress-strain behavior of laminates

4.To aware about various failure pattern of laminates

5.To study various laminate engineering properties.

Course Outcomes: At the end of the course, the student will be able to

1. Relate the basic concepts and characteristics of Composite materials.
2. Examine elastic behavior of lamina.
3. Understand the stress-strain behavior of laminates
4. Interpret various failure theories.
5. Examine elastic behavior of multidirectional laminates.

	Course Content
Unit I	**Composite materials:** Introduction: definition, Classification and characteristics of Composite materials, advantages and limitations. Current Status and Future Prospects; Basic Concepts and characteristics: Homogeneity and Heterogeneity, Isotropy, Orthotropy and Anisotropy
Unit II	**Elastic Behaviour of Laminates:** Characteristics and configurations of lamina, laminate, micromechanics and macro-mechanics. Constituent materials and properties; Elastic behavior of unidirectional lamina: Anisotropic, separately orthotropic and transversely isotropic materials,
Unit III	**stress-strain behavior of laminates:** Stress-strain relations for thin lamina, transformation of stress and strain, transformation of elastic parameters, Strength of unidirectional lamina.

Unit IV	**Failure theories of laminates:** Macro-mechanical failure theories- Maximum stress theory, maximum strain theory, Deviatoric strain energy theory, Interactive tensor polynomial theory.
Unit V	**Elastic Behavior of multidirectional laminates:** Elastic Behavior of multidirectional laminates: Basic assumptions, Stress-strain relations, load deformation relations, symmetric and balanced laminates, laminate engineering properties.

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	R.M. Jones, Mechanics of Composite materials, Taylor and Francis, 1999.
2	M. Daniel and O. Ishai, Engineering mechanics of Composite materials, Oxford university press, 1999
3	P.K. Mallick, Fiber-reinforced Composites, Marcel Dekker Inc, 1988.
4	D. Hull and T.W. Clyne, An introduction to composite materials, Cambridge university press, Second Edition, 1996.
5	J.N. Reddy, Mechanics of laminated composite plates and shells-Theory and Analysis, CRC Press, BocaRaton, Second Edition, 2003.

THIRD SEMESTER M. TECH. (STRUCTURAL ENGINEERING)

Course Title: Structural Instrumentation (Program Elective-V)

Course Code: 24PSE323T

Teaching Scheme: L-T-P: 3-0-0 **Total Credits: 3**

Course Objectives:

1.To get the knowledge of Structural Instrumentation.

2.To aware about tools for Structural Instrumentation.

3.To know about various strain gauges

4.To aware about static & dynamic strain measurement

5.To study various method and technique of NDT

Course Outcomes: At the end of the course, the student will be able to

1. Explain principles of Measurement and its methods.

2. Illustrate Transducers, its classification, working principle and construction.

3. Describe Strain Gauges, its classification, working principle and its construction.

4. Understand the static & dynamic strain measurement techniques.

5. Demonstrate the knowledge and understanding of NDT

Course Content	
Unit I	Measurement, methods, basic principles, errors in measurement, error analysis. Measurement of displacement, pressure, force, torque etc
Unit II	Transducers, classification, working principle and construction of load cell, sensitive dial gauge and LVDT.
Unit III	Strain gauge, classification, electrical resistance strain gauges, working Principle, types and construction, materials, strain gauge circuits, rosette analysis
Unit IV	Indicating and recording devices, static & dynamic strain measurement, data acquisition and processing systems, load strain behaviour.

Unit V	Nondestructive testing techniques, methods of NDT, working principle of rebound hammer, ultrasonic pulse velocity, Model analysis.

Sr.No.	**Suggested Text Books/Reference Books/ Web page (URL)/Research paper, etc.**
1	Dally J. W. and Riley W.F., Experimental stress Analysis, McGraw-Hill, Inc. New York.
2	Srinath L.S, Experimental Stress Analysis, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3	Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi.
4	Renganathan S, Transducer Engineering, Allied Publishers Limited, Chennai.

COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

MECHANICAL ENGINEERING DESIGN (MED)

Of

RASHTRASANT TUKDOJI MAHARAJ

NAGPUR UNIVERSITY, NAGPUR

Scheme of Examination of M.Tech MED

Semester Pattern

I Semester M.Tech MED

Sr. No.	Course Code	Course	L	P	Credits	Maximum. Marks			ESE Duration (Hrs)
						Continues Assessment	End Sem Exam	Total	
1	23PME101 T	Dynamics of Machinery	4	0	4	40	60	100	3
2	23PME101P	Laboratory -I Dynamics of Machinery	0	2	1	25	25	50	-
3	23PME102 T	Mechanical Vibrations	4	0	4	40	60	100	3
4	23PME102P	Laboratory -II Mechanical Vibrations	0	2	1	25	25	50	-
5	23PME103 T	Research Methodology and IPR	2	0	2	40	60	100	2
6	23PME11X T	Program Elective-I	3	0	3	40	60	100	3
7	23PME12X T	Program Elective-II	3	0	3	40	60	100	3
8	23PME13X A	Audit Course Pedagogy Studies	2	0	-	-	-	-	-
		Total	**18**	**4**	**18**	**250**	**350**	**600**	

Course Code	**Program Elective I**
23PME111T	Computer Aided Mechanical Design
23PME112T	Reliability, Maintainability & wear
23PME113T	Machine Tool Design

Course Code	**Program Elective II**
23PME121T	Robotics
23PME122T	Mechanization In Food Processing
23PME123T	Artificial Intelligence

Course Code	**Audit Courses**
23PME131A	English for Research Paper Writing
23PME132A	Disaster Management
23PME133A	Value Education

II Semester M.Tech MED

Sr. No.	Course Code	Course	L	P	Credits	Maximum. Marks			ESE Duration (Hrs)
						Continues Assessment	End Sem Exam	Total	
1	23PME201T	Advanced Mechanisms	4	0	4	40	60	100	3
2	23PME202T	Advanced Mechanical Drives	4	0	4	40	60	100	3
3	23PME203T	Stress Analysis	4	0	4	40	60	100	3
4	23PME203P	Laboratory -I Stress Analysis	0	2	1	25	25	50	
5	23PME204P	Laboratory -II Finite Element Analysis	0	2	1	25	25	50	
6	23PME21XT	Program Elective-III	3	0	3	40	60	100	3
7	23PME22XT	Program Elective-IV	3	0	3	40	60	100	3
8	23PME23XA	Audit Course	2	0	0	---	--	--	--
		Total	**20**	**4**	**20**	**250**	**350**	**600**	

Course Code	Program Elective III
23PME211T	Tribology and Bearing Design
23PME212T	Design of Hydraulic and Pneumatic Systems
23PME213T	Plastic Engineering

Course Code	Program Elective IV
23PME221T	Finite Element Analysis
23PME222T	Optimization In Engineering Design
23PME223T	Rapid Prototyping

Course Code	Audit Courses
23PME231A	Pedagogy Studies
23PME232A	Stress Management by Yoga
23PME233A	Personality Development through Life Enlightenment Skills

III Semester M.Tech MED

Sr. No.	Course Code	Course	L	P	Credits	Maximum. Marks			ESE Exam Duration
						Continues Assessment	End Sem Exam	Total	
1	23PME301P	Project- Phase-I	0	16	8	100	--	100	--
2	23PME31XT	Program Elective -V	3	0	3	40	60	100	3
3	23PME32XT	Open Elective	3	0	3	40	60	100	3
3									
		Total	**6**	**16**	**14**	**180**	**120**	**300**	

Course Code	Program Elective V
23PME311T	Design of Mechanical Handling System
23PME312T	Vibration based condition Monitoring
23PME313T	Modelling & Simulation

Course Code	Open Elective
23PME321T	Business Analytics
23PME322T	Industrial Safety
23PME323T	Operations Research

IV Semester M.Tech MED

Sr. No.	Course Code	Course	L	P	Credits	Maximum. Marks			ESE Duration
						Continues Assessment	End Sem Exam	Total	
1	23PME401P	Project- Phase-II	-	32	16	150	150	300	--
		Total		**32**	**16**	**150**	**150**	**300**	

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME101T **Course : Dynamics of Machinery**

L: 4 Hrs. P:0 Hrs. Per week **Credits: 4**

Course Objectives:

The overall objectives of this course is to understand quantitative kinematic analysis, static force analysis, dynamic force analysis, stress distribution in links, dynamics motion analysis which includes energy distribution method, the rate of change of energy method, variation mechanics, balancing of linkages by various methods, natural frequency of given system and balancing of rigid rotors.

Expected Outcomes:

The expected outcomes are students will be able to understand the effect of dynamic forces on various links of a mechanism, dynamic motion analysis, balancing of linkages and flywheel requirement, determination of natural frequency of various systems using different methods.

Syllabus:

1. **Dynamics of Mechanisms:** Forces in mechanisms, friction in links connection, stress distribution in links. Various approaches for dynamic analysis: Lagranjes, Recursive Lagranjes.

2. **Dynamic Motion Analysis:** Energy distribution method, the rate of change of energy method,

3. Balancing of linkages and flywheel requirements. Lagranjian Euler formulation, Hamilton’s Formulation, variation Mechanics.

4. **Rotor Dynamics :** Torsional Vibration in reciprocating machines, Critical speed, bending vibration

5. **Balancing of rotating shaft:** .Out of balance, balance of rigid rotors, whirling speed of shaft, hydrodynamic instability

Tutorial: - Based on above syllabus.

References:

1. S.Timoshenko ,Vibration Problems in Engineering.
2. Marplex ,Dynamics of machinery.
3. J.S.Rao,Rotor Dynamics.
4. Housner ,Advanced Dynamics.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME101P **Course : Dynamics of Machinery**

L: 0 Hrs. P:2 Hrs. Per week **Credits: 1**

Based on syllabus of Dynamics of Machinery mention in subject code 23PME101T with emphasis on quantitative kinematic analysis, static force analysis, dynamic force analysis, stress distribution in links, dynamics motion analysis.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME102T **Course : Mechanical Vibrations**

L:4 Hrs. P:0 Hrs. Per week **Credits:4**

Course Objectives:

The study of Vibration is concerned with understanding of cause of vibration in any system also it is concerned with determination of natural frequency for various degrees of freedom.The overall object of this course is to learn, understand meaning of vibration relevant to Mechanical system and Mechanics. It also helps to know Vibration Phenomenon for various continues and discrete system.This course includes various Vibration analysis techniques, Vibration response, longitudinal and transverse Vibration for various structures, Vibration Instrumentation devices, introduction of FFT analyzer and Noise Control techniques.

Expected Outcomes:

The students will able to understand ―vibration phenomenon‖ and its concept, disadvantages and advantages of vibration various techniques to determine natural frequency of the system for any DOF system.

Syllabus:

Review of Fundamentals: Vibration problems in engineering causes and effects of vibration relevance of vibration analysis continuum and discrete modeling lumped parameter systems free vibration and response to damped single degree freedom systems. Frequency response function-amplitude and phase plots mechanical impedance and mobility – vibration isolation.

Response of Systems to Arbitrary Periodic Excitation: Duhamel’s integral impulse response function – shock spectra –Laplace and Fourier transform methods.

Multi Degree Freedom Systems: Matrix formulation Eigen values and Eigen formulation matrix iteration techniques – normal modes and orthgonality transient response of multidegree freedom system mode superposition technique tensional oscillations of malty rotor systems.

Continuous Systems: Longitudinal and transverse vibration of beams-forced response of beams. Vibration of plates –finite element techniques in vibration analysis.

Vibration Instrumentation and Noise Control : Vibration measurements instrumentation electrodynamics exciters impact hammers piezoelectric accelerometers signal conditioning and amplification preamplifiers and power amplifiers real time analysis digital Fourier transforms FFT analysis structural frequency response measurement random sinusoidal and transient test methods model testing of beams.Sound and Noise parameters prorogation of sound noise in carious machinery's noise measurements techniques. Noise Control Techniques, Sound absorption, sound insulation, methods.

Tutorial: - Based on above syllabus.

REFERENCE :

3. J.S. Rao and K. Gupta Advanced theory of vibration.Willey Eastern.1992.
4. P.Srinivasan Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi 1982.
5. N. L. Meirovitch , Elements of vibration Analysis, Mc Graw Hill New York 1986.
6. J.P.Den Hartog Mechanical Vibration (4th edition Mc Graw Hill, New York 1985.
7. Timoshenko, Engineering vibration.
8. Irwin & Garf , industrial Noise & Vibration Control.
9. R.A. Collacott, Vibration Monitoring and diagnosis, John Willey, New York, 1979.

M. Petyt , Introduction to Finite Element Vibration Analysis Cambridge University Press,Cambridge 1990.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME102P **Course : Mechanical Vibrations**

L:0 Hrs. P:2 Hrs. Per week **Credits:1**

Based on syllabus of mechanical vibrations mention in subject code MT103T with emphasis on vibration measurement on equipment and machinery.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME103T **Course : Research Methodology and IPR**

L:2 Hrs. P:0 Hrs. Per week **Credits:2**

Course Objectives:

The objective of this course is to provide students with:

1. An insight into how scientific research is conducted

2. Knowledge of Research Process, Concepts, diverse research tasks and equip them to undertake research.

3. Understanding the concepts of Data collection, system modeling and reliability.

4. To develop an understanding for the optimization methods in research work.

5. Methods for presentation of research results.

Course Outcomes:

At the end of this course, students will be able to

1.Understand research problem formulation.

2.Analyze research related information

3.Follow research ethics

4.Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

5.Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

6.Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT I: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II: Effective literature studies approaches, analysis Plagiarism, Research ethics.

UNIT III: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT IV: Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT VI: New Developments in IPR:

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.

5. Mayall, “Industrial Design”, McGraw Hill, 1992.

6. Niebel, “Product Design”, McGraw Hill, 1974.

7. Asimov, “Introduction to Design”, Prentice Hall, 1962.

8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.

9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME111T **Course : Computer Aided Mechanical Design**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objectives:

The subject deals with the solid and 2-D modeling of machine elements by using computers which was earlier were carried out manually. The objective of the course is to study representation of geometrical entities like line, circle, curves, surfaces and solid parts mathematically and hence computer software can be used for modeling of any engineering entities.

Expected Outcomes:
The student will learn modeling, drafting and dimensioning of machine elements by using computer software and will be able to generate several alternate design options very easily. Also students will understand the requirements of hardware & software for computer aided design process.

1. Product Cycle: Role of Computers in the design process. Requirement of Hardware & Software in CAD. Representation of Line, Circle, & Other analytic curves,
2. Algorithms & Programs. Drafting of machine elements with dimension and tolerances using 2-D drafting packages. Graphic standards GKS [Graphical Kernal System] IGES [Initial Graphic Exchange Specifications].
3. CAD of Machine Elements: Development of interactive design programs [with drafting] for machine elements, incorporating choice of materials and other parameters, Generation of several alternate designs and evaluation.
4. Curves : Mathematical representation of Hermite cubic, Bezeir & B-spline curves.
5. Geometric Modeling: Introduction to difference type of surfaces and solids generated in surface and solid model respectively. Assembly modeling and interference checking .

Tutorial: - Based on above syllabus.

Reference:

1. Groover ,M.P.and Zimmers ,E.W CAD/CAM, Computer Aided Design and manufacturing, Prentice Hall of India 1986
2. Ibrahim Zeid, CAD/CAM Theory and Pratice, Mc Graw Hill, 1991.
3. Dimarogons, A.D. Computer Aided Machine Design, Prentice Hall,1986.
4. Ranky, P.G. Computer Integrated Manufacturing,Prentice Hall,1986.
5. Radhakrishanan,P. and Kothandaraman, C.P. Computer Graphics & Design, Dhanpat Rai & Sons, Delhi, 1990.
6. Software Manuals on GEODRAW, GEOMOD, and SUPERTAB, Structural Dynamics Research Corporation, U.S.A. 1986

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME112T **Course : Reliability, Maintainability & Wear**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objectives:

The course deals with study of reliability, availability, maintainability and wear of machine and its components. The objective of this course is to perform reliability engineering analysis, to understand the maintainability and estimate wear of machines and their components.

Expected Outcomes:

The student will be able to estimate the life of machine and their components and various maintenance processes. Also student will understand basic reliability measures such as MTTF, MTBF, MTTR, availability, failure rate, Bathtub curve, etc.

Syllabus:

1. Introduction to reliability availability and maintainability failure distributions, Weibull distribution and its applications to industries.
2. Design and manufacturing for reliability, reliability assessment of mechanical systems
3. FMES and FTA techniques.
4. Monte carlo simulation method, markov chains in reliability. Maintenance policies
5. Philosophies conditions based antennae , Vibration monitoring non destructive testing.

Tutorial: - Based on above syllabus.

References:

1. Reliability & Maintainability Engineering Charles E. Ebeling – Tata Mc Graw Hill
2. Reliability Methods Engineering and its application – G.P. Chhalotra –Khanna
3. Introduction to Reliability in Design –Charles O. Smith – Mc. Graw Hill
4. Reliability Engineering –E. Bala guruswamy –Tata Mc. Graw Hill
5. Reliability Engineering –D.J. Smith- Pitman Publishing
6. Reliability Engineering –L.S. Srinath –Affiliated East West Press Pvt. Ltd.
7. Mechanical Reliability – A.D.S. Carter- Mc Millan
8. Friction and Waer of Material –Ernest Rabinowicz-John Wiley & Sons
9. Kapur K. C. , Lamberson L.R. Reliability in engineering Design.
10. Thomson A. Reliability Based Mechanical DesignHull B. , Jhon V. , Non Destructive testing.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME113T **Course : Machine Tool Design**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objectives:

To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.

Course Outcomes:

This subject deals with the basic structure of machine tools , its design and design of gear box, guides , and other machine tool elements.

Unit 1:

Introduction, classification, general requirements, characteristics, technical and economical prerequisites for machine tool design, machine tool design process, machine tool layout, motion in machine tool, machine tool drives, hydraulic and mechanical drives,types and elements, individual and group drives, devices for intermittent motion, reversing and differential mechanism, selection of electric motor.

Unit 2:

Aim of speed and feed regulations, stepped regulations of speed-Various laws of step regulation, Selection of range ratio, Standard value of Geometric progression ratio and guidelines for selection proper values, Breakup of speed steps, Structure diagrams and its analysis, Classification of speed and feed boxes, design of feed box, machine tool drives using multiple speed motors, Special cases of gear box Design speed box with Overlapping speed steps, Speed box with combine structure, Speed box with Broken geometric progression, electromechanical system of regulation, Friction, Pressure and Ball Variations, Epicyclic Drive.

Unit 3:

Function and requirement of machine tool structure, design criteria from strength and stiffness consideration, concept of unit rigidity, unit strength under bending for material of machine tool structures, compare steel and cast iron on the basis of material properties,manufacturing problems and economy, role of static and dynamic stiffness in design of elements of machine tools, profiles of machine tool structures, factors affecting stiffness of machine tool structures.

Unit 4

Function and types of Guideways, types of slideways and antifriction ways, functional features of slides ways, its shapes and materials, methods of adjusting clearance, design criteria (wear resistance and stiffness) and calculations for slideways operating under semi liquid friction condition, stick slip phenomenon affects accuracy of setting and working motions, comparision of design and stiffness of hydrodynamic, hydrostatic and aerostatics slide ways, design of antifriction Guideways, concept of combination of Guideways, Design of sliding friction power screw for wear resistance, strength, stiffness and buckling stability, design of rolling friction power screw for strength under static loading.

Unit 5

Function and requirements of spindle units, their materials, effect of machine tool compliance on machining accuracy, design of spindles for bending stiffness: deflection of spindle axis due to a) bending b) compliance of spindle supports c) compliance of tapered joints, optimum spacing between spindle supports permissible deflection and design for stiffness: additional check for strength like additional supports, location of bearings and drive elements, balancing.

Text Books:

1) Machine Tool Design N. K. Mehata TMH

2) Principles of Machine Tools –Gopal Chandra Sen , Amitabh Bhattacharya New central book agency

3) Machine Tool Design Basu, Pal Oxford IBH

4) Technology of Machine Tool by Steve F. Krar Indian Edition 2013 (McGraw Hill)

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME121T **Course : Robotics**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objective:

The course deals with various robot components, kinematic and dynamic analysis and control of robot manipulator. The objective of this course is to learn various components, configuration, programming method and applications of robot.

Expected Outcomes:

The student will be able to perform kinematic analysis i.e. robot mechanism synthesis and its dynamic analysis to calculate the forces and torque required to actuate the joints and hence intern can select proper linear and rotary actuators. Also student will understand motion analysis, trajectory planning of end effectors, various robot sensors and programming methods.

UNIT - I

Basic concepts in Robotics: Advanced and applications of robotics of Robots, Resolution, Accuracy and Repeatability, Point, Continuous part system control loops, types of manipulators, wrist & Grippers.

UNIT - II

Kinematic Analysis of Robots. Geometry based direct kinematics, Co-ordinate and vector transformation using matrix, Denant - Hardenberg Convention, application of DH notation, Inverse Kinematics.

UNIT - III

Robot- an Dynamcis : Elementary treatment of Lagrange - Euler, Newton – Euler formulations, Generalised D Alembert equations of motion.

UNIT - IV

Drives, Control of Trajectory: Hydraulic system stepper motor, Direct current servomotors, A-C servomotors, adaptive control, interpolators, trajectory planning, resolved motion rate control method.

UNIT - V

Robotic Sensors: Vision system, range ,proximity, touch, force and torque sensors, Assembly Aid devices, Robot programming, Artificial Intelligence. Application of Robot: Handling loading, unloading welding, Painting Assembly, Machining Manufacturing , Work- cell, Installation of Robots .

Tutorial: - Based on above syllabus.

References :

1. M.P. Groover, M.Weiss, P.N.Nagal, and N.G Odrey, Industrial Robotics, McGraw Hill International Deduction, 1986.

2. Shimon Y. Nof (Editor), hand book of industrial robotics Jhon Wiley and sons, 1985,

3. Fu. K. S. , Gonzalez R. C. and Lee C. S. G., Robotics : Control sensing vision and intelligence, Mc Graw Hill, 1987.

4. D. T. Pham , Expert – System in Engineering , Springer Verlog , 1988.

5. Anthony C. , Mc Donald, Robot Technology, theory , designand applications, Prntice Hall, New Jersey, 1986.

6. Yoren Koren , Robotes for engineers.

7. K. S. Fu, R.C. Gonzaler C.S.G. Lee, Robothes (Control, sensing vision & intelligence).

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME122T **Course : Mechanization In Food Processing**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objective:

The course deals with the various processes in food processing as cleaning material, sorting, heat processing, dehydration, packaging etc. The course objective is to learn the basics involved in above mentioned various food processing processes and engineering solutions to them.

Expected Outcomes:

The students will be able to understand the various constructional and operational characteristics of food processing devices and will be able to design unit for particular food processing application.

Syllabus:

I Constructional features, operation, Operational characteristics Advantages & Disadvantages,

II Limitations designing considerations of following food processing devices. Cleaning of new materials, sorting and grading.

III size reductions and Expression, centrifugation, crystallizations, Heat Processing , Evaporation.

IV Dehydration, Freezing, Irradiation ,Pumps, piping, packaging.

V Automation and Computer systems, Lubrication, Food plant design.

Tutorial: - Based on above syllabus.

References

1. J.G. Brennan Butters “ Food Engineering operations “. Elsevier Publication

2. Farral “ Food Engineering System”, AVI publishing .

3. Ian McFarlane,” Automatic Control of Food Manufacturing Process “, Applied Science Publishing .

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME123T **Course : ARTIFICIAL INTELLIGENCE**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objectives:

To learn about the automation of machines tools making the system intelligent.

Course Outcomes:

Understanding the different techniques used for implementation of artificial intelligence.

UNIT 1

Human and machine intelligence, Artificial Intelligence (AI), Programming in AI environment,. Natural Language processing (NLP), Need of AI.

UNIT 2

Architecture of an Expert system, Knowledge base, inference engine forward and backward

chaining, use of probability and fuzzy logic. Selection of inference mechanism, (Relevant case studies)

UNIT 3

Neural Network and application artificial neural network models, NN applications in Cellular manufacturing and other areas of mechanical Engg..(Relevant case studies)

UNIT 4

Introduction to Rule Based System. Conflict Resolution Advantages and Drawbacks of Rule Based Systems Clausal Form Logic, Rule Base Verification, Refinement and Validation. Creating Knowledge Base, Knowledge Engineer and Domain Expert, Phases of Knowledge Engineering, Tools for Knowledge Engineering.

UNIT 5

Fundamentals of OOP (Object oriented programming), creating structures and objects, object operations, invoking procedures, programming applications, Object oriented expert systems. Semantic nets, structure and objects, ruled systems for semantic nets, certainty factors, automated.

Books for Reference:

- Addis, T.R., “Designing Knowledge Based System”, Prentice Hall, 1985.
- Rolston, D.W., “Principles of Artificial Intelligence and Expert Systems Development”, McGraw Hill, 1988.
- Maus, R. and Keyes, J., “Handbook of Expert Systems in Manufacturing”, McGraw Hill, 1991
- Robert Levine, “A comprehensive guide to artificial intelligence and expert systems",Elain Rich ,”Artificial Intelligence”,
- Sasikumar, Ramani, et al ,”Rule based expert systems”.
- Graham Winstanley, “Program Design for Knowledge Based Systems”, Galgotia Publications.
- Artificial Neural Networks", Zurada
- V.B. Rao and H.V. Rao, “C++ : Neural Networks and Fuzzy Logic”, BPB Publications.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME131A **Course : English For Research Paper Writing**

L:2 Hrs. P:0 Hrs. Per week **Credits:**

Course objectives:

Students will be able to:

1. Understand that how to improve your writing skills and level of readability

2. Learn about what to write in each section

3. Understand the skills needed when writing a Title

4.Ensure the good quality of paper at very first-time submission.

Course outcomes:

Students will be able to

1. Understand & differentiate between literary piece of writing & Technical Writing.

2. Write technical documents in clear, concise & effective manner

3. Design own style of writing to inform or instruct an audience with a specific goal in mind.

4. Will be able to write proposals.

5. Will be able to design, create and write technical manuals.

UNIT I: Planning and Preparation, Word Order, Breaking up long sentences,Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

UNIT III: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNITIV: Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNITV:Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT VI:useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.

4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME132A **Course : Disaster Management**

L:2 Hrs. P:0 Hrs. Per week **Credits:**

Course Objectives: -Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course outcomes:

Students will be able to

1.To work as a think tank for the society by providing assistance in policy formulation.

2.Develop ability and understanding of disaster mitigation and management.

UNIT I: Introduction

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II :Repercussions Of Disasters And Hazards:

Economic Damage, Loss Of 4 Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts**.**

UNITIII:Disaster Prone Areas In India:

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

UNIT IV:Disaster Preparedness And Management :

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard;Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V:Risk Assessment:

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

UNIT VI: Disaster Mitigation:

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication Pvt. Ltd., New Delhi.

SYLLABUS OF SEMESTER I, M. TECH. (MED)

Course Code: 23PME133A **Course : Value Education**

L:2 Hrs. P:0 Hrs. Per week **Credits:**

Course Objectives:

Students will be able to

1. Understand value of education and self- development

2. Imbibe good values in students

3. Let the should know about the importance of character

Course outcomes:

Students will be able to

1. Knowledge of self-development

2. Learn the importance of Human values

3. Developing the overall personality.

UNIT I:

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles,Value judgements

UNIT II:

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity.

Patriotism.Love for nature,Discipline

UNIT III:

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV:

Character and Competence –Holy books vs Blind faith. Self-management and Good health.

Science of reincarnation. Equality, Nonviolence,Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

Suggested reading

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University

Press, New Delhi

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME201T **Course : Advanced Mechanisms**

L:4 Hrs. P:0 Hrs. Per week **Credits:4**

Course Objectives:

The overall objectives of this course is to understand kinematics synthesis of mechanism, to learn how to synthesis a given mechanism, when input and output is given with different methods optimal synthesis of mechanism, and synthesis of spatial mechanism along with application.

Expected Outcomes:

At the end of this course students will be able to understand various methods of synthesis, optimization of synthesis, graphical and analytical methods of synthesis along with computer application.

Syllabus:

1. Introduction to kinematic synthesis type number and dimension synthesis practical applications, degree of freedom class -I, class-II chain Grumblers criteria, concept of transmission angle.

2. Synthesis of planner mechanism: Introduction to function generation, path generation, path generation & rigid body guidance. Problems, accuracy points chebychev's spacing, Graphical approaches for synthesis for above problem Central point curve, circle point curve ,point position, inflection circle Bo-billior construction, Euler's savory equation, Hartman construction, vector approach &matrix approach, rotation matrix, displacement matrix, Freudenstein‟s equation, computer approach for the above problem .

3. Optimal synthesis of planar mechanisms, Powells search methods least square method penalty function computer approach.

4. Kinematic analysis & synthesis of spatial mechanisms Hi notations screw matrix, kinematic analysis for linkages like R-S-S-R, R-C-P-R-C etc.

5. Introduction to kinematics synthesis of Robot arms.

Tutorials: - Based on above syllabus.

References:-

1. Tao, D.C.,Applied Linkages.
2. Erdman & Sandor ,Advanced Mechanisms, Vol.- I,II,
3. Denavit & Hartenberg, –Kinematic Synthesis

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME202T **Course : Advanced Mechanical Drives**

L:4 Hrs. P:0 Hrs. Per week **Credits:4**

Course Objectives:

The study of Mechanical Drives concerned with understanding of its various design techniques and its detail analyzer by virtue of vibration. The overall objective of this course is to learn and understand practical use of various applications with its detail design and vibration analysis. This course include belt Vibration with pulley design its vibration response, detail dynamics of gear tooth, spur gear tooth vibration, kinematic analysis of complex gear trains, detailed dynamics and vibration analysis of chains, concept of PIV drive and coupling misalignment.

Expected Outcomes:

The students will be able to understand critical and detailed analysis of various mechanical drives along with its Vibration analysis.

Syllabus:

Belt Drives: Belt vibrations, additional stress due to vibration, modern development in toothed belt, fatigue, synchronization, slip due to wear. Dynamics & vibration of Arms of Pulleys by three Approaches (1) Equal sharing of load zone (2) Equilibrium of rim (3) FEM Approach.

Gears: Detailed dynamics of gear tooth, spur tooth vibrations, Estimation of additional stress under vibration. Fatigue in tooth due to contact stress. Exact estimation of gear meshes frequencies in signature analysis.

Gear Boxes: Kinematic Analysis of complex gear trains, Force Analysis including gyroscopic effects, Vibration Analysis of Gearboxes, Lubrication Methods, Contamination of Lubrication Oils, wear debris analysis.

Chain Drives : Detailed dynamics of chains considering Rolling friction of hanging portion of tracks, Resistance of sprocket bearings, Resistance due to chain stiffness , chain vibrations : Lateral & longitudinal, wear debris formation & effect on efficiency, impact loads in chains. Analysis of power & conveyor chains.

PIV Drives: Concept, Need, Classification & Types. Detailed kinematics & dynamics of 4/5 important drives. Stress analysis of coupling bolts during one rotation, Rubbing of coupling pins & its effect on signature, Analysis due to misalignment, Degree of shock absorption due to flexible elements in flexible couplings.

Tutorial: - Based on above syllabus.

References:

4. Gear, Spur Helical ,Worm by Earle Buckingham ,Mc-Graw Hill.
5. Rothebirt ―Mechanical Design & Systems Handbook‖ Mc-Graw Hill
6. Handbook of shaft Alignment
7. M.P.Alexandrov, ―MATEIALS HANDING EQUIPMENT‖, MIR Publications, Moscow 1981.
8. Fairs, ―Mechanisms‖ McGraw Hill.
9. J.S. Beggs, ― Mechanisms‖ Prentice Hall.
10. David W. South & Jon R. Mancuso‖ Mechanical Power Transmission Components‖ Marcel Dekker inc New York.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME203T **Course : Stress Analysis**

L:4 Hrs. P:0 Hrs. Per week **Credits:4**

Course Objectives:

The overall objectives of this course is to understand the fundamental of stress and strain, application of equation of equilibrium, compatibility, Airy's stress function for determining stress field in Cartesian co-ordinate and polar co-ordinate for two dimensional problems, various methods of experimental stress analysis using strain gauges, strain rosettes and photoelasticity, evaluation of thermal loads and thermal stress in simple object and given systems, fundamental of fracture mechanics.

Expected Outcomes:

At the end of this course students will be able to understand how to determine stress field a given object, various strain gauges and strain rosettes for determination of stress field, direction of principle stresses by isoclinic fringer, magnitude of principal stress using isochromatic, stress optic law, evaluation of thermal stresses in a given object and fracture mechanics.

Syllabus:

Fundamentals of stress & strain, stress strain relationship, Elastic constant , plane stress, plane strain. Stress Analysis for two dimensional problems in Cartesian co-ordinate system, equations of Equilibrium, compatibility equation, Airy „s stress function, Analysis of rectangular plates by polynomials.

Two dimensional problems in polar co-ordinates, general equations in polar co-ordinates for any symmetric case, pure bending of curved beams, crane hooks , bending of beams with initial curvature , Analysis of piston rings, stresses in rotating discs, with variable and constant sections , Effect of holes on stress distribution in plates, contact stresses.

Torsion: Torsion of non circular section , St. Venants theory, Membrane analogy , Torsion of thin walled tubes.

Experimental stress analysis by strain gauge & photo elasticity technique, strain rosettes, recording instruments, Brittle coating techniques, poloriscope, Isochromatic & isoclinic fringes, compensation techniques.

Thermal stresses Thermo elasticity, thin circular discs, thermal stresses in turbine rotors, Analysis of beams under thermal load.Introduction to fracture Mechanics.

Tutorial: - Based on above syllabus.

References :

1.Timoshanko & Goodier, Theory of Elasticity.
2.Dalley & Raillery , Experimental stress analysis.
3.Dove & Adams , Experimental Stress Analysis.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME203P **Course : Stress Analysis**

L:0 Hrs. P:2 Hrs. Per week **Credits:1**

List of Practical: (Minimum Eight)

1. Measurement of stress for different types of loading by using strain gauges.
2. Models making for poloriscope.
3. Molding for model material.
4. Verifying theoretical stress distributions on poloriscope.
5. Study of stain gauge.
6. Study of stain analysis using torque gauge.
7. Study of stain analysis using three element rectangle rosettes.
8. Determination of principal stresses using tardy method.
9. Study of plain poloriscope.
10. Study of circular poloriscope.
11. To determine material fringe value by using diffused light research poloriscope.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME204P **Course : Finite Element Analysis**

L:0 Hrs. P:2 Hrs. Per week **Credits:1**

Practical on the standard CAE packages like ANSYS, NASTRAN, ABAQUS,MATLAB, CATIA, UNIGRAPHICS, PRO-E or any other relevant software.

List of Practical: (Minimum Eight)

1. Static structural analysis of bar with 1-D elements using standard FEA package.
2. Static structural analysis of truss with 2-D elements using standard FEA package.
3. Static structural analysis with 2-D CST element using standard FEA package.
4. Static structural analysis with 2-D Axis-symmetric element using standard FEA package.
5. Static structural analysis of a beam in transverse loading using standard FEA package.
6. Dynamic structural analysis to determine natural frequency and mode shapes, using standard FEA package.
7. Analysis of 3-D truss using standard FEA package.
8. Thermal analysis to estimate nodal temperatures using standard FEA package.
9. Application of finite element analysis in the areas like Contact Mechanics, drop test, Crash Analysis, MEMS etc.
10. Finite Element Analysis of live problem/case reported or identified by an Industry.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME211T **Course : Tribology And Bearing Design**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objective:

The course deals with the study of lubrication and its role in bearing design. The course objective is to provide the knowledge of friction, wear and lubrication process, to learn about tribological modeling and simulation and to create an awareness of the importance of tribology in design and selection of machine elements.

Expected Outcomes:

The student will be able to apply the basic theories of friction, wear and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces as bearings and wheel on rail contact.

Syllabus:

Friction and wear Friction control and wear prevention, boundary lubrication, tribological properties of bearing materials and lubricants, theories of friction and wear, instabilities and stick-slip motion .

Lubrication of bearings Mechanics of fluid flow, Reynold's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow)

journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), finite bearings - hydrostatic, hydrodynamic and thrust oil bearings, heat in bearings Hydrostatic squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings

Elasto-hydrodynamic lubrication Pressure-viscosity term in Reynold's equation, hertz theory, Ertel-Grubin equation, lubrication of spheres Air lubricated bearings Tilting pad bearings, hydrostatic, hydrodynamic and thrust bearings with air lubrication Tribological aspects of rolling motion Mechanics of tire-road interaction, road grip and rolling resistance

The Design of Aerostatic Bearings, Gas Bearings, tribological aspects of wheel on rail contact.

Tutorial: - Based on above syllabus.

Reference Books :

1. Principles of Lubrication, Camaron, Longman's Green Co. Ltd.
2. B. C. Majumdar, –Introduction to Tribology and Bearings–, S.Chand and Company Ltd. New Delhi
3. Fundamental of Friction and Wear of Metals – ASM
4. The Design of Aerostatic Bearings – J. W. Powell
5. Gas Bearings – Grassam and Powell
6. Theory Hydrodynamic Lubrication, Pinkush and Sterrolicht
7. Tribology in Machine Design, T. A. Stolarski
8. –Surface Engineering of Metals: Principles, Equipments, Technologies, Taylor and Francis

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME212T **Course : Design of Hydraulic And Pneumatic System**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

--Course Objective:

The course deals with the study of various hydraulic and pneumatic systems. The course objective is to provide the understanding of hydraulic and pneumatic circuits, their specifications and characteristics, various components and their maintenance.

Expected Outcomes:

The students will be able to design and select the proper hydraulic or pneumatic circuits as per application. Also student will be able to install these system and can recognize any maintenance problem if any in the system.

Syllabus:

1. **Oil Hydraulic Systems:** Hydraulic Power Generator, selection and specification of pumps, pump characteristics.

2. **Hydraulic Actuators:** Linear & Rotary Actuators, Selection, Specification and Characteristics. Pneumatic equipments, selection of components, design calculations, application, fault finding, hydro pneumatic automation, robotic circuits .

3. **Control & Regulation Elements:** Pressure, direction and flow control valves, relief valves, non return and safety valves actuation systems.

4. **Hydraulic Circuits :** Reciprocating quick return, sequencing synchronizing circuits, accumulator circuits, industrial circuits, press circuits, hydraulic milling machine, grinding ,planning copying, forklift earthmover circuits, design and selection of components, safety and emergency modules.

5. **Pneumatic System, and Circuits :**Pneumatic fundamentals ,control elements, position and pressure sensing, logic circuits, switching circuits, fringe condition modules and their integration, sequential circuits, cascade methods, mapping methods, step counter method, compound circuit design, combination circuit design .

Tutorial: Based on above syllabus.

References:

- Peter Rohner, Fluid power logic circuits design the Macmillan Press Limited ,1979.
- Stewart,H.L., Hydraulic and pneumatic power for production, Industrial press, New York 1955.
- Walter Ernest, –Oil hydraulic power and industrial applications, Mc Graw Hill Book,Co 1962.
- Pease ,D.A. –Basic fluid power, Prentice Hall ,1987.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME213T **Course : Plastic Engineering**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objectives: To familiarize students with :1.Various Plastic materials, Their properties and applications 2.Different plastic processing techniques

Course Outcome: Students will be able to :1.Select the suitable plastic material for given application 2.Select suitable plastic processing technique

Unit 1

Chemistry and Classification of Polymers Properties of Thermo Plastics Properties of Thermosetting Plastics Applications Merits and Disadvantages

Unit 2

Extrusion Blow Molding Thermo Forming Rotomolding

Unit 3

Compression and Transfer Molding study of compression molds

Unit 4

Injection Molding study of injection molding machines and molds.

Unit 5

General Machining properties of Plastics Machining Parameters and Their effect

Joining of Plastics Mechanical Fasteners Thermal bonding Press Fitting. Testing of plastic

Text Books:

- Plastics Extrusion technology1988 F.Hensen, Publishers
- Polymer extrusion1990C.Rauwendaal, Hanser Publishers
- Manufacturing Engineering & Technology6st Edition (2013) S Kalpakjian & SR Schmid Pearson Education Canada Machining of Plastics1981Akira Kobyashi,McGraw Hil

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME221T **Course : Finite Element Analysis**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objectives:

To understand methods of analysis in depth and study comparison of separation of variables, Laplace transformation, Rayleigh Reitz method, Galerkin's method, minimum potential energy, principle of virtual displacement, finite element method and finite difference method. To study some of the elements, selection of number of elements, convergence criterion, boundary conditions and its significance. To explore applications of FEA in various fields. To understand various FEA softwares.

Expected Outcomes:

At the end students will be able to understand individual element stiffness matrix, shape functions, general procedural for solving problems of finite element analysis, method of analysis, various types of elements, applying FEA techniques in various fields like solid mechanics, heat transfer, vibration etc. To describe given object into number of elements, selection of type of element, decide the boundary condition and to determine nodal displacement, element stresses, element strain, support reactions etc.

UNIT-I

General Concept Introduction, the finite element method advantages and disadvantages, history of development, relevance, scope and engineering application – review of basic concepts of elasticity, principle of minimum potential energy, principle of virtual displacements.

UNIT-II

Variational and Weighted Residual Formulations: Boundary value problems, approximate method of solution, review of variational calculus, the Euler-lagrange equations, geometric and natural boundary conditions, method of weighted residuals. Raleigh Ritz and Galerkin methods –finite element formulations – comparisons through simple examples – the finite element basis, displacement models, convergence criteria.

UNIT-III

Elements Shape Function: Parameters functions , one dimensional elements ,global coordinates, natural co-ordinates, two dimensional elements, three noded triangular and four noded quadrilateral elements, three dimensional elements, four noded tetrahedral element.

UNIT-IV

Isoparametric Element Formulation: Isoparametric elements, characteristics, formulations and shape functions for one dimensional, two dimensional and three dimensional elements, numerical quadrate formulae, Jacobean matrices and transformations.

UNIT-V

Problem in Solid Mechanics: Formulation of the problems of axial, torsional and flexural deformations of beams, plane stress, plane strain and axis symmetric problemsfree vibration of beam and shafts.

Tutorial: Based on above syllabus.

References :

1. Reddy J.N. An introduction to the finite element method McGraw Hill Book Co.1984.

2. Larry J. Segerlind, Applied finite element analysis, John Willey, 1984.

3. Krishnamurthy , C. S., finite element analysis : Theory and programming , Tata Mc Graw Hill Publishing Co. , 1987.

4. Zienkiewiez , O. C. the finite element method, Tata Mc Graw Hill Publishing co. 1979.

5. M. Petyt, Introduction to finite element vibration analysis, Cambridge University Press, Cambridg, 1990.

6. Gowri Dhatt and Gilbert Touzot, The finite element method displayed ,Jhon Willey and Sons, 1985.

7. Hubner, K. H. and E . A. Thornton , the finite element method for engineers, Jhon Willey and sons,1982.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME222T **Course : Optimization In Engineering Design Course Objectives**

L:3 Hrs. P:0 Hrs. Per week **Credits:3**

Course Objectives:

The study of optimization is concerned with understanding of optimality of various design parameters for any system.It includes maximization or minimization of any designparameters or any affecting parameters concerned with practical industrial mechanical system. The overall objective of this course is to learn and understand principals of optimization techniques for various mechanical Engg. problems .This course includes conceptual and practical approach of optimization to mechanical field, introduction of various optimization techniques for varied condition of contained and unconstrained system, design of loaded members, design of shaft, beam for minimum cost & maximum power, optimum design of single, two DOF system optimum design of structural members under dynamics loads.

Expected Outcomes:

Students will able to understand the concepts of optimization along with its various methods of implementations for practical problem.

Syllabus:

UNIT-I

Introduction : General characteristics of mechanical elements, adequate & optimum design, principles of optimization, formulation of objective function, Design constraints.

UNIT-II

Optimization Techniques : Unconstrained minimization methods single multivariable search methods, random, pattern gradient search techniques, minimization procedure with equality and inequality constraints, penalty functions, concept of multicriterion Optimization.

UNIT-III

Application to Mechanical Engg. Problems : Design of simple axial transverse loaded members for torsionaly loaded members, shafts for minimum cost weight maximum

power,

UNIT-IV

Design of springs hydraulic cylinders, optimum design of single two degree of freedom system,

UNIT-V

vibration absorbers optimum design of simple machine/structural members under dynamic loads, multicriterion optimization of machine tools spindles . Tutorial: Based on above syllabus.

Reference :

1.Rao S.S. optimization Theory & Applications, Wiley Eastern Limited,New Delhi , 1978.

2.Fox Richard L.Optimizations methods for Engg. design, Addision Wesley ,1971 .

3.Haug,E.J.and Arora, J.S. Applied optimal design Wiley Inter Science Publication ,New York ,1979

4.Douglas J. Willde, Globally optimal design Jhon Wiley & Sons, New York, 1978

5.Johnson Ray C. optimum design of mechanical elements, John Wiley & Sons 1981.

6.Mischke, Charles R., An introduction to Computer Aided Design, Prentice Hall Inc ,1968

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME223T Course : Rapid Prototyping

L:3 Hrs. P:0 Hrs. Per week Credits:3

Objective

To learn the Product Life Cycle. Study the process of Rapid prototyping and different Rapid Prototyping methods

Course Outcome

Student will learn basics of Rapid Prototyping the process of RP model slicing for RP Liquid and solid based RP systems powder based RP system tooling and manufacturing

UNIT I

CAD CAM and its integration, Development of CAD CAM., The importance of being Rapid, The nature of RP/T, The state of RP/T industry. Rapid Prototyping Defined. Time compression Technologies, Product development and its relationship with rapid prototyping.

UNIT II

Data Preparation (Preprocessing), Part Building, Post Processing. CAD Model Preparation, Reverse Engineering and CAD model, Digitizing Techniques: Mechanical Contact Digitizing, Optical Non contact Measurement, CT Scanning Method, Data Processing for Surface Reconstruction.Data interface for Rapid Prototyping: STL interface Specification, STL data generation, STL data Manipulation, Advantages and limitations of STL file format. Open files. Repair of STL files. Alternative RP interfaces.Part orientation and support generation Factors affecting part orientation, various models for part orientation determination, the function of part supports, support structure design, Automatic support structure generation.

UNIT III

Model slicing and skin contour determination, Identification of external and internal contours, Contour data organization, Direct and adaptive slicing: Identification of peak features, Adaptive layer thickness determination, Skin contour computation. Tool path generation.Part Building Recoating, parameters affecting part building time, part quality.Post Processing Part removal, finishing, curing.Other issues: Shrinkage, Swelling, Curl and distortion, Surface Deviation and accuracy, Build Style Decisions,

UNIT IV

Classification, Description of RP Machines: SLA, SLS, FDM, 3D Printing, LOM, SDM, Contour Crafting

UNIT V

Classification of RT Routes, RP of Patterns, Indirect RT: Indirect method for Soft and Bridge Tooling, Indirect method for Production Tooling, Direct RT: Direct RT method for Soft and Bridge Tooling, Direct method for Production Tooling, Other RT Approaches. Rapid Manufacturing: Methods, limitations.

BOOKS RECOMMENDED

1 Bjorke, Layer Manufacturing, Tapir Publisher. 1992.

2 Jacobs, PF (Ed), Rapid Prototyping and Manufacturing, Society of Manuf. Engrs, 1992.

3 Burns, M., Automated Fabrication: Improving Productivity in Manufacturing, 1993.

4 Jacobs, P.F. (Ed.), Stereo lithography and Other RP&M Technologies: From Rapid Prototyping to Rapid Tooling, Society of Manuf. Engrs. NY, 1996.

5 Chua C. k. and L. K. Fai, Rapid Prototyping: Principles and Applications in Manufacturing.

6 Gibson, I. (Ed.), Software Solutions for Rapid Prototyping, Professional Engineering Publications, London., 2002

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME231A Course : PEDAGOGY STUDIES

L:2 Hrs. P:0 Hrs. Per week Credits:

Course Objectives:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.

2.Identify critical evidence gaps to guide the development.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?

2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?

3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Syllabus

UNIT I: Introduction and Methodology:
Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

UNIT II: **Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.

UNIT III: Curriculum, Teacher education. Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV:
Professional development: alignment with classroom practices and follow-up support Peer support

Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes

UNIT V: Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.

7. www.pratham.org/images/resource%20working%20paper%202.pdf.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME232A **Course : STRESS MANAGEMENT BY YOGA**

Credits: L:2 Hrs. P:0 Hrs. Per week

Course Objectives:

1. To achieve overall health of body and mind

2. To overcome stress

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also

2. Improve efficiency

Syllabus

UNIT I : Definitions of Eight parts of yog. (Ashtanga)

UNIT II: Yam and Niyam. Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III : Asan and Pranayam

i) Various yog poses and their benefits for mind & body

ii)Regularization of breathing techniques and its effects-Types of pranayam

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
Model Curriculum of Engineering & Technology PG Courses [Volume-I]

2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

SYLLABUS OF SEMESTER II, M. TECH. (MED)

Course Code: 23PME233A Course: Personality Development Through Life Enlightenment Skills

L:2 Hrs. P:0 Hrs. Per week Credits:

Course Objectives:

1. To learn to achieve the highest goal happily

2. To become a person with stable mind, pleasing personality and determination

3. To awaken wisdom in students

Course Outcomes:

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and

achieve the highest goal in life

2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity

3. Study of Neetishatakam will help in developing versatile personality of students.

Syllabus

UNIT I: Neetisatakam-Holistic development of personality

Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism) ,Verses- 26,28,63,65 (virtue);

Verses- 52,53,59 (dont's); Verses- 71,73,75,78 (do's)

UNIT II: Approach to day to day work and duties.

Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48; Chapter 3-Verses 13, 21, 27, 35; Chapter 6-Verses 5,13,17, 23, 35; Chapter 18-Verses 45, 46, 48.

UNIT III: Statements of basic knowledge.

Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68; Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42;

Chapter 4-Verses 18, 38,39 ; Chapter18 – Verses 37,38,63

Suggested reading

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication

2. Department), Kolkata

3. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,

4. Rashtriya Sanskrit Sansthanam, New Delhi.

SYLLABUS OF SEMESTER III, M. TECH. (MED)

Course Code: 23PME311T Course : Design of Mechanical Handling System

L:3 Hrs. P:0 Hrs. Per week Credits:3

Course Objectives:

The study of Design of various Mechanical handling system is concerned with understanding of various industrial system and devices with its basic design. It includes various based use in practical design field. The overall objectives of this course is to understand and learn about various industrial mechanical handling devices starting from their basic design for any desired condition and its safety analysis with its theoretical knowledge. This curse includes designed considerations of conveying mechanics like trucks, trolleys, Rope ways, Cranes, Elevators, Draglines, Robotics handling, Belt conveyers, Chain conveyers, screw conveyers, pneumatic conveying system.

Expected Outcomes:

Students will able to understand the practical basic design of various material handling systems for various loading conditions along with various material loading conditions.

Syllabus:

Constructional features, operation, operational characteristics advantages Disadvantages, limitations, Design considerations of following conveying machines.

Unit Load conveying: Fork lift Trucks, Trolley, conveyers. Cableways, Rope ways, Cranes , Over head cranes

Elevators, Drag lines , Robotic Handling , AGV Bulk solid us conveying: Belt conveyers , chain conveyers, Roller conveyers, (Gravity & Powered)

Screw conveyers, Tubular screw conveyers, Escalators, Vibrating conveyers, (Crank type & spring type), Pneumatic conveying.

Tutorial: - Based on above syllabus.

References:

1. Aleczandow : ‒Materials Handling‖, MIR Publ.
2. Acma, Reference book for Belt conveyers .
3. Conveyaing Machings ‒, by CITADINOV, MIR publ.

SYLLABUS OF SEMESTER III, M. TECH. (MED)

Course Code: 23PME312T Course : Vibration based condition Monitoring

L:3 Hrs. P:0 Hrs. Per week Credits:3

Course Objectives:

To understand vibration from basics to advanced level by diagnosis of problem using spectrum. To gain the knowledge in the coupling its types and application diff rent alignment techniques and latest trends in alignment

Expected Outcomes:

Students will able to understand various problems occurring in machines and their Diagnosis.

Syllabus:

I Vibration Instrumentation: Displacement, Velocity, Acceletation Shock Measurement, Transducers, Terminatings devices

II spectrum Analyzers , Exciters, Special Mounting Techniques .

III Signature Analysis : Concept of signature & prediction of trouble by signature monitoring , signatures due to imbalance,

IV coupling ,bearing, electric motor, gear drive , beltdrive , chain drive., PIV drive, piping .

V Effect of special phenomena : Bent shaft / Bowed Rotor , Transmitted vibrations, sympathetic vibration, impact , shock. Trend analysis, Approach for Diagnostics .

References :

1. W. Wowak , “ Machinery Vibrations”, Mc-Graw, Hill

2.Kolacoat ,” Vibration Based Condition Monitoring”, Prentice – Hall.

SYLLABUS OF SEMESTER III, M. TECH. (MED)

Course Code: 23PME313T   Course : Modelling & Simulation

L:3 Hrs. P:0 Hrs. Per week   Credits:3

Course Objectives: The course aims to develop the engineering analysis capability for engg problems using basic statistical tools and techniques. Detailed treatment of various modeling techniques leading to complete understanding and simulation the processes including its optimization is envisaged in this course.

Course Outcomes: Students are able to design the electronic and informatic means to implement them on control systems.

Unit 1

Introduction to mathematical modeling, Need, Advantages, Limitations, Disadvantages & Applicable to mechanical, manufacturing, process, Automotive,Electrical & Control System, Software tools available for modeling [Matlab Simulink, AutoLISP, ADAMS/Pro-Mechanica/ Visual Nastran/Working Model 4D, MathCAD/ Mathematica, Lab View and computer languages[C/C++/ Fortran /AutoLISP/ Simula /SIMSCRIPT/GASP/GPSS] for mathematical modelling.

UNIT 2

Introduction to automatic controls. Modeling of general second order system(mechanical systems [spring, mass, damper], flow, heat transfer and electrical, pneumatic and vibration systems). Block diagram and transfer function, Modeling of continuous system, Extraction of reduced order models. Transient and frequency response evaluation using Laplace transform, Control loop and its elements, Dynamic behaviour of first, second and higher order physical systems. Linearization of nonlinear systems. Controller hardware, sensors, transmitters and control valves

UNIT 3

Characteristics of hydraulic controller, pneumatic, electronic controller, electro hydraulic and electro pneumatic controllers, PID control, Stability, Gain and phase margins, Control system design using root and compensation

UNIT 4

Simulation Introduction, Advantages, Limitations, Disadvantages, Concept of System, Process, Activity, Attributes, Closed & Open System, Activities: Deterministic & Stochastic, Models: Static, Dynamic, Transient, Simulation Approaches: Event Scheduling, Process Interaction, Activity Scanning, Steps in Simulation Study

UNIT 5

Instrumentation and Process Control-Introduction, Study of various measuring parameters of a process/system and Measuring instruments for: Temperature, pressure, level, flow, Control schemes with applications to Machine tool,Boiler, Engine Governing, Aerospace, Active vibration control, Manufacturing, Process control, etc.

Text Books:

1. S.R Bhonsale, K.J., “Mathematical modeling for design of machine components”, Weinmann, 1999, Prentice Hall.

2. A.F. D’souza V K Gar, “Englewood Cliffs Advanced Dynamics: Modelling and Analysis,” N. J., Prentice Hall, 1984

3. Averal M. Law, W. David Kelton, “Simulation, Modelling and analysis”, McGraw Hill, 1992.

SYLLABUS OF SEMESTER III, M. TECH. (MED)

Course Code: 23PME321T Course : Business Analytics

L:3 Hrs. P:0 Hrs. Per week Credits:3

Course objectives:

1. Understand the role of business analytics within an organization.

2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.

3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.

4. To become familiar with processes needed to develop, report, and analyze business data.

5. Use decision-making tools/Operations research techniques.

6. Mange business process using analytical and management tools.

7. Analyze and solve problems from different industries such as manufacturing, service,

retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Outcomes:

1. Students will demonstrate knowledge of data analytics.

2. Students will demonstrate the ability of think critically in making decisions based on

data and deep analytics.

3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.

4. Students will demonstrate the ability to translate data into clear, actionable insights.

UNIT I:

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II:

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III:

Organization Structures of Business analytics, Team management,Management Issues, Designing Information Policy, Outsourcing,Ensuring Data Quality, Measuring contribution of Business analytics,Managing Changes.Descriptive Analytics, predictive analytics, predicative Modelling,Predictive analytics analysis, Data Mining, Data Mining Methodologies,Prescriptive analytics and its step in the business analytics Process,Prescriptive Modelling, nonlinear Optimization.

UNIT IV:

Forecasting Techniques: Qualitative and Judgmental Forecasting,Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend,Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, News vendor Model, Overbooking Model, Cash Budget Model.

UNIT V:

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

UNIT VI:

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G.

Schniederjans, Christopher M. Starkey, Pearson FT Press.

2.Business Analytics by James Evans, persons Education.

SYLLABUS OF SEMESTER III, M. TECH. (MED)

Course Code: 23PME322T Course : Industrial Safety

L:3 Hrs. P:0 Hrs. Per week Credits:3

Course Objectives:

1.To know about Industrial safety programs and toxicology ,Industrial laws , regulations and source models.

2.To understand about fire and explosion, preventive methods, relief and its sizing methods

3.To analyse industrial hazards and its risk assessment.

Course Outcomes:

By the end of the course the students will be able to

1.Analyze the effect of release of toxic substances

2.Understand the industrial laws, regulations and source models.

3.Apply the methods of prevention of fire and explosions.

4.Understand the relief and its sizing methods

5.Understand the methods of hazard identification and preventive measures.

UNIT-I: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV: Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V: Periodic and preventive maintenance: Periodic inspection-concept and need,degreasing, cleaning and repairing schemes, overhauling of mechanical components,overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance.Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Reference Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

SYLLABUS OF SEMESTER III, M. TECH. (MED)

Course Code: 23PME323T Course : Operations Research

L:3 Hrs. P:0 Hrs. Per week Credits:3

Course Objectives:

1.To make the students aware with quantitative tools and techniques, which are frequently applied to business decision-making.

2.to provide a formal quantitative approach.

3.To problem solving and an intuition about situations where such an approach is appropriate.

Course Outcomes: At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discreet

and continuous variables.

2. Students should able to apply the concept of non-linear programming

3. Students should able to carry out sensitivity analysis

4. Student should able to model the real world problem and simulate it.

Syllabus Contents:

UNIT I:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques,

Sensitivity Analysis, Inventory Control Models

UNIT II:

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex

method - sensitivity analysis - parametric programming

UNIT III:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow

problem - CPM/PERT

UNIT IV:

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V:

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008

2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008

4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009

5. Pannerselvam, Operations Research: Prentice Hall of India 2010

6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

SYLLABUS OF SEMESTER IV, M. TECH. (MED)

Course Code: 23PME401P   Course : Project- Phase-II

L:0 Hrs. P:32 Hrs. Per week   Credits:16

Student should publish at least two research papers in National/ International journals on project spade work and research.

COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

DEFENCE TECHNOLOGY

Of

RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

Semester -1

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-1			Branch Defence Technology
		Compulsory Courses	**Periods/Week**			**Total Credits**
			L	**T**	**P**	
1.	23PDT 101T	Systems and warfare Platforms	4	-	-	4
2.	23PDT 102T	Warfare Simulations & Strategies	4	-	-	4
3.	23PDT 103T	Advanced Engineering Mathematics	4	-	-	4
4.	23PDT 101P	Systemsand warfare Platforms Lab	-	-	2	2
5.	23PDT 102P	Warfare Simulations & Strategies Lab	-	-	2	2
		ElectiveCourses				
6.	23PDT 11XT	Elective 1	3	-	-	3
7.	23PDT 12XT	Elective 2	3	-	-	3
8.			-	-	-	-
		Total credits				22

Semester-1 Elective Courses

- Students are expected to select the Elective-I course of their choice, provided that atleast a group of 7 students should opt for the similar elective course.

S.No.	Course Code	Course of study and scheme of examination	M.Tech Semester-1			
		Elective1	Periods/Week			
			L	T	P	Total Credits
1.	23PDT 111T	Rockets & Missiles Fundamentals	3	-	-	3
2.	23PDT 112T	Advanced Thermal Engineering	3	-	-	3
3.	23PDT 114T	Numerical methods forscience & engineering	3	-	-	3
4.	23PDT 115T	CommunicationTechnology	3	-	-	3
5.	23PDT 113T	Advanced Mechanical Engineering	3	-	-	3

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-1			
		Elective2	Periods/Week			
			L	T	P	Total Credits
1.	23PDT 124T	Autonomy and Navigation Technology	3	-	-	3
2.	23PDT 121T	Optimizationtheory & applications	3	-	-	3
3.	23PDT 122T	Military Electronics System Engineering	3	-	-	3
4.	23PDT 123T	System Engineering & Analysis	3	-	-	3

Semester-2: **Main Stream Defence Technology with following six specialization**

S. No.	Main StreamDefence Technology
1.	CombatVehicleEngineering
2.	AerospaceTechnology
3.	NavalTechnology
4.	CommunicationSystems & Sensors
5.	DirectedEnergyTechnology
6.	HighEnergyMaterialsTechnology

1. Combat Vehicle Engineering

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-2			Branch Defence Technology
		Compulsory Courses	**Periods/Week**			**Total Credits**
		Combat Vehicle Engineering	**L**	**T**	**P**	
1.	23PDTCV201T	CombatVehicleDynamics	4	-	-	4
2.	23PDTCV202T	CombatSystem Engineering	4	-	-	4
3.	23PDTCV203T	Test & Evaluation of Weapon System	4	-	-	4
4.	23PDTCV201P	Combat Vehicle Dynamics Lab	-	-	2	2
5.	23PDTCV202P	CombatSystem Engineering Lab	-	-	2	2
		ElectiveCourses				
6.	23PDT CV23XT	Elective 1	3	-	-	3
7.	23PDTCV 24XT	Elective 2	3	-	-	3
8.		Seminar	-	-	1	1
		Total credits				23

2. Aero space Technology

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-2			Branch Defence Technology
		Compulsory Courses	**Periods/Week**			**Total Credits**
		AerospaceTechnology	**L**	**T**	**P**	
1.	23PDTAT201T	Aero space System Configuration, Design & Simulation	4	-	-	4
2.	23PDTAT202T	Guidance & control	4	-	-	4
3.	23PDTAT203T	Aerospace Propulsion	4	-	-	4
4.	23PDTAT201P	Aerospace System Configuration, Design & Simulation Lab	-	-	2	2
5.	23PDTAT202P	Guidance & control Lab	-	-	2	2
		ElectiveCourses				
6.	23PDTAT 23XT	Elective 1	3	-	-	3
7.	23PDTAT 24XT	Elective 2	3	-	-	3
8.			-	-	-	
		Total credits				22

3. Naval Technology

S. No	Course Code	Course of study and scheme of examination	M.Tech Semester-2			Branch Defence Technology
.		**Compulsory Courses**	**Periods/Week**			**Total Credits**
		Naval Technology	**L**	**T**	**P**	
1.	DT-NT-01	Naval combat system engineering	4	-	-	4
2.	DT-NT-02	Guidance, Navigation, and Control of Marine Systems	4	-	-	4
3.	DT-NT-03	Marine Propulsion	4	-	-	4
4.	DT-NT-L01	Naval combat system engineering Lab	-	-	2	2
5.	DT-NT-L02	Guidance, Navigation,and Control of Marine SystemsLab	-	-	2	2
		Elective Courses				
6.		Elective 1	3	-	-	3
7.		Elective 2	3	-	-	3
8.		Seminar	-	-	1	1
		Total credits				23

4. Communication Systems & Sensors

S. No	CourseCode	Course of study and scheme of examination	M.Tech Semester-2			Branch Defence Technology
.		**Compulsory Courses**	**Periods/Week**			**Total Credits**
		Communication Systems & Sensors	**L**	**T**	**P**	
1.	DT-CSS-01	Radar Technologies	4	-	-	4
2.	DT-CSS-02	Digital & satellite Communication and Navigation from Space	4	-	-	4
3.	DT-CSS-03	Tactical battle field Communication & Electronic Warfare	4	-	-	4
4.	DT-CSS-L01	Radar Technologies Lab	-	-	2	2
5.	DT-CSS-L02	Digital & satellite Communication and Navigation from Space Lab	-	-	2	2
		Elective Courses				
6.		Elective 1	3	-	-	3
7.		Elective 2	3	-	-	3
8.		Seminar	-	-	1	1
		Total credits				23

5. **Directed Energy Technology**

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-2			Branch Defence Technology
		Compulsory Courses	**Periods/Week**			**Total Credits**
		Directed Energy Technology	**L**	**T**	**P**	
1.	DT-DET-01	Directed Energy Sources (Lasers, Microwave)	4	-	-	4
2.	DT-DET-02	Beam Control Technology, Targetacquisition, Beam Pointing & Tracking	4	-	-	4
3.	DT-DET-03	Directed Energy Weapons (DEW) System Engineering	4	-	-	4
4.	DT-DET-L01	Directed Energy Sources (Lasers, Microwave) Lab	-	-	2	2
5.	DT-DET-L02	Beam Control Technology, Target acquisition, Beam Pointing & Tracking Lab	-	-	2	2
		ElectiveCourses				
6.		Elective 1	3	-	0	3
7.		Elective 2	3	-	0	3
8.		Seminar	-	-	1	1
		Total credits				23

6. **High Energy Materials Technology**

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-2			Branch Defence Technology
		Compulsory Courses	**Periods/Week**			**Total Credits**
		High Energy Materials Technology	**L**	**T**	**P**	
1.	DT-HEM-01	High Energy Materials Modeling & Simulation	4	-	-	4
2.	DT-HEM-02	Munitions and Target Response	4	-	-	4
3.	DT-HEM-03	Manufacturing and Materials Properties of Explosives	4	-	-	4
4.	DT-HEM-L01	High Energy Materials Modeling & Simulation Lab	-	-	2	2
5.	DT-HEM-L02	Munitionsand Target	-	-	2	2
		ResponseLab				
		Elective Courses		-		
6.		Elective 1	3	-	-	3
7.		Elective 2	3	-	-	3
8.		Seminar	-	-	1	1
		Total credits				23

Elective Courses of fered for Semester 2

- Students are expected to select the Elective-I course of their choice, providedthatatleastagroupof7studentsshouldopt for thesimilar electivecourse.

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-2			
		Elective 1 (for all Specializations)	**Periods/Week**			
			L	**T**	**P**	**Credits**
1.	23PDT CV231T	Robotics (MSS, MCC)	3	-	-	3
2.	23PDT CV234T	EMI/EMC in Military Systems	3	-	-	3
3.	23PDT CV235T	Defence Electro-Optics and Imaging Systems	3	-	-	3
4.	23PDT CV236T	Structural Dynamics and Aero-Elasticity	3	-	-	3
5.	23PDT CV232T	Safety, Health & Hazard Management	3	-	-	3
6.	23PDT CV233T	Fundamental of telemetry, telecomm and & transponder	3	-	-	3
7.	23PDT CV237T	Jamming and ECM/ECCM technologies	3	-	-	3
8.	23PDT CV238T	Software defined Radios	3	-	-	3
9.	23PDT CV239T	Advanced Light weight and Composite Structures	3	-	-	3
10.	23PDT CV240T	Testmethodologies for DEW systems (Lasers & Microwave)	3	-	-	3
11.	23PDT CV241T	Advanced Analytical Techniques /Lab testing	3	-	-	3
12.	23PDT CV242T	Sonar System Engineering	3	-	-	3

S. No.	Course Code	Course of study and scheme of examination	M.Tech Semester-2			
		Elective 2 (for all Specializations)	**Periods/Week**			
			L	**T**	**P**	**Credits**
1.	23PDTAT 244T	Unmanned Aerial Vehicle Design	3	-	-	3
2.	23PDTAT 245T	Naval Ocean Analysis and Prediction	3	-	-	3
3.	23PDTAT 246T	Modeling & simulation of LaserMatterInteraction	3	-	-	3
4.	23PDTCV 241T	Computational Aero dynamics	3	-	-	3
5.	23PDTAT 247T	Launch Vehicle Design & Analysis	3	-	-	3
6.	23PDTCV 242T	Acquisition,Tracking & Pointing Technology	3	-	-	3
7.	23PDTAT 248T	Data acquisition, tracking & post flight analysis	3	-	-	3
8.	23PDTAT 249T	Air in dependent propulsion & Batteries	3	-	-	3
9.	23PDTCV 243T	Advanced digital modulation technologies & standards	3	-	-	3
10.	23PDTAT 250T	Trajectories modeling & simulation	3	-	-	3
11.	23PDTAT 251T	Sensor Technology	3	-	-	3

Semester -3

S. No.	Course Code	Course	Credit
1.	23PDT301P	Project Dissertation- Phase1	8
2.	23PDT302P	Seminar/Industrialtraining	4
		Total credits	**12**

Semester –4

S. No.	Course Code	Course	Credit
1	23PDT401P	Project Dissertation Phase-2	16
		Total credits	**16**

7. Procedure to approach DRDO Labs

Prospective institute may contact the DRDO Lab near its vicinity for conducting thisprogram, e.g. prospective institute located in Hyderabad may seek help from DRDOLabs located inside or near the vicinity of Hyderabad.List of DRDO Labs is provided inAnnexureA.

8. Eligibility criteria

Those who have pursued under graduation in following disciplines are eligible for takinguptheM.Tech.DefenceTechnology courses:

1) AerospaceEngineering
2) Aeronauticalengineering
3) AppliedElectronicsandCommunicationEngineering
4) AppliedElectronicsandInstrumentationEngineering
5) ChemicalTechnology
6) Chemicalengineering
7) ComputerScience& Engineering
8) ComputerandCommunicationEngineering
9) ComputerEngineering
10) ComputerEngineeringandApplications
11) ComputerNetworking
12) ComputerScienceandInformationTechnology
13) ComputerScienceandTechnology
14) ComputerTechnology
15) ElectricalandComputerEngineering
16) ElectricalandElectronicsEngineering
17) ElectricalandInstrumentationEngineering
18) ElectricalandPowerEngineering
19) ElectricalEngineering
20) Electronicsengineering
21) Electrical,ElectronicsandPowerEngineering
22) ElectronicsandCommunicationengineering
23) Instrumentationengineering
24) Electronics,InstrumentationandControlEngineering
25) Electronics,Scienceand Engineering
26) ElectronicsandComputerEngineering
27) ElectronicsandCommunicationEngineering

28) Electronicsand ComputerScience
29) Electronicsand ControlSystems
30) ElectronicsandPowerEngineering
31) ElectronicsandTelecommunication
32) Electronics,Instruments andControlEngineering
33) ElectronicsSystemEngineering
34) InstrumentationandElectronics
35) InstrumentationEngineering
36) MarineEngineering
37) MarineTechnology
38) MechanicalandAutomationEngineering
39) MechatronicsEngineering
40) Mechanicalengineering
41) MetallurgicalandMaterialsEngineering
42) Militaryengineering
43) OpticsandOpto-electronics
44) PowerElectronicsEngineering
45) Radio,PhysicsandElectronics
46) SoftwareEngineering
47) StructuralEngineering
48) TelecommunicationEngineering

9. Guidelines

i. To begin the courses, it will be preferred to have institutes / universities in vicinity of DRDO/PSU/ private defence industries for effective conduction of courses.

ii. Keeping in view the uniqueness of the courses of this program, each course can be conducted on sharing basis, the faculty (s) from prospective institute/university can share the course to be conducted with the super annuated/working scientists from the DRDO labs located in the vicinity of the institute. Onrequest by the institutions, the experts/ scientists For conducting the respective courses will be made available by DRDO lab provided that the prospective institution should plan the teaching assignment well in advance and communicate to the near by DRDO lab for the meaningful. The institutes/university should cater for remuneration / funding to the mentioned lecturers for course activities as per university rules.

iii. The laboratory work mentioned in semester 1 & 2 can be held at respective DRDO labs / PSU/ private defence industries located in the vicinity on demandfromtheinstitution/ university.

iv. There will be mentor from academic institute / university as well as from DRDOlab/

Industries forconductingonline/offlinelabexperiments.

v. M. Tech. Project phase 1& 2 may be done in respective DRDO labs, DRDO established Center of Excellence, DIAT Pune, PSUs and private defence industries. As regard M.Tech dissertation based upon the topic of dissertation, the respective students will be placed appropriately to the various respective labs located all over countries.

vi. The model course structure has been provided for reference. The prospective institutions / universities can get it approved from the concerned bodies. Also the prospective institutions / universities may take approval of DRDO scientist toteach the courses on sharing basis.

vii. The prospective institution/universities can conduct the examination appropriately for theory, practical courses and dissertation.The dissertation examination can be conducted at DRDO lab as per the requirement of the dissertation topic, in case the developed product / system can not be taken out from the DRDO lab.

viii. The list of DRDO superannuated scientists along with contact details, willing to contribute for this program has been provided.

ix. Classes may be conducted online as well as offline as per need.

Course Contents

M.Tech.(Defence Technology)

Semester-1 Compulsory Course

- **CourseTitle : Systems and warfare Platforms**
  CourseCode :23PDT 101T
  Teaching Scheme: L: 4, T: 0, P:0 Credits:4

Course Objectives:

The main objective of the course is to provide knowledge to the students aboutvarious types of military platforms used in air, naval & land warfare. Students willalso be apprised for weapon system and self-protection strategies and tech-niques.

Course Outcomes:

At the end of the course the student should be able to

- Understand types of warfare platform used for Army, Air and Marine and theirdesignfundamentals.
- Understand the weapon systems like guns, ordnance, missiles projectiles ,mines/countermines, lasers, under sea weapons, air-launched weapons, anti-aircraft, anti-ship and anti-submarine.

Course Content:

Unit	Contents	Contact Hrs.
1.	Types of platforms: land, sea, air; Lifecycle: concept, design, pre-production, production, operations, support.	7
2.	Ship design fundamentals: buoyancy, stability, ship resistance, survivability; damage control, NBCD, crew numbers, power requirements. Submarine design: buoyancy, stability, hull/tank design,air interdependence.	7
3.	Mechanics of flight: fixed and rotary wing, straight and level flight of aircraft, aircraft control and movement, aircraft control surfaces, aerodynamics, power requirements, range; speed, ceiling, survivability,payload.	7
4.	Military vehicle fundamentals: tracked, wheeled, A, B and C vehicles.	7
5.	Weapon systems: guns, ordnance, missiles, rockets, bombs, sub-munitions, projectiles, mines/countermines, lasers, under sea weapons, air-launched weapons, anti-aircraft, anti-personnel, anti-ship,anti-submarine.	6
6.	Self defence and Protection systems: Armour, smoke, chaff, decoys; Introduction to instrumentation, lab tests and flighttrials.	6
Total		40

References / Suggested Books:

1. “Light And Heavy Vehicle Technology“, by Nunney. Publisher Elsevier.
2. “Practical approach to motor vehicle engineering and maintenance”, by Bonnick Allanet.Al.Publisher:Yesdee.
3. “Automotive Vibration Control Technology: Fundamentals, Materials, Construc-tion, Simulation, and Applications”,by Trelleborg.
4. “An Introduction to Weapons Systems”,by Yacov Bar-Shlomo.Publisher :Create Space Independent Publishing Platform.
5. “Heavy Vehicle Mechanics”,by Ian Nicholson.Publisher: McGraw-Hill Education –Europe.
6. “Military Laser Technology for Defense: Technology for Revolutionizing 21st Century Warfare”, by Alastair D.McAulay. Publisher: Wiley-Interscience;1stedition.
7. Literature/books suggested by respective course Lecturers.

- **CourseTitle : Warfare Simulations & Strategies**
  Course Code :23PDT 102T
  Teaching Scheme: L:4,T:0, P:0, Credits: 4

Course Objectives:

The main objective of the course is to provide knowledge to the students aboutwarfare system and affluent them with combat modeling using mathematical modeling.

Course Outcomes:

At the end of the course the student should be able to

- Understand the systems used inwarfare scenario.
- Understand combat simulation & modelling
- Understand the war gaming simulation & modeling and human factor repre-sentation.

Course Content

Unit	Contents	Contact Hrs.
1.	Introduction to Warfare systems: air, surface,subsurface,littoral,electronic	7
2.	Military capabilities: air warfare,surface warfare,subsurface warfare, littoral warfare	7
3.	Introduction to the methods used in modeling combat and their application in support of defence decision making and training, Combat simulation.	7
4.	Wargaming/interactive simulation, Lanchester "sequations, Mathematical models of combat.	7
5.	Wargaming and combat modeling in practice,manual wargaming.	6
6.	Human factors representation in wargaming and combat modeling.	6
	Total	40

References/Suggested Books:

1. "Defense Modeling, Simulation, and Analysis:Meeting the Challenge".Publish-er: National Academies Press(October22,2006).
2. "Introduction to Electronic Warfare Modeling and Simulation"by David L. Adamy".Publisher:Artech Print on Demand(October 31, 2002).
3. "Engineering Principles of Combat Modeling and Distributed Simulation",by An-dreas Tolk (Editor),Old Dominion University. Publisher: JohnWiley & Sons.
4. Literature/books suggested by respective course Lecturers.

- **Course Title : Advanced Engineering Mathematics**
  Course Code :23PDT 103T
  Teaching Scheme:L:4,T:0,P:0 Credits:4

Course Objectives

The main objective of the course is to provide knowledge to the students of probability theory, algebra, solutions of Differential equations, Transform techniques, special functions & their applications in theareaswithdefencerelevance.

Course Outcomes

At the end of the course the student should be able to

- Know the methods for solving differential equations, generating functions.
- Understand basic concepts of Fourier Transform, Laplace Transforms andsolve problems with periodic functions, step functions, impulse functions and convolution.
- Demonstrate MATLAB programming for engineering problems.
- Understand the utilization of mathematical methods for solving problems having relevance to defence applications.

Course Content:

Unit	Contents	Contact Hrs.
1.	Elements of Probability and Statistics, components of operations research, Linear Algebra	6
2.	Ordinary Differential equations, Numerical methods for ODE and P.D.E. Generating functions, recurrence relations	7
3.	Transform Techniques, Fourier series, Fourier Transform, Laplas Transform	7
4.	Special functions: Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.	7
5.	Elements of Ramsey theory, theorems of Burn side and Polya, and balanced in complete block designs.	7
6.	Application areas with defence relevance range from mathematics to computer science and operations research, applications in probability, gametheory, network design, coding theory, and experimental design.	6
	Total	40

References/Suggested Books:

1. “Advanced engineering mathematics”,by Kreyszig.Publisher: Wiley.
2. “Advanced engineering mathematics”,by Jain/Iyenger.Publisher: Narosa.
3. “Advanced engineering mathematics”,by Taneja.Publisher:IKinternational
4. “Advanced engineering mathematics”,by AlanJeffery. Publisher:Academic Press.
5. “Advanced engineering mathematics”,by Peter V.O‟Neil.Publisher:Cengage Learning.
6. Literature/books suggested by respective course Lecturers.

- **Course title : Warfare simulations & Strategies lab**
  Course Code :23PDT 102P
  Teaching Scheme:L:0,T:0, P:2 Credits:2

Lab experiments will be added in consultation with DRDO labs considering the available facilities.

Semester 1, Elective-1 Courses

- **Course Title : Rockets & Missiles Fundamentals**
  CourseCode :23PDT 111T
  Teaching Scheme: L:3,T:0, P:0 Credits:3

Course Objectives:

The main objective of the course is to provide knowledge to the students about missile system, classification of missiles, aerodynamics of missiles, subsystems and missile trajectory.

Course Outcomes:

At the end of the course the student should be able to

- Understand basics of missile physics as well as the engineering aspects of missile integration.
- Understand physics behind guide dmissiles and aerodynamics of missiles.
- Characterization of sub-systems used in missiles.

Course Content:

Unit	Contents	Contact Hrs.
1.	Basics of Missile Physics, Introduction to Guided Missiles, Classification of Missiles,	5
2.	Missile Aerodynamic Configurations, Introduction to Missile System, Interrelationship between various Missile Sub-Systems.	5
3.	Basic Characteristics of Guided Missile Systems, Missile System Reliability, Range dispersion and CEPC oncept,	5
4.	Design, System Layout and integration of Sub-Systems,	7
5.	Coordinate Transformation, Transformation Matrices. Two, Threeand Six DOF Equations of Motion, Ballistic Missile Trajectory,	7
6.	Effect of Curvature of Earth, Rotation of Earth, Variation of Gravityon Missile Trajectory.	7
	Total	36

References/Suggested Books:

1. “Fundamentals of Guided Missiles”, by S.R.Mohan. Publisher: Defence Re-search and Development Organisation.
2. “Estimation and Prediction of Ballistic Missile Trajectories” by Jeffrey A.Isaac-son, David R.Vaughan.Publisher: RAND (29May1996)
3. “Introduction to Modern Algebra and Matrix Theory”, by O.Schreier, E.Sperner, Martin David, Melvin Hausner. Publisher: Dover Publications.
4. Literature/ books suggested by respective course Lecturers.

❖ **Course Title : Advanced Thermal Engineering**
Course Code :23PDT 112T
Teaching Scheme:L: 3,T: 0, P:0 Credits:3

Course Objectives

The main objective of the course is to provide knowledge to the students for the thermal management requirements/problems of the defence systems and thermal system design & simulation for the various air, land & naval defence systems utilized under different environmental conditions.

Course Outcomes:

At the end of the course the student should be able to

- Understand thermal designand simulations for system design.
- Carryout CFD simulations,design of heat exchangers,refrigeration.
- Understand the concept of thermal management requirement & design for defence systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	System thermal design & Analysis, Tools for thermal design and simulation, Heat transfer analysis (conduction, convection & radiation),	7
2.	Computation fluid dynamics (CFD), Thermal Finite Element Analysis	7
3.	Heat Exchangers for: Heat Exchanger Network Design	6
4.	Refrigeration, Humidifiers, Air Washers and Cooling Towers	5
5.	Thermal management design of defence system (combat vehicles, missiles, aerial vehicles etc.)	6
6.	Thermal testing, thermal operation, and integration of thermal design in to the defence systems.	5
	Total	36

References/Suggested Books:

1. "Fundamentals of Heat and Mass Transfer", by Incropera and Dewitt. Publication: John Wiley.
2. "Convective Heat and Mass Transfer",by WMK ays and ME Craw ford. Publisher: McGraw-Hill publishing Company.
3. "Thermal Radiation Heat Transfer" by J Siegeland R Howell. Publisher: Elsevier.
4. "Manohar Prasad,Refrigeration and Air Conditioning",3rd Edition, New Age International, 2015.
5. "Computational Fluid Dynamics—The Basics with Applications", by John DAnderson. Publisher:1st Edition, McGraw Hill,2012.
6. "Thermal System Design and Simulation", by P.L. Dhar, 1st Edition.
7. Literature/books suggested by respective course Lecturers.

- **Course Title : Numerical methods for science and engineering**
  Course Code :23PDT114T
  Teaching Scheme:L: 3,T:0, P:0 Credits: 3

Course Objectives

The main objective of the course is to provide knowledge to the students todevelop numerical methods aided by technology to solve algebraic equations, calculate derivatives and integrals, curve fitting and optimization techniques. Thecourse will also develop an understanding of the finite element analysis and computational fluid engineering.

Course Outcomes

At the end of the course the student should be able to:

- Use the numerical techniques (algorithms) to find the solution (approximate) algebraic equations and system of equations.
- Fit the data using interpolation technique and spline methods.
- Use to finite element analysis, interpretation of analysis results.
- Understanding of computational engineering process.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction, solution of non-linear equations, solution of linear systems.	5
2.	Introduction and polynomial approximation, curve fitting, Numerical applications & intergradations, numerical optimization.	5
3.	Matrices and types of linear systems, direct elimination methods, conditioning and stability of solutions,	5
4.	Introduction to Finite Element Analysis (FEA) simulation software, Pre-and Post- Processing, Freemesh and Mapped mesh techniques, Quality checks on nodes and elements, Boundary conditions,	7
5.	Introduction to computational fluid engineering, Fundamental equations, Computational Engineering Process.	7
6.	Fluid Simulation for Computer Graphics, Modelling techniques.	7
	Total	36

References/Suggested Books:

1. "Numerical Methods for Scientific and Engineering Computation",by M. K. Jainand S.R.K. Iyengar. Publisher:New Age International Publishers.
2. "Applied Numerical Analysis", by Gerald & Wheatley. Publisher Addison —Wesley.
3. "Introductory Methods of Numerical Analysis", by, S.S. Sastry. Publisher: PHI Pvt.Ltd., 5thEdition, New Delhi,2009.
4. "Applied Numerical Methods Using MATLAB",by W.Y.Yang, W.Cao, T.S.Chung and J.Morris.Publisher:Wiley India Edn.,2007.
5. "Numerical Methods for Engineers with Programming and Software Applications", by

Steven C. Chapra and Ra P. Canale. Publisher: Tata McGraw Hill,2014$7^{th}$ Edition.

6. “Finite Element Procedures”,by K.J.Bathe, Prentice Hall of India.
7. “Finite Elements in Engineering”, by Chandrupatla and Belegundu.
8. “Finite element Method”, by J.N.Reddy.
9. Literature/books suggested by respective course Lecturers.

❖ **Course Title : Communication Technology**
CourseCode :23PDT115T
Teaching Scheme:L: 3,T: 0,P:0 Credits:3

Course Objectives

The main objective of the course is to provide knowledge to the students about communication system design, calculation of bandwidth and signal-to-noise ratio of a signal, digital communication systems, performance evaluation, explain the concepts of link budget and multi pleaccesses asitapplies towire less communication.

Course Outcomes:

At the end of the course the student should beable to

- Understand communication system design methodologies, communication system architecture, analogue & digital modulation techniques.
- Computation of data rates, bandwidth, BER.
- To carry out the link budget analysis.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction on Communication Systems, Basics of wireless channel behavior	6
2.	Digital data communication systems, digital signaling techniques	6
3.	Data rates and bandwidth calculation in digital data communication systems	5
4.	Probability of error and BER calculation, Modulation technologies (analogue & digital), Voice source coding, transmitter and receiver systems	7
5.	Communication system architectures, terminal design and performance, associated information systems	7
6.	Link budget calculations, telemetry and control and IO/I Wimplications. Antenna types and their impact on the communicaiton systems	5
	Total	36

References/Suggested Books:

1. "Fundamentals of communication systems,"by Proakis and Salehi. Publisher: Pearson.
2. "Communication Systems",by Simon Haykin and Michael Moher. Publisher: Wiley.
3. "Modern digital and analog communication systems,"by B.P. Lathi and Zhi Ding. Publisher: Oxford University Press.
4. Literature/books suggested by respective course Lecturers.

- **Course Title : Advanced Mechanical Engineering**
  Course Code :23PDT 113T
  Teaching Scheme:L:3,T:0,P:0 -Credits:3

Course Objectives:

The main objective of the course is to provide knowledge to the students aboutdifferent methods of mechanical system analysis, mechanical simulation soft-ware and use of computational techniques for structural and fluid dynamics.

Course Outcomes

At the end of the course the student should be able to

- Underst and mechanical analysis software and carry out mathematical modeling for simulation of phenomena behind the structural and fluid dynamics.
- Carryout design & finite element analysis of components of systems and sub-systems.
- Carry out the CFD analysis.

CourseContent

Unit	Contents	Contact Hrs.
1.	Introduction to tools for mechanical design & analysis	5
2.	Stress engineering–theory & simulation, mechanics of solids	7
3.	Finite element methods in structural dynamics, Structural integrity	7
4.	Fluid mechanics	5
5.	Computational fluid dynamics	7
6.	Component design, Applied materials and corrosion	5
	Total	36

References/Suggested Books:

1. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" by H.Versteeg. Publisher: Pearson.
2. "Computational Fluid Dynamics the Basics with Applications", by John D.Ander Jr.Publisher :McGraw Hill Education(1July 2017)
3. "Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cam-bridge-iisc)" by C.S.Jog. Publisher: Cambridge University Press.
4. "Fundamentals of Machine Component Design",by Robert C. Juvinall, Kurt M.Marshek. Publisher: John Wiley & Sons
5. Literature/books suggested by respective course Lecturers.

Semester1, Elective-2 Courses

- **Course Title : Autonomy and Navigation Technology**
  Course Code :23PDT124T
  Teaching Scheme:L:3,T: 0, P: 0 -Credits:3

Course Objectives:

The main objective of the course is to provide knowledge to the students about technology of modern navigation systems, particularly satellite-based systems, UAV guidance systems,GPS,SLAM.

Course Outcomes:

At the end of the course the student should be able to:

- Describe the basic principle of operation of a global navigation satellite system
- Understand the navigation systems and derive the navigation equations.
- Carry out path planning the UGV/UAV.
- Solve the equations for calculating a position estimate from a given satellite constellation.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction on navigation and guidance systems, Guidance approaches: conventional guidance such as PN (Proportional Navigation)	6
2.	Geodetic fundamentals of navigation, positioning, reference- and coordinate systems and computational methods for navigation and positioning on the surface of theearth.	7
3.	Geometric guidance,pathplanningand following,andoptimal guidance; path planning for UGV/UAV guidance systems	7
4.	Navigation approaches: navigation systems, Understanding the Global Positioning System(GPS)	5
5.	GNSS (Global Navigation Satellite System), terrain based navigation	6
6.	SLAM (Simultaneous Localization and Mapping); Cooperative guidance and collision avoidance.	5
	Total	36

References/Suggested Books:

1. "Global Navigation Satellite Systems: Insights Into GPS",by Bhatta,B.,Glonass, Galileo, Compass, and Others. Publisher **:** BS Publications, New Delhi2010.
2. "Global Positioning Systems, Inertial Navigation, and Integration", by Grewal, M.S., Weill, L. R.,Andrews, A.P.,Publisher: John Wiley & Sons,New York,2006.
3. "GNSS — Global Navigation Satellite Systems", by Verlag Wien. Hofmann-Wellenh of, B.,Lichtenegger, H.,Wasle,E..Publisher: Springer2008.
4. "Global Positioning System Theory and Practice",Hofmann-Wellenh of, B.,Lichtenegger, H.,Verlag Wien,Collins, J.Publisher: Springer2001.
5. Literature/books suggested by respective course Lecturers.

❖ **Course Title : Optimization theory & applications**
Course Code :23PDT121T
Teaching Scheme: L:3,T:0,P: 0 -Credits:3

Course Objectives

The main objective of the course is to provide knowledge to the students on thenumerical optimization algorithms. The course objective is to cover the concepts of optimization methods and algorithms developed for solving various types ofoptimization problems. Apply the mathematical results and numerical techniques of optimization theory to various Engineering and Analytics problems and applications in both theoretical and applied research areas.

Course Outcomes

At the end of the course the student should be able to

- Understand mathematical modeling and the formulation of optimization problems.
- Create programs based on different optimization algorithms using IT tools,suchas MATLABetc.
- Underst and theory about linear programming, integer programming, and stochastic programming
- Understand the process of finalizing design of engineering systems by applying the numerical optimization.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1.	Introduction to optimization, classical optimization techniques.	6
2.	Linear programming & nonlinear programming and dimensional minimization methods.	7
3.	Noncoordination optimization techniques, coordinate doptimization techniques, coordinated programming.	7
4.	Dynamic programming, integer programming,stochastic programming.	6
5.	Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques.	5
6.	Additional Topics: multi-objective, optimization, game theory, optical control theory.	5
	Total	36

References/Suggested Books:

1. "Numerical Optimization",by Jorge Nocedal and Stephen J.Write. Publisher: Springer, 2006.
2. "Practical methods of Optimization" by R.Fletcher. Publisher :Wiley,1987.
3. "Iterative method for optimization"by C.T. Kelley. Publisher : SIAM,1999.
4. "Introduction to Nonlinear Optimization: Theory, Algorithm, and Application with MATLAB. MOS-SIAM Series on Optimization",by Amir Becker.
5. "Dynamic Programming and Optimal Control (VolumeI)" by Dimitri P. Bertsekas. Publisher: Athena Scientic,2005.
6. "Optimization Theory and Applications", by S S Rao.
7. Literature/books suggested by respective course Lecturers.

- **Course Title : Military Electronics System Engineering**
  Course Code :23PDT122T
  TeachingScheme: L:3,T:0,P: 0 -Credits:3

Course Objectives

The main objective of the course is to provide knowledge to the students aboutthe learning ofthe electronics systems requirement for military environment,generation of system requirements, limitations of COTS equipment and radiationeffects ontheelectronicsystems.

Course Outcome

At the end of the course the student should be able to:

- Understand the military electronics systems.
- Generate system design requirements as per mission needs & operational requirements.
- To create digital simulation models.
- Understand the limitations of the COTS available electronics systems
- Evaluate the radiation effects on the performance of electronics systems

CourseContent:

Unit	Contents	Contact Hrs.
1.	Introduction to electronics engineering concepts and methods for the design and integration of complex defense systems.	5
2.	Familiarity with the systems engineering process through case studies of representative defense systems.	5
3.	Introduction to methods used for determination of system requirements from mission needs and operational requirements.	6
4.	Digital simulation models, including those in current used in defence for determining engineering and performance trade-offs.	7
5.	Limitations of commercial-off-the-shelf (COTS) integrated circuits, thermal failure, electrostatic breakdown, noise in solid state devices, packaging reliability issues.	7
6.	Radiation effects dueto space and nuclear environments, and the limited availability of military integrated circuit suppliers.	6
Total		36

References/Suggested Books:

1. "Introduction to Electronic Defense Systems",by Neri Filippo. Publisher: Artech House Publishers.
2. "Military Handbook of Electronic Reliability design",by USD epartment of Defence.
3. "Defence Electronics Standards and Quality Assurance",by Ray Tricker. Pub-lisher: Elsevier

4. “Handbook of Defence Electronics and Optronics: Fundamentals, Technologies and Systems”, by Anil K.Maini.Publisher: John Wiley & SonsLtd
5. “Digital Simulation Methods”,by M.G.Hartley.Publisher: P.Peregrinus Ltd
6. “Analysis and Simulation of Noisein Nonlinear Electronic Circuits and Systems”,By Alper Demir. Publisher: Springer.
7. Literature/books suggested by respective course Lecturers.

- **CourseTitle :System engineering and analysis**
  Course Code :23PDT123T
  Teaching Scheme:L: 3,T:0, P:0 Credits:3

Course Objectives:

The course is intended to provide knowledge to the students about the military systems engineering, system requirements, basics of system design, architecture, operational requirements, system reliability and management.

Course Outcome

At the end of the course the student should be able to:

- Understand the system design requirements, architecture, functional requirements
- Generate the system requirements documents as per the requirement analysis.
- Understand the system reliability, maintainability, usabilityissues.
- Carry out the system reliability analysis.

Course Content

Unit	**Contents**	**Contact Hrs.**
1.	Fundamentals of systems engineering and system architecting of weapon system, *systemengg. Standards 15288*, requirements analysis, functional analysis and allocation, preliminary system architecture.	7
2.	Systems analysis, system design, and the basics of test and evaluation, Introduction to combat systems,	6
3.	System development phases (Conceiving, Designing, Implementing,and Operating),	5
4.	Techniques of system design and assessment for operational feasibility, including reliability, maintainability, usability (including human factors and human performance).	7
5.	Supportability, and producibility, System cost assessment and effectiveess estimation.	4
6.	Reliability analysis and management (basic tools and methods of reliability for developing complex systems including electronic components, mechanical components,andsoftware), *redundancy, gracefuldeg radation,fault tolerance, MTBF*.	7
	Total	36

References/Suggested Books:

1. “The Engineering Design of Systems:Models and Methods”,by Buede D.M.2.Publisher:JohnWiley & SonsInc.
2. “Systems engineering fundamentals”, by Defense Acquisition University Pressfort Belvoir, Virginia
3. “System Analysis Design and Development”, by Charles S. Wasson. Publisher :Wiley Seriesin System Engineering and Management.
4. “Principles of Planned Maintenance”, by Clifton R H. Publisher: McGraw Hill,NewYork.
5. “An introduction to Reliability and Maintainability Engineering”, by Ebling CE.Tata McGraw Hill.
6. "Reliability Engineering", by Srinath L S. Publisher : Affiliated East-West Press Limited, New Delhi,2002.
7. “Engineering Maintainability”,by Dhillon BS.Publisher:Prentice Hall of India.
8. Literature /Literature /books suggested by respective courseLecturers.

Semester –2(CompulsoryCourses)

1. CombatVehicleEngineering

❖ **Course Title : Combat Vehicle Dynamics**
Course Code :23PDTCV201T
Teaching Scheme: L:4,T: 0,P: 0 Credits:4

Course Objectives:

The main objective of the course is to provide knowledge to the students about important concepts of combat vehicle dynamics, terrain modeling, vehicle sus-pension systems, wheeled & tracked vehicles.

Course Outcomes

At the end of the course the student should be able to

- Carry out terrain modeling.
- Carry out simulation and testing of suspension system.
- Carry out design of military vehicles.
- Understand longitudinal dynamic response during acceleration and braking,
- Vertical dynamic response to analyze ride, pitch and roll.

Course Content:

Unit	Contents	Contact Hrs.
1.	Human response to vibration(HRV).	5
2.	Terrain modeling.	7
3.	Selection and design formilitary vehicles.	6
4.	Suspension types, modeling, simulation and testing of suspension systems and components, this includes transient, frequency random response.	8
5.	Spring and damper types, selection and characteristics, effects of noise Tires for military and civilian vehicles and their behavior.	7
6.	Wheeled and tracked vehicle satlow and high speed including steady state and transient response.	7
	Total	40

References/Suggested Books:

1. "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles",by Mat-thew Harrison. Publisher: Butter worth-Heinemann.
2. "Vehicle Noise and Vibration Refinement", by Xu Wang. Publisher : Woodhead Publishing.
3. "Noise and Torsional Vibration Analysis of Hybrid Vehicles (Synthesis Lectureson Advances in Automotive Technology)", by Xiaolin Tang, Yanjun Huang. Pub-lisher: Morgan & Claypool Publishers.
4. "Principles of Vibration Analysis with Applications in Automotive", by C.Q.Liu. Publisher: S A E International.
5. Literature/books suggested by respective course Lecturers.

- **Course Title : Combat System Engineering**
  Course Code :23PDTCV202T
  Teaching Scheme: L:4,T: 0,P: 0 Credits: 4

Course Objectives:

The main objective of the course is to provide knowledge to the students about the basic principles, processes and products of combat systems engineering, sensor technologies. They will also be introduced to weapons of mass destruction.

Course Outcome:

At the end of the course the student should be able to:

- Understand principles of design of combat systems.
- Learn how to design, build, and maintain systems that control different kinds of weapons, including nuclear, chemical, and biological weapons.
- Understand sensor systems, such as radarandsonar.
- Understand risks and threat stocombat systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Engineering principles to the design of combat systems with emphasis on detection, tracking, and identification systems	6
2.	Threat Spectrum, Battle Field Environment.	6
3.	Vehicle Configuration, Man Machine Interface.	6
4.	Sensor technologies (radars, ESM, active and passivesonar, infrared, electro-optical, and magnetic/electric/gravity fields ensors).	8
5.	Introduction to information warfare and weapons (includingelectronicwarfare).	7
6.	Directed energy weapons,weapons of mass destruction (nuclear,chemical, biological, and radiological), and nonlethal weapons.	7
Total		40

References/SuggestedBooks:

1. "Warship Combat System Engineering Management Software"by Zhao Xiao Zhe**.**
2. "Measurement, Instrumentation and sensor Handbook",by John G Webster. Publisher: C R C Press, Florida 2nd edition.
3. "Engineering Principles of Combat Modeling and Distributed Simulation",by Andreas Tolk.Publisher:Wiley Publication.
4. "Sensors and Transducers",by Patranabis D. Publisher: Prentice Hall India Limited.
5. "Magnetic Sensors Principles and Applications" by Author Kuang.
6. Literature/books suggested by respective course Lecturers.

- **Course Title : Test and Evaluation of weapon system**
  CourseCode :23PDTCV203T
  Teaching Scheme:L:4,T: 0, P:0 Credit:4

Course Objectives:

The main objective of the course is to provide knowledge to the students about weapon system, the factors that affect their performance and test methodologies.

Course Outcome:

At the end of the course the student should be able to:

- Understand the weapon system requirements and weapon performance characterization undero perating and ambient conditions.
- Understand the system reliability, maintenance, life cycle cost, and test procedures that govern the acceptance and induction of system.

Course Content

Unit	Contents	Contact Hrs.
1.	Weapon system requirements (land,air,naval).	6
2.	Weapon performance characterization, Operating environment and ambient conditions.	6
3.	Factors affecting system performance, System Acceptance testing.	6
4.	System reliability, system maintenance concept, functional analysis, life cycle costs, logistics support analysis, systems design, production, spare/repair parts management	8
5.	Static test procedures, Shock and vibration tests, Accelerated environmental tests.Closed vessel test.Conditioning chambers.	7
6.	Test methods for evaluation of safety. Dynamic trials. Range requirement analysis, range instrumentation. Posttrial Analysis.	7
Total		40

References/Suggested Books:

1. "Reliability Evaluation of Engineering Systems Concepts and Techniques",by Billinton, Roy, Allan, Ronald N. Publisher: Springer
2. "Man-Machine-Environment System Engineering", by Editors: Long, Shengzhao, Dhillon, Balbir S.Publisher:Springer.
3. "Vibration Testing: Theory and Practice",by Kenneth G. Mcconnell. Publisher :John Wiley & Sons.
4. "Vibration Monitoring, Testing, and Instrumentation",by Clarence W.deSilva. Publisher: CRC Press.
5. Literature/books suggested by respective course Lecturers.

- **Course title : Combat Vehicle Dynamics Lab**
  Course Code :23PDTCV201P
  Teaching Scheme:L:0,T:0,P:2 Credits: 2

  Lab experiments will be added in consultation with DRDO labs considering the available facilities.

- **Course title :Combat system engineering lab**
  Course Code :23PDTCV202P
  Teaching Scheme:L: 0,T:,P:2 Credits:2

  Lab experiments will be added in consultation with DRDO labs considering the available facilities.

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2. Aerospace Technology

- **Course Title** **: Aerospace System Configuration, Design and Simulation**
  CourseCode :**23PDTAT201T**

  TeachingScheme:L:4, T:0,P:0 Credits:4

Course Objectives

The main objective of the courseis to provide knowledge to the students about the process & techniques of aerospace system design, meeting the specified design requirements. They will also learn about carrying structural and aerodynamic analysis, performance evaluation of aircraft and stability analysis.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the concept of missile system and its design requirements and process.
- Design an aerospace vehicle and articulate its benefits in written and verbalforms.
- Understand the methods for aero-elastic analysis, computational fluid analysis and advances inaero-dynamics.
- Understandthe air to air, ground to air,air to ground weapon system, UAV mounted GW and UCAVs.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction (aero-elastic phenomena and design requirements), Introduction to missiles & systems, Design process.	6
2.	Structural requirement, Structural and aerodynamic stiffness, Static aero-elasticity :torsional divergence, Structural vibration and modal analysis.	6
3.	Aerodynamic loads on an oscillating lifting surface, Characteristics of flutter and important design parameters, Methods for aero-elastic analysis, Computational fluid dynamics, advances in aero dynamics (Hypersonic Flows and Aerodynamic Heating).	7
4.	Aircraft performance (cruising, climb, descent, takeoff, landing, maneuver, flight path).	7
5.	System‟s stability & control, aerodynamics control, Introduction to dynamic stability, first and second order responses, Equations of motion and modal characteristics.	7
6.	Introduction to air to air, ground to air, air to ground weapon systems, UAV mounted GW and UCAVs.	7
	Total	40

References/Suggested Books:

1. "Aircraft design: a conceptual approach",by D.Raymer
2. "Flight Dynamics Principles", by Michael V.Cook
3. "Introduction to Structural Dynamics and Aeroelasticity", by Dewey H.Hodges, G. Alvin Pierce
4. "Airplane Aerodynamics and Performance",by Chuan Tau Edward Lan
5. "Fundamentals of Structural Dynamics",by Roy R.Craig Jr.,Andrew J.Kurdila.
6. Literature/books suggested by respective course Lecturers.

❖ **Course Title** **: Guidance & control**
Course Code **:**23PDTAT202T
Teaching Scheme:L: 4,T:0, P:0 **Credits: 4**

Course Objectives

The main objective of the course is to provide knowledge to the students about fundamental of satellite navigation, navigation mathematics, principles of radio navigation, INS/GNSS integration andmissile control methods.

Course Outcome:

At the end of the course the student should be able to:

- Understand the principles of satellite navigation, inertial navigation, radio positioning.
- Understand various aspects of designing a navigation system.
- Develop mathematical model of missile dynamics.
- Carry out simulation for aircraft/missile using mathematical tools like MATLAB.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1.	Introduction to Navigation, Navigation Mathematics.	6
2.	GNSS: fundamentals, Signals, and Satellites: Fundamentals of Satellite Navigation, Inertial Navigation, Advanced satellite Navigation, Principles of radio Positioning, Terrestrial radio Navigation, Short-Range Positioning, Satellite Navigation Processing.	7
3.	Errors and Geometry, Dead Reckoning, Attitude, and Height Measurement, Feature matching, INS/GNSS Integration.	6
4.	Missile Control Methods: Aerodynamic and Thrust Vector Control, Polar and Cartesian Control.	6
5.	Mathematical Modeling of Missile Dynamics; Missile Actuators and Sensors. Roll and Roll Rate Stabilization.	8
6.	Design and Analysis of Lateral Autopilots, 6DOF simulation for aircraft/missile using MATLAB	7
	Total	40

References/Suggested Books:

1. "Modern Inertial Technology Navigation, Guidance, and Control", by Anthony Lawrence 2012. Publisher: Springer New York.
2. "The Global Positioning System & Inertial Navigation", by Jay Farrell. Publisher : McGraw-Hill Education (16 December 1998).
3. "MATLAB for Engineering Applications", by William Palm. Publisher : McGraw-Hill Education; 4th edition (February6,2018).
4. "Global Navigation Satellite Systems, Inertial Navigation, and Integration", by Grewal, M. S., Andrews, A. P., Bartone, C. G. (2013). Publisher: John Wiley andSonsInc.
5. "Principles of GNSS, inertial and multi-sensor integrated navigation systems", by Groves, P.D. Publisher: Artech House.
6. "Optimal State Estimation",by Kalman, H Infinity.
7. "Nonlinear Approaches", by Simon,D. (2006).Publisher: Wiley-Interscience
8. Literature/books suggested by respective course Lecturers.

❖ **Course Title : Aerospace Propulsion**
Course Code :23PDTAT203T
Teaching Scheme: L:4,T: 0,P: 0 Credits:4

Course Objectives

The main objective of the course is to provide knowledge to the students about different criteria for the selection and evaluation of different types of propulsion systems, analysis of propulsion systems and the thermodynamics behind the critical parts of Aerospace system.

Course Outcomes

At the endofthe course the student will have:

- Knowledge about thermodynamics and fluid dynamics behind the aerospace system.
- Understanding of Rocket motor design
- Understanding of different design aspects related to propulsion systems used in aerospace.

Course Content

Unit	Contents	Contact Hrs.
1.	Classification & mode of operation of various propulsion systems, basis thermodynamics & fluid Dynamics.	7
2.	Rocket motor design & analysis, Gas Turbine Engine design, GT engine efficiency, GT engine heat transfer & cooling.	8
3.	Aircraft performance, jet engine performance.	6
4.	Jet engine control (compressor performance, axial turbine performance, Fuel systems & pumps, airframe fuel systems, hydro-mechanical fuelmetering, Electronics engine control)	7
5.	System integration	6
6.	Computational fluid dynamics (flow modeling strategies, physical modelling, finite difference equations, etc.)	6
Total		40

References/Suggested Books:

1. "Rocket Propulsion Elements",by George Paul Sutton and Oscar Biblarz.Pub-lisher:John Wiley & Sons
2. "Modern Engineering for Design of Liquid-Propellant Rocket Engines: Progress in Astronautics and Aeronautics Series"by Dieter K. Huzel, David H.Huang.
3. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method"by H.Versteeg.Publisher:Pearson;2nd edition.
4. "Computational Fluid Dynamics the Basics with Applications" by John D.Ander-son, Jr.Publisher: McGraw Hill Education(1July2017)
5. "Fluid Mechanics: Volume 2:Foundations and Applications of Mechanics",by C. S. Jog. Publisher: Cambridge University Press;3rd edition.
6. "Parallel Processing for Jet Engine Control"" by Thompson**,** Haydn A, Publisher: Springer-Verlag London
7. "Fundamentals of Machine Component Design",by Robert C.Juvinall, Kurt M. Marshek. Publisher: John Wiley & Sons.
8. "Gas Turbinesfor Electric Power Generation",byS.CanGülen.
9. "Gas Turbine Theory", by H.I.H.Saravanamuttoo, Prof G.F.C.Rogers,H.Co-hen. Publisher: Prentice Hall.
10. "Elements of Propulsion: Gas Turbines and Rockets" by Jack D.Mattingly, Keith Boyer. Publisher: American Institute of Aeronautics & Astronautics.
11. Literature/books suggested by respective course Lecturers.

- **Course title :Aero space system configuration, Design & simulation Lab**

  CourseCode : 23PDTAT201P

Teaching Scheme:L:0,T:0, P:2 Credits:2

Lab experiments will be added in consultation with DRDO labs considering the available facilities.

- **Course title : Guidance & Control lab**
  Course Code :23PDTAT202P
  Teaching Scheme: L:0, T:0, P:2Credits:2

Lab experiments will be added in consultation with DRDO labs considering the available facilities.

3. Naval Technology

- **Course Title : Naval combat system engineering**
  Course Code :DT-NT-01
  Teaching Scheme:L: 4,T:0, P:0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students about the basic principles, processes and products of combat systems engineering. They will earn about systematic approach for the development and management of complete naval combat systems and functional analysis, design synthesis and system analysis, ship integration and test,management and planning.

Course Outcomes

At the end of the course the student should be able to:

- Understand the theory of Naval Combat System Engineering.
- Understand the integration of components to develop survivable combat sys-tem
- Apply the knowledge to integrate the principles of Naval Architecture and Ma-rine Engineering in the design of ship subsystems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction of naval combat systems	6
2.	Integration of naval combat systems, Detection, engagement, and control elements interact with each other and on how to combine the min to an efficient and survivable combat system	7
3.	Signature reduction	7
4.	Readiness assessment, embedded training, and support system interfaces	6
5.	System-oriented approach to integrating the principles of Naval Architecture and Marine Engineering in the design of ship subsystems	8
6.	Engineering design tools and analysis methods to meet specified systems requirements.	6
	Total	40

References/Suggested Books:

1. “Introduction to Naval Architecture”, by Tupper, E.C Fourth. Publisher Butter worth-Heinemann. Formerly Muckle's Naval Architecture for Marine Engineers.
2. “Introduction to Naval architecture”, by Gillmer, Thomas C. Publisher : Naval In-stitute Press.
3. “The Maritime Engineering Reference Book: A Guide to Ship Design, Construc-tion and Operation”. Publisher: Butterworth-Heinemann.
4. “Naval Architecture for Marine Engineers:Vol 4”, by Richard Pemberton, E A Stokoe. Publisher : Thomas Reed.
5. “Principles of Naval Architecture, Volumes 1 & 2”,by Henry E.Rossel, Lawrence B. Chapman. Publisher :Society of Naval Architects and Marine Engineers.
6. “Modern Naval Combat”, by David Miller. Publisher :Crescent
7. Literature/books suggested by respective course Lecturers.

❖ **Course Title : Guidance, Navigation, and Control of Marine Systems**
Course Code :DT-NT-02
Teaching Scheme: L:4,T:0, P:0 -Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students aboutthe fundamentals of inertial navigation, principles of inertial accelerometers, andgyroscopes. They will learn the classical approach to the robust design of non-linear GNC system. They will learn the mathematical tools for generating theo-retical building blocks for solutions to current and future naval challenges.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the principles of inertial navigation.
- Understand various aspects of designing anavigation system
- Apply Mathematical modeling for design & analysis of navigation systems.
- Apply MATLAB and Simulink tool for simulation of navigation systems.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1.	Fundamentals of inertial navigation, principles of inertial accelerometers, and gyroscopes.	5
2.	Derivation of gimbaled and strapdown navigation equations and corresponding error analysis.	7
3.	Classical approach to the robust design of nonlinear GNC systems that	6
	Accounts for both the stability and performance specifications, robust autopilot design.	
4.	Mathematical modeling.	8
5.	Advanced capabilities of MATLAB & Simulink.	8
6.	Multi-robot control techniques, theoretical building blocks for solutions to current and future naval challenges.	6
	Total	40

References/Suggested Books:

1. Modern Inertial Technology Navigation, Guidance, and Control" by Anthony Lawrence, Publisher: Springer NewYork, 2012
2. "Marine Control Systems Guidance, Navigation, and Control of Ships, Rigs and Underwater Vehicles" by ThorI. Fossen, Publisher: Marine Cybernetics, Trondheim, Norway (January1,2002)
3. "MATLAB for Engineering Applications" by William Palm Publisher : McGraw-Hill Education; 4th edition(February6,2018)
4. "Modeling and Simulation of Systems Using MATLAB and Simulink" by Deven-dra K.Chaturvedi, Publisher: CRC Press,2010
5. "Autonomous Mobile Robots and Multi-Robot Systems: Motion-Planning, Com-munication, and Swarming" by Eugene Kagan, Nir Shvalb, Irad Ben-Gal, Wiley2019.
6. Literature/books suggested by respective course Lecturers.

❖ **Course Title : Marine Propulsion**
Course Code :DT-NT-03
Teaching Scheme:L: 4,T:0, P:0 Credits: 4

Course Objectives:

The main objective of the course is to provide knowledge to the students aboutbasic principles of power and propulsion of marine system. They will understand fluid mechanics, dynamic propulsion system modeling and aerothermodynamics of various subsystems of marine systems. They will be introduced to modern control design theory.

Course Outcome:

At the end of the course the student should be able to:

- Understand the propulsion of marine system
- Understand the aerothermodynamics of compressors, combustors, turbines, heat exchange rsetc.
- Model the Dynamic propulsion systems
- Apply the analysis methods and design strategies for control system andmarine propulsion.

Course Content:

Unit	Contents	Contact Hrs.
1.	Basic principles of power and propulsion of marine systems.	6
2.	Laws of thermodynamics and fluid mechanics to analyze and design of components and systems, Dynamic propulsion systems modeling and analysis methods.	7
3.	Aerothermodynamics of compressors, combustors, turbines, heatexchangers, inlets and nozzles.	7
4.	Mechanical and structural design aspects of engine development, Control design specifications and design strategies.	8
5.	Introduction to modern control design theory and multivariable methods. Theory and applications of optimal control and discrete-time control systems.	6
6.	Case studies of current naval propulsion control systems.	6
Total		40

References/Suggested Books:

1. "Marine Propellers and Propulsion",by John Carlton Publisher: Butterworth-Heinemann.
2. "Advanced Thermodynamics for Engineers Book",by D.E.Winterbone. Publish-er: Mercury Learning & Information
3. "Elements of classical thermodynamics: For advanced students of Physics",by A. B. Pippard. Publisher CAMBRID GEUNIVERSITY PRESS
4. "Gas Turbines for Electric Power Generation",by S. Can Gülen.
5. Literature/books suggested by respective course Lecturers.

- **Course title : Naval Combat system engineering lab**
  Course Code :DT-NT-L01
  Teaching Scheme: L:0,T:0,P:2 Credits:2

  Lab experiments will be added in consultation with DRDO labs considering the available facilities.

- **Course title :Guidance, Navigation and control of Marine systems Lab**

  Course Code :DT-NT-L02

Teaching Scheme:L:0, T:0,P: 2 Credits:2

  Lab experiments will be added in consultation with DRDO labs considering the available facilities.

4.Communication Systems and sensors

- **CourseTitle : Radar Technologies**
  Course Code :DT-CSS-01
  Teaching Scheme:L: 4,T:0, P:0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students aboutlearning on the radar systems, radar parameters, radar environment, theory ofdetectionanddesignofradarelements,differenttypesofradars&theirapplication.

Course Outcomes

At the end of the course the student should be able to:

- Understand the design of radar systems, solve range equations.
- Apply appropriate mathematical and computer models relevant to radar systems to calculate system performance, and assess the limitations of particular cases
- Understand the major components of a modern radar system
- Learn basic radar signal processing techniques.
- Understand advanced radar techniques.
- Know the major functions and applications of a modern radar systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to RADAR, Radar parameters/definitions, radar equations.	6
2.	Radar cross section (RCS) & Theory of detection, Clutter.	6
3.	Atmospheric propagation, Surveillance and Tracking Radar, Radar Designs.	6
4.	Radar elements Design, Radar Transmitter design, Radar antenna design, Duplexer/TR switch & Radar Receiver.	7
5.	Radar signals and networks, Radar signal processing chain, Pulse compression and micro-doppler processing, Tracking algorithms	7
6.	Phased array radar, Data processing for phased array radar, Air borne radar, imaging radar, Synthetic aperture radar, inverse synthic aperture radar, adaptive array processing.	8
Total		40

References/Suggested Books:

1. “Introduction to Radar Systems”,by M.I. Skolnik.Publisher: Tata Mcgrawhill edition,2001.
2. “Radar Systems Analysis and Design using MATLAB”, by B.R.Mahafza. Publisher CRC Press,2013.
3. “Monopulse Principles and Techniques”, by S.M.sherman and D.K.Barton. Publisher: Artechhouse,2011
4. “Fundamentals of Radar Signal Processing”,by M.A.Richards. Publisher Tata Mcgrawhill.
5. “Ground Penetrating Radar: Theory and Applications”,by, Editor: H.M.Jolt. Publisher: Elsevier.
6. "Radar, Sonar And Navigation Engineering", by K.K Sharma.Publisher: S K Kataria & Sons.
7. Literature/books suggested by respective course Lecturers.

- **Course Title** **: Digital & Satellite Communication and Navigation from Space**
  Course Code **:DT-CSS-02**

Teaching Scheme:L: 4,T:0, P:0 **Credits: 4**

Course Objectives

The main objective of the course is to provide knowledge to the students on the analogue and digital communication systems, optical communication, satellite communications systems, modulations techniques, signal propagation effects,navigation techniques.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the communication techniques
- Evaluate the performance ofcommunication systems
- Design the analogue and digital communication systems
- Understand and analyse the signal transmission effects
- Understand the different types of navigation techniques

Course Content

Unit	Contents	Contact Hrs.
1.	Elements of a communication system and their relationship to system performance.	6
2.	Free space optical communication, Fiber optics communication, Wireless/cellular communications.	7
3.	Fundamental concepts such as current/voltage relationships, time and frequency domains, power spectral density, random signals, Communications system components and functions, analog and digitalcommunications systems,	7
4.	Modulation transmission and reception; baseband and pass band digital modulation; system, noise, transmission lines, wave guides and antennas, FEC techniques form itigating channel errors.	7
5.	Propagation effects on signal transmission; end-to-end path calculations for wire/coax, and RF systems including terrestrial ground links and satellite communications, Spread spectrum, concept of frequency hoping.	7
6.	Navigation techniques from space regarding functioning of GPS, GLONASS, IRNSS & Galileo	6
	Total	40

References/Suggested Books:

1. "Satellite communication",by T.Pratt, C.W. Bostian, J.E.Allnut. Publisher: John Willey and sons
2. "Satellite Communications Systems: systems, techniques and technology", by G.Maral, M.Bousquet, Z. Sun. Publisher: John Willy and sons
3. "Digital Communications: Fundamentals and Applications", B.Sklar. Prentice-Hall, Inc.
4. "Understanding of GPS/GNSS: Principles and Applications",by E.Kaplan and C.Hegarty. Publisher: Artech House Publishers.
5. Literature/books suggested by respective course Lecturers.

- **Course Title: Tactical Battle field Communication & Electronic Warfare**
  Course Code :DT-CSS-03
  Teaching Scheme:L:4,T:0, P:0 Credits:4

Course Objectives

The main objective of the course is to provide knowledge to the students on the techniques for setting up intercept and jamming links for Electronic Warfare (EW) against ground to ground enemy communication signals, UAV command and data links, cell phone links and weapon control links, techniques for predicting intercept and jamming performance.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the nature of tactical battlefield communication
- Calculate communication link performance
- Calculate the requirements for interception of tactical communication
- Calculate the requirements for emitter location, intercept and jamming of tactical comm. signals including weapon control link, UAV links, Cell phone links.
- Use various tools to perform electronic warfare calculations

Course Content:

Unit	Contents	Contact Hrs.
1.	Radiometry and power calculation, signature generation, atmospheric effects.	6
2.	Radar ES operational use, radar /ES detection battle, quietradar, jamming techniques & strategies, jamming of SAR systems.	6
3.	Introduction to radarwaveform interception, Technology and operational characteristics of electronic warfare, Signal processing statics & analysis, statistics & noise, analogue & digital signal processing.	7
4.	Decision theory- hypothesis testing, probabilities of false alarm and detection, Bayesian systems, error probability and biterrorrate, receiver operating.	7
5.	UAV Payload/link Issues, cell phone issues, Intercept links, Frequency hopping and other LPI threats; Special techniques for jamming LPI signals	7
6.	Introduction to electronic counter measures and counter-counter measures.	7
	Total	40

References/Suggested Books:

1. "Tactical Battlefield Communications Electronic Warfare", by David Adamy 2008
2. "Military Communications in the Future Battlefield", by Marko Suojanen.
3. "Electronic Warfare for the Digitized Battlefield",by Michael Frater, Michael Ryan.
4. Literature/books suggested by respective course Lecturers.

- **Course title : Radar Technologies Lab**
  Course Code :DT-CSS-L01
  Teaching Scheme:L:0,T:0,P:2 Credits:2

  Lab experiments will be added in consultation with DRDO labs considering the available facilities.

- **Course title:Digital & Satellite Communication and Navigation from Space**

  Course Code :DT-CSS-L02

Teaching Scheme:L:0, T:0,P: 2 Credits:2

Lab experiments will be added in consultation with DRDO labs considering the available facilities.

5. Directed Energy Technology

- **Course Title : Directed Energy Sources (Lasers, Microwave)**
  Course Code :DT-DET-01
  Teaching Scheme:L: 4,T:0, P:0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students on the high power laser sources, laser powers caling methodologies, laser beam characterization, optics requirements for high power lasers and generation of high power micro wave sources.

Course Outcome:

At the end of the course the student should be able to:

- Understand high power lasers sources, power scaling methodologies of lasers.
- Carryout the atmospheric effects on high power laser beam propagation.
- Estimate optics requirement for handling high power laser beams.
- Understand generation and testing of high power micro wave sources.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction of directed energy weapons, Potential weapon applications, how they work,application scenarios	6
2.	High power laser sources (solidstate,fiber,freeelection,liquid etc.), Laser power scaling	7
3.	Atmospheric Laser Beam propagation.	7
4.	Characterization of laser beam parameters	6
5.	Optical material & coating for high energy lasers.	7
6.	High power microwave sources, HPM effects, testing of HPM sources.	7
Total		40

References/Suggested Books:

1. “High Power Laser Hand book, by Hagop Injeyan & Gregory D. Goodno
2. “High Power Microwaves James Benford”, by John A. Swegle, Edl Schamiloglu.
3. “Coherent Laser Beam Combining”,by Arnaud Brignon.
4. “High-Power Optics Lasers and Applications”,by Apollonov, VictorV.
5. Literature/books suggested by respective course Lecturers.

❖ **Course Title** :**Beam Control Technology, Target Acquisition, Beam Pointing & Tracking**

Course Code :**DT-DET-02**

Teaching Scheme: L:4,T:0, P:0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students about high power laser & microwave beam control technologies, laser beam directors, their operational requirements, design procedure, design criticality, active target imaging & target tracking, recent developments in the targettracking, atmospheric effects on laser propagation, mitigation methodologies and adaptiveoptics.

Course Outcome:

At the end of the course the student should be able to:

- Understand of high power laser & microwave beam directors, design requirements & design methodologies.
- Gain knowledge of active target imaging, coarse & fine target tracking and contemporary target tracking technologies
- Compute atmospheric effects on the laser beam performance and hence carryout conceptual design of adaptive optics.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introductiontobeamcontrol,Beamcontrolhardware	6
2.	Introduction to laser beam directors, Requirement for high power laser beam directors, Conceptual optical design & analysis of beam Dirtectors.	7
3.	Laser beam tracking, pointing & control, Gimbals, Coarse & fine tracking.	7
4.	Active laser imaging & target tracking, Closed loop image tracking, Hardware requirement, Various tracking algorithms, multi-spectral	6
	Target imaging, Multiple target engagements, rapid retargeting.	
5.	Atmospheric propagation of Laser beams, atmospheric propagation of laser beams, Correction of atmospheric effects, Adaptive optics, Atmospheric modeling of laser propagation.	6
6.	Introduction to HPM beam control technology, major sub-assemblies.	8
	Total	40

References/Suggested Books:

1. “Beam Control for Laser Systems”,by Paul Merritt.
2. “Principles of Adaptive Optics”,by Robert Tyson.
3. Literature/books suggested by respective course Lecturers.

- **Course Title : Directed Energy Weapon (DEW) System Engineering**
  Course Code :DT-DET-03
  Teaching Scheme:L:4,T:0, P:0 Credits:4

Course Objectives

The main objective of the course is to provide knowledge to students about Directed Energy Weapon sub-systems, systems. They will also gain knowledge about system design & analysis, thermal management & power management of DEW and the operational requirements. The course will also provide an in sight about the DEW systems developed internationally.

Course Outcome:

At the end of the course the student should be able to:

- Understand of DEW systems, design requirements
- Evaluate the thermal and power requirements
- Evaluate the system performance.

Course Content:

Unit	Contents	Contact Hrs.
1.	Attributes of DEW, System requirements, DEW system design, system analysis.	6
2.	DEW subsystems, System modeling & simulation.	6
3.	Thermal management of DEW, Power management of DEW.	7
4.	Operational requirements of directed energy systems, platform integration.	7
5.	Weapon effectiveness under different operating conditions.	7
6.	Overview of internationally developed systems (Airborne Laser	7
	Laboratory, Airborne Laser, Tactical High Energy Laser, Advanced Tactical Laser, and Space-Based Laser programs).	
Total		40

References/Suggested Books:

1. "Directed-Energy Beam Weapons Hard cover",by Bahman Zohuri.
2. "Directed Energy Weapons: Physics of High Energy Lasers (HEL)",by Bahman Zohuri.
3. "An Introduction to Laser Weapon Systems",by Glen P. Perram.
4. "Effects of Directed Energy Weapons", by Philip Nielsen.
5. Literature/books suggested by respective course Lecturers.

- **Course title : Directed energy laser source Lab**
  Course Code :DT-DET-L01
  Teaching Scheme:L:0,T:0,P:2 Credits:2

List of Experiments:

1. Optical resonator design and experimental evaluation
2. Optics Alignment using He-Nelaser
3. Measurement of Laser Power, Beam Width, Spatial Profile,Wavelength
4. Measurement of Laser Beam Parameter (M^2)
5. Optics Surface Quality test using Interfero meter
6. Optical Coating Reflectivity, Transmission Test
7. Characterization of Microwave sources

More experiments may be planned in discussion with the concern DRDOLab.

- **Course title :Beam Control technology, target acquisition, Beam pointing and tracking lab**
  Course Code : DT-DET-L02

Teaching Scheme:L:0,T:0, P:2 Credits:2

Lab experiments will be added in consultation with DRDO labs considering the available facilities.

6. High Energy Materials Technology

❖ **Course Title : High Energy Materials Modeling & Simulation**
Course Code :DT-HEM-01
Teaching Scheme:L: 4,T:0, P:0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students about high-energy materials from theoretical and practical and points. This course also includes detailed formulations and reactions presented with the rmochemical calculations to aid understanding to the theory and chemical types of explosives.

Course Outcome

At the end of the course the student should be able to:

- Formulate the basis for evaluating competitive and alternative high energy material systems.
- Understand the theory and methods of simulations and applications of high energy materials.
- Understand the usage of tools for carrying out modeling & simulation of high energy materials for using them for creating defence related systems.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1	Understanding of high energy materials from theoretical and practical stand points, to formulate the bases for evaluating Competitive and alternative high energy materiall systems	8
2	High energy materials physics and chemistry	6
3	Molecular energetic of the high energy materials molecule including Molecular orbital and valence bonding and resonance stabilization	7
4	Concepts and practical implications of sensitivity and energy potential, oxygen balance and thermodynamic, reaction rate theory, hot-spot theory, shock physics and detonation theory	7
5	Tools for high energy materials modeling & simulation	6
6	Overview high energy materials modeling using FEM technique	6
	Total	40

References/Suggested Books:

1. **“**Chemistry of High-Energy Materials”, by Thomas M. Klapötke,De Gruyter,2012
2. “Shock Waves Science and Technology Library, Detonation Dynamics-Vol.6,”by Zhang F.Publisher :Springer.
3. “Physics of Shock Waves” by Zel'dovich & Raizer.
4. “The Chemistry of Explosives”,by Jacqueline Akhavan 2011
5. “High energy materials modeling & simulation”,by Andreoni Wanda,Yip Sid-ney. Publisher: Springer, 2020.
6. Literature/books suggested by respective course Lecturers.

- **Course Title : Munitions and Target Response**
  Course Code :DT-HEM-02
  Teaching Scheme: L:4,T:0,P: 0 Credits: 4

  Course Objectives

  The main objective of the course is to provide knowledge to students about warheads, ammunition and armour design, and the underlying wound ballistics and human vulnerability. The course will also cover characterization of highenergy materials for different properties.

Course Outcome

At the end of the course the student should be ableto:

- Design warheads, ammunition and armours.
- Understand fragmentation theory, small arms and cannon ammunition.
- Understand the characterization of high energy materials.

Course Content:

Unit	Contents	Contact Hrs.
1	Introduction to warheads and ammunition, Introduction to armour Design	7
2	Wound ballistics and human vulnerability, Fragmentation theory and warheads, Small arms and cannon ammunition, Shelland Projectile design	7
3	Target penetration and shock events covering subsonic to hydro dynamic regimes, Shaped charge and Explosively Formed Penetrator (EFP) warhead design, Kinetic Energy(KE) Ammunition and penetrator design	7
4	Mine threat and damage mechanisms, Complex armour, spacing, obliquity, disposition and failure mechanisms	7
5	Characterization and testing of materials for high strain rate Loading	6
6	Blast effects, blast-structure interactions including internal detonations,Terminal ballistics demonstration.	6
	Total	40

References/Suggested Books:

1. "A Comprehensive Guide to Munitions: Bullets, Bombs, Artillery, Mines, Missiles & Explosives"2016", by Paul F.Kisak.
2. "Ammunition: Small Arms, Grenades and Projected Munitions", by Ian V.Hogg. Publisher: Green hill Books.
3. "MILITARYS MALL ARMS:Design Principlesand Operating",by Derek Allsop
4. "Armour: Materials, Theory, and Design",by Paul J.Hazell. Publisher: CRC Press,2015.
5. Literature/books suggested by respective ecourse Lecturers.

- **Course Title : Manufacturing and Materials Properties of Explosives**
  Course Code :DT-HEM-03
  Teaching Scheme: L:4,T:0, P:0 Credits:4

Course Objectives:

The main objective of the course is to provide knowledge to students about synthesis of high energy materials such as Lead Azide/Styphnate, TNT, RDX, NC, NG etc. Various properties of high energy materials, filling processes of high energy materials, plant design, and safety issues will be covered.

Course Outcome:

At the end of the course the student should be able to:

- Understand the basic chemistry of nitration for the synthesis of high energy material molecules
- Have environmental awareness Engineering of the manufacturing of high energy materials.
- Understand physics of high energy materials: Detonation theory, Shocks physics, Explosive strain.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1	Chemistry of the synthesis of high energy material molecules: Basic Chemistry of nitration,	8
2	Synthesis examples of Lead Azide/Styphnate, TNT, RDX, NC, NG, Basicstability/compatibility	6
3	Material science of high energy materials: Basichazard/performance properties, Crystal properties, Binder properties, Mechanical properties,	7
4	Environmental awareness, Engineering of the manufacturing of high Energy materials	6
5	Filling processes of high energy materials, Plant design,safety, Quality Control	6
6	Physics of high energy materials: Detonation theory, Shocks physics, Explosive strain.	7
	Total	40

References/Suggested Books:

1. "Detonation: Theory and Experiment",by Wildon Fickett. Publisher: Dover Publications
2. "Organic Chemistry of Explosives", Jai Prakash Agrawal, Robert Dale Hodgson, Publisher: Wiley and sons, 2006
3. "High explosives and propellants",by S.Fordham.
4. "Demystifying Explosives: Concept sin High Energy Materials",by Sethurama Sharma Venugopalan.
5. "Chemistry and Physics of Energetic Materials",by Bulusu,S.N.Publisher: Springer.
6. "High Energy Materials: Propellants, Explosives and Pyrotechnics",by Jai Prakash Agrawal.Publisher:Wiley.
7. Literature /books suggestedbyrespectivecourseLecturers.

- **Course title : High energy materials modeling & simulation lab**
  Course Code :DT-HEM-L01
  Teaching Scheme:L:0,T:0,P:2 Credits:2

  Lab experiments will be added in consultation with DRDO labs considering the available facilities.

- **Course title : Munitions and target response lab**
  Course Code :DT-HEM-L02
  Teaching Scheme:L:0,T:0,P:2 Credits:2

  Lab experiments will be added in consultation with DRDO labs considering the available facilities.

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Semester2, Elective-1 Courses

- **Course Title : Robotics (MSS, MCC)**
  Course Code :23PDTAT231T
  Teaching Scheme :L: 3,T:0, P:0 Credits:3

Course Objectives:

The course is intended to provide learning on the basic concepts of robotics by ex-posing students to a broad range of topics with emphasis on basics of manipula-tors, coordinate transformation and kinematics, trajectory planning, control tech-niques, sensors and devices, robot applications and economics analysis.

Course Outcomes:

At the end of the course the student should be able to:

- Use matrix algebra and Lie algebra for computing the kinematics of robots.
- Calculate the forward kinematics and inverse kinematics of serial and parallel robots.
- Calculate the Jacobian for serial and parallel robot.
- To dothe path planning for a robotic system.
- To use software tools for analysis and design of robotic systems.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1.	Fundamentals of land-based robotic systems covering the areas of locomotion, manipulation, grasping, sensoryperception, and teleoperation.	7
2.	Kinematics, dynamics, manipulability, motion/force control, real-time programming, controller architecture, motion planning, navigation, and sensor integration, Control system design.	5
3.	Transformation of coordinates, Kinematics and inverse kinematics, Jacobians.	4
4.	Modelling Control, Proportional(P), Proportional-Integral(PI), Proportional-Integral-Derivative (PID) and Model Based Predictive Controller (MPC)	7
5.	Feedback Control System, Motion and path planning, Collision avoidance and navigation	7
6.	Fundamental of AI, Programming methods forrobotics, Human-Robot interaction.	6
Total		36

References/Suggested Books:

1. Text Book: Introduction to Robotics by S.K.Saha (TataMcGraw-Hill,New Delhi,India 2008,1st Reprint2009)
2. “Introduction to Robitcs: Mechanics and Control”, by Craig,J.J. Publisher :Pear-son, Delhi.
3. “Fundamentals of Robotics: Analysis and Control”, by Schilling Robert J. Publish-er: Prentice-Hall,1990.
4. “An Introduction to Robotics Analysis, Systems, Applications”, by Niku Saeed B. Publisher: Prentice-Hall,2001.
5. Stuart Russell and Peter Norvig, Publisher: Prentice Hall
6. Literature/books suggested by respective course Lecturers.

- **Course Title** :**EMI/EMC in Military Systems**
  Course Code :**23PDTAT234T**
  Teaching Scheme :**L: 3,T:0,P:0** **Credits:3**

Course Objectives:

The course is intended to provide learning on the basic concepts of EMI/EMC design, techniques for prevention of electronic equipment through good EMI/EMC design techniques — grounding, shielding, cable management, and power interface design, trouble shooting techniques, EMI/EMC standards.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the concept of EMI/EMC protectionof equipment
- Identify and prevent the common EMI/EMC problem sinmilitary systems.
- Understand the Design impact (by requirement) of military EMC specifications.
- Understand EMI/EMC trouble shooting tips and techniques.
- Learn generate EMI/EMC requirements document.

Course Content

Unit	**Contents**	**Contact Hrs.**
1.	Basic Concepts: Definition of EMI/EMC *and EMP*, Classification of EMI/EMC, Sources of EMI, EMI coupling modes, ESD Phenomena and effects, Transient phenomena and suppression,	6
2.	EMC requirements for electronic systems, Non-ideal Behaviors of Components; EMI Measurements: Basic principles of EMI measurements, EMI measuring instruments;	6
3.	EMI Control Methods: Conducted and radiated emissions and	6
	susceptibility, Crosstalk and shielding, Grounding, Bonding, Filtering, EMI gasket, Isolation transformer, opto isolator; *Faraday cage, isolation of shelters*	
4.	EMC Standard and Regulations: National and Intentiona lst and ardizing organizations, Frequency assignment, Spectrum conversation;	5
5.	EMC Design and Interconnection Techniques: Cablerouting and connection, Component selection and mounting, PCB design (Tracerouting, Impedance control, decoupling, Zoning and grounding);	7
6.	EMC analysis and detection techniques: Using tools for signal integrity analysis, Study eye diagrams for communication systems.	6
	Total	36

References/Suggested Books:

1. "EMI/EMC Computational Modeling Handbook", by bruce archambeault, Omar M.Ramahi,etal.
2. "EMI/EMC Computational Modeling Handbook: 630 (The Springer International Series in Engineering and Computer Science)",by Bruce R.Archambeault,Omar M.Ramahi,etal.
3. "Apractical approach to electromagnetic compatibility", by Chetan Kathalay
4. Literature/books suggested by respective course Lecturers.

 Course Title : Defence Electro-Optics and Imaging Systems
Course Code :23PDTAT235T
Teaching Scheme: L:3,T:0,P:0 Credits:3

Course Objectives:

The aim of the course is to provide an introduction to the principles of wide range ofcurrent and future electro-optic and imaging devices. Course will also to enable stu-dents to light on application of electro-optics and imaging system in defence applica-tion.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the technology and principle sun derpinning electro-optic devices and systems.
- Apply their knowledge to practical electro-optic design and acquisition prob-lems.
- Understand the trade-offs in electro-optic systems design.

Course Content

Unit	Contents	Contact Hrs.
1.	Principles of radiometry, The human eye,Visible band optical sighting systems.	6
2.	Camera systems, Image intensifiers, Missile seekers.	6
3.	Electro-optic counter measures.	6
4.	Thermal imagers, II cameras, Hyper-spectral imaging, Digital image processing.	7
5.	EO sensors for Lasers and laser DEW	5
6.	Electro-optic protection measures.	6
	Total	36

References/Suggested Books:

1. "Systems engineering analysis of electro-optical and Infrared system",by William Wolfgang Arrasmith.
2. "Introduction to Infrared and Electro-Optical Systems",by Author Ronald G.Driggers Ronald G.Driggers.
3. "Handbook of Defence Electronics and Optronics: Fundamentals, Technologies and Systems",by Author(s): Anil K.Maini
4. "Building Electro-Optical Systems: Making Itall Work",by Author Philip C.D.Hobbs.
5. "Electro-Optical Instrumentation: Sensing and Measuring with Lasers", by Author Silvano Donati.
6. "Electro-optical systems design, Analysis and testing",by Author Michael C.Dudzik.
7. Literature/books suggested by respective course Lecturers.

- **Course Title : Structural Dynamics and Aero-elasticity**
  Course Code :23PDTAT236T
  Teaching Scheme: L:3,T:0, P:0 Credits:3

Course Objectives:

The course is intended to provide learning on the mathematics behind the computational analysis, Different methods of analysis, Mathematical modeling of the various phenomena related to vibration analysis, various failure criteria and the ory related to elastic fracture.

Course Outcomes:

At the end of the course the student should be able to:

- Understand vibrations and fluid dynamics behind the aerospace system.
- Understand of different design aspects related to loading in aerospace system.
- Do the system dynamic analysis using finite element methods.

Course Content:

Unit	Contents	Contact Hrs.
1	Principles and methods of computational structural dynamics and vibration analysis.	6
2	Introduction to dynamic analysis using the finite element method, Calculation of modal parameters.	6
3	System dynamic response via mode superposition, frequency response, model reduction, and structural synthesis techniques, Fatigue analysis.	7
4	Introduction to aero-elasticity, Aerodynamic Loading, Bending Moment, Sectional properties of Aero foil, V-n Diagram,	6
5	Basic theory of linear elastic fracture mechanics; strain energy releaserate;	6
6	Applications to delamination crack grow thin polymer composite laminates, Damage to leran ceissues in composites	5
	Total	36

References/Suggested Books:

1. "Elements of vibration analysis",by Leonard Meirovitch. Publisher: McGraw-HillInc.,US; 2nd edition (1March1986)
2. "Finite Element Analysis Theory And Application With ANSYS", by Moaveni Publisher: Pearson Education; 3rd edition(1January2011)
3. "Mechanical Vibrations |SI Edition| Sixth Edition",by Singiresu S.Rao.Publisher:Pearson
4. "Elements of Fracture Mechanics",by Prashant Kumar.Publisher:McGraw Hill Education.
5. "Introduction to Structural Dynamics and Aeroelasticity",by Dewey H.Hodges and G.Alvin Pierce. Publisher: Cambridge University Press.

5.Literature/ books suggested by respective course Lecturers.

 Course Title : Safety, Health & Hazard Management
Course Code :23PDTAT232T
Teaching Scheme :L: 3,T:0, P:0 Credits:3

Course Objectives:

The main objectives of the course will be to inculcate a holistic approach towards safety health and hazard management. The course will provide understanding on the safety & hazard management of the toxic chemicals, gases,explosives etc.

Course Outcomes:

At the end of the course the student should be able to:

- Understand chemical safety standards,fire safety,hazard management.
- Handle toxic liquids & gases,explosives.
- Understand theNBC warfare safety, health & environment safety.

Course Content

Unit	Contents	Contact Hrs.
1.	Chemical Safety: Standards and regulations of chemical safety in Industries or Laboratories, Storage of hazardous chemicals, Compatibility and classification codes, Chemical risk analysis and management	6
2.	Firetri angle and Handling of Toxic, Industrial Gases	4
3.	Hazard Management: HAZOP and HAZAN techniques, Hazardin manufacture,Hazard prevention measures, Disposal of hazardous materials;	7
4.	Warfare: Classifications of explosives based on hazards, Nuclear, Biological and chemical warfare safety;	7
5.	Health:Assessment of human factors, Health & Environmentsafety	6
6.	Nanomaterials safety(Toxicologystudy)	6
	Total	**36**

References/Suggested Books:

1. "Occupational Health and Safety Management A Practical Approach",by Charles D.Reese. Publisher: CRC Press.
2. "Occupational and Environmental Safety and Health",Arezes, P.M., Baptista,J.S., Barroso, M.P., Carneiro, P., Cordeiro, P., Costa, N., Melo, R.B., Abreu dos Santos Baptista ,J.M.,Perestrelo, G.(Eds.). Publisher :Springers, 2019
3. "Handbook of Occupational Safety and Health", byS. Z. Mansdorf. Publisher :Wiley.
4. "Institution of Chemical Engineers",by Trevor Kletz" Hazop and Hazan
5. "Handbook Of Toxicology Of Chemical Warfare Agents", by Ramesh C. Gupta2nd Edition Elsevier,2015
6. "Nanomaterials Safety Toxicity And Health Hazards", by Shyamasree Ghosh DeGruyter.
7. "Hazardous Chemicals Handbook", by Phillip Carson, Clive Mumford Butter worth-Heinemann.
8. Literature/books suggested by respective course Lecturers.

- **Course Title** : **Fundamental of telemetry, telecommand& transponder**
  CourseCode :**23PDTAT233T**
  Teaching Scheme :**L: 3,T:0,P:0** **Credits:3**

Course Objectives:

The main objectives of the course will be to provide knowledge of the students about the satellite communication, telemetry, modulation techniques, target tracking, signal processing of communication systems.

Course Outcomes:

The students will have in depth knowledge on:

- Satellite communication and related technologies.
- Overall control of satellites through collection, processing, and transmission of data.
- Determination of the satellite‟s exact location through the reception, processing, and transmitting of ranging signals.
- Proper control of satellite through the reception, processing, and implementation of commands transmitted from the ground.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1	Fundamental of satellite communication, different modulation And multiplexing schemes.	6
2	Satellite Telemetry, Tracking and Tele-command, Multiple Access Techniques Telemetry, Data Transmission, Methods of Modulation, Time Division and Frequency Division Multiplexing, FDMA, TDMA ,CDMA and DAMA, Coding Schemes.	6
3	Satellite Packet Communications, Tracking and Telemetry.	6
4	Doppler and Electro-Optical methods oftracking, Airborne Missile.	6
5	Signal Processing: Processing of Signal, Data Acquisition and Reduction.	6
6	Introduction to satellite communication, transponders.	6
	Total	36

References/Suggested Books:

- “Space craft TT & C and Information Transmission Theory and Technologies”, by, Jiaxing Liu. Publisher: Springer, 2014
- “Introduction to PCMT elemetering Systems”, by Stephen Horan.Publisher: CRC Press
- “Satellite Communications Systems: Systems, Techniques and Technology”,by Gerard Maral, Michel Bousquet, Zhili Sun. Publisher: Wiley, 2020
- “Satellite Communications”, by Timothy Pratt, Jeremy E.Allnutt, 3rd Edition Publisher:
- “Principles of Modern Communication Systems”,by Samuel O.Agbo,Matthew N. O.Sadiku 2017
- Literature/books suggested by respective course Lecturers.

- **Course Title** : **Jamming and ECM/ECCM technologies**
  Course Code :**23PDTAT237T**
  Teaching Scheme :**L: 3,T:0,P:0** **Credits:3**

Course Objectives:

The course is intended to provide learning on the concept of jamming, frequency matching, continuous interference, factors affecting ECM, basic principle of noisejamming,different types of jamming systems, ECM techniques, and ECCM.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the concept of electronic attacks.
- Understand the principles and the practical applications of current and evolving electronic jamming technology
- Understand the different types of electronics counter measures and counter–counte rmeasures.

Course Content

Unit	**Contents**	**Contact Hrs.**
1.	Principals of Electronic Attack (EA), Jamming-to-Signal Ratio, Jamming Types Burn-Through, Cover Jamming, Range Deceptive Jamming, Inverse Gain Jamming.	7
2.	Repeater Jamming Equations, Noise Jammingvs. Deception, Repeatervs. Transponder, Sidelobe Jamming vs.Mainlobe Jamming.	6
3.	Stand-Off Jamming, Escort Jamming, Self-Protection Jamming, ECM techniques, On-Board ECM Systems, Off-Board ECM Systems.	5
4.	Infrared Counter measures (IRCM), Off-Board ECM Systems, Communications Counte rmeasures (COM-ECM), Electro-Optic Counter Measure (EOCM) Systems.	6
5.	Airborne Tactical Jamming System, Shipboard Self-Defense System, EA/ Susceptibility against Weapon Systems. Search Radar Counter-Counter measures, Tracking Radar.	6
6.	Counter-Counter measures, Infrared Counter-Counter measures, Communications Counter-Counter measures.	6
Total		36

References/Suggested Books:

1. "Electronic Countermeasure and Electronic Counter-Countermeasure", by Bahman Zohuri.
2. "Fundamentals of Electronic Warfare 2001",by S .A.Vakin,L.N.Shustov,R.H.Dunwell.
3. "Communications, Radar and Electronic Warfare by Adrian Graham 2010
4. "Electronic Warfare & Radar Systems Engineering Handbook" 2013, Naval Air Warfare Center Weapons Division.
5. "EW101:A First Course in Electronic Warfare (Artech House Radar Library)",1st Edition
6. Literature/books suggested by respective course Lecturers.

- **Course Title** **:Software defined Radios**
  Course Code **:23PDTAT238T**
  Teaching Scheme **:L: 3,T:0 ,P:0** **Credits:3**

Course Objectives:

The course is intended to provide understanding of the fundamental of software defined radios, different aspects of SDRs, practical scenarios along with knowledge of different SDR hardware and software.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the concept, application of SDRs.
- Understand of analog RF components as front end block in implementation of SDR.
- Gain knowledge of digital hardware architectures and its development techniques.
- Gain knowledge of software development for embedded wireless systems.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1.	SDR introduction, major standards, SDR architecture, SDR enablers, advantage/disadvantages, Applications.	6
2.	Waveform platform bifurcation, red – black separation, digital modulation-advanced linearand non-linear band width efficient modulations. Bandwidth and power efficiency, peak to average power, error vector magnitude and error probability.	6
3.	SDR Hardware, super-heterodyne architecture, homodyne architecture, advantages & disadvantages, Software for SDR, Processing architecture for SDR.	6
4.	RF channels, receiver channel equalization, multiple access techniques Frequency, time and code division techniques as well as carrier sensing, Wireless sensor networks and beam steering in azimuth and elevation, receiver analogue signal processing, receiver digital signal processing..	6
5.	Source and channel coding (Source and channel coding, sampling, entropy, data compression, voice coding, block and convolution coding, turbocoding, space-time coding and trelliscoding).	7
6.	Case studies in software radio design, Introduction and a Historical perspective	5
Total		36

References/Suggested Books:

1. "Software Radio, (A modern approach to radio engineering)", by Jeffery H. Reed Publisher: PHIPTR.
2. "RF and Digital Signal Processing for Software Defined Radio", by John J. Rouphael. Publisher: Elesiver.
3. "Digital Techniques in Frequency Synthesis", by B.G.Golderg. Publisher: McGraw-Hill.
4. "Multirate Signal Processing",by N.J.Fliege. Publisher: John Wiley and sons.
5. Literature/books suggested by respective course Lecturers.

- **Course Title** : **Advanced Lightweight and Composite Structures**
  Course Code :**23PDTAT239T**
  Teaching Scheme :**L: 3,T:0, P: 0** **Credits:3**

Course Objectives:

The main objectives of this course is to impart thorough knowledge of advanced composite materials, their manufacturing techniques and to develop mathematical models & design structures made of composites. Basic understanding of structures used in airborne systems like missiles and aircrafts & their performance under static and dynamic loading, including crash and bird strike will also be covered.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the design of advanced structures and light weight materials for aerospace materials.
- Understand the numerical and analytical skills in structural mechanics for both composite and metallic components.
- Apply knowledge to solve real engineering problems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Review of Strength of Materials, Introduction to Aerospace Materials –Metal Alloys and Fiber Reinforced Composite	6
2.	Introduction to different types of constructions: Monocoque, Semi-Monocoque, Truss, and Corrugated shell	7
3.	Introduction to Aircraft and Missile Structural Components: Spars; Ribs; Stringer; Longerons	6
4.	Analysis of stress; Analysis of strain	7
5.	Material Constitutive Relations	5
6.	Failure Theories; Fatigue theory	5
	Total	36

References/Suggested Books:

1. "Composite Structures Safety Management",by Dr.Bjorn Backman. Publisher: Elsevier Science.
2. "Composite Structures: Design, Mechanics, Analysis, Manufacturing and Testing",by Manoj Kumar Buragoha in.Publisher: CRC Press.
3. "Light weight Composite Structures in Transport: Design, Manufacturing, Analysisand Performance",by James Njuguna Wood head Publishing,2016
4. "Structural and Stress Analysis",by T.H.G.Megson.Publisher: Butterworth-Heinemann.
5. Literature/books suggested by respective course Lecturers.

- **Course Title** :**Test Methodologies for DEW Systems (Lasers & Microwave)**

Course Code : **23PDTAT240T**
Teaching Scheme :**L: 3,T:0, P:0** **Credits:3**

Course Objectives:

The course is intended to provide learning on the testing requirements, characterization, system performance testing procedures, test setups, safety standards, safety tools of laser and microwave based DEW systems.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the characterization and testing requirements of DEW systems.
- Carry out the indoors & outdoors system performance testing.
- Understand the safety issues, safety standards, handling high power sources.

Course Content:

Unit	Contents	Contact Hrs.
1.	Testing requirements of DEW system, types of testing, laser effect testing on target, system output testing.	6
2.	System performance testing, System out door test & measurement instruments.	7
3.	Lasertesting issues, Lasersafety,Lasersafety standards,laser safetytools.	5
4.	Microwave system testing Impedance measurement, S-Parameters and the Smith Chart.	5
5.	Power Measurement, Noise Figure and Phase Noise measurement, Frequency measurements (Spectrum Analysis), Gain Compression and Inter modulation, Network Analysis,	7
6.	Microwave subsystem/system characterization techniques. HPM safety tools, safety standards.	6
Total		36

References/Suggested Books:

1. "An Introduction to Microwave Measurements", by Ananjan Basu.
2. Literature/books suggested by respective course Lecturers.

- **Course Title** :**Advanced Analytical techniques/Labtesting**
Course Code :**23PDTAT241T**
Teaching Scheme :**L: 3,T:0, P:0** **Credits: 3**

Course Objectives:

The main objective of the course is to impart an in-depth knowledge of material characterization by all the conventional well established techniques used worldwide. The course provides understanding on the material characterization, having main focus on polymeric techniques, chromatography and Spectroscopy.

Course Outcomes:

At the end of the course the student should be able to:

- Understand different characterization techniques.
- Apply appropriate analytical technique for a particular material organic /inorganic /nanomaterial/polymeretc.

Course Content:

Unit	Contents	Contact Hrs.
1.	Instrumental Analysis: Qualitative analysis	4
2.	Genesis of instrumental analysis, hyphenated techniques	4
3.	Polymeric Techniques: Rheology Techniques, Molecular weight determination; Thermal Techniques: Thermo Gravimetry(TG), Differential Thermal Analysis(DTA), and Differential Scanning Calorimetry(DSC)	8
4.	Chromatographic Techniques: Gas Chromatography(GC), High Performance Liquid Chromatography (HPLC), Thin Layer Chromatography(TLC), Ionchromatography	8
5.	Spectroscopy: Ultra Violet-Visible Spectroscopy UV-VIS, Infra-Red spectroscopy(IR), Nuclear Magnetic Resonance(NMR), Massspectroscopy, Atomic Absorption Spectroscopy(AAS)	8
6.	XRD and SEM techniques, Sensitivity studies.	4
	Total	36

References/Suggested Books:

1. “Fundamentals of molecular spectroscopy”by C.N.Banwell.Publisher:McGraw Hills.
2. “Introduction to Spectroscopy”by Donald L.Pavia, Gary M.Lampman, and George S. Kriz. Publisher: Cengage Learning,2014.
3. “Chromatography: Concepts and Contrasts”by James M.Miller. Publisher:Wiley.
4. “Chromatography: Principles and Instrumentation”,by Mark F.Vitha.Publisher:Wiley.
5. “Elements of X-Ray Diffraction” by B.D.Cullity Deceased, S.R. Stock.Publisher :Pearson.
6. “Electron Microscopy: Principles and Fundamentals”by S.Amelinckx, Dirkvan Dyck, J.van Landuyt, Gustaafvan Tendeloo.Publisher: Wiley.
7. “Polymer Characterization: Physical Techniques”,by Dan Campbell, Richard A.Pethrick, Jim R.White 2nd Edition.Publisher CRC Press.
8. Literature/books suggested by respective course Lecturers.

 Course Title : **SONAR System Engineering Course**
Code :**23PDTAT242T**
Teaching Scheme :**L: 3,T:0, P:0** **Credits:3**

Course Objectives:

The objective of the course is to provide an in-depth understanding of under water acoustic principles, sonar technology and applications, hardware and software de-sign engineers new to sonar system design.

Course Outcomes:

After the successful completion of the course student should be able to

- Knowthe basic building blocks of a radar system**.**
- Have anin-depth knowledge on different types of signals thatare used.
- Know about the ambiguity function and its significance in radar signal processing.
- Know the physics behind sound propagation in water and principle of operation of sonar.
- Apply the knowledge acquired in this course in real time applications**.**

Course Content

Unit	**Contents**	**Contact Hrs.**
1.	Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operation.	6
2.	Topics from complex aperture theory, array theory.	6
3.	Signal processing	5
4.	Introduction to undersea warfare and engine eringacoustics	6
5.	Principles of optimal signal processing techniques for detecting signal sinnoise, maximum likelihood, Bayesrisk.	7
6.	Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROCcurves)	6
Total		36

References/Suggested Books:

1. "Fundamentals of Radar, Sonar and Navigation Engineering",by K.K. Sharma.
2. "Principles of Modern Radar: Advanced techniques",by editor William L.Melvin.
3. "An Introduction to Sonar Systems Engineering", by Lawrence J.Ziomek.
4. "Sonar for practicing engineers",by A.D.Waite.
5. "Underwater Acoustics: Analysis, Design and Performance of Sonar", by Richard P. Hodges.
6. Literature/books suggested by respective course Lecturers

- **Course Title** : **Unmanned Aerial Vehicle Design Course**

Code :**23PDTAT244T**

Teaching Scheme :**L: 3,T:0,P:0** **Credits:3**

Course Objectives:

The course is intended to provide the understanding of the initial designing and sizing process for rapidly growing fixed — wing UAV technology, integrated with its performance and stability analysis, air-safety issues, airworthiness and proto type testing.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the design requirements, design parameters of UAV.
- Perform the aerodynamic analysis, performance and stability analysis.
- Understand the performance testing of the UAVs.
- Understand the air worthiness and safety requirements of UAV.

CourseContent:

Unit	Contents	Contact Hrs.
1.	UAV design Requirements, design parameters, design algorithms, Certification approaches: aircrafts and UAVs. Airworthiness of aircrafts and UAVs.	6
2.	Air safety issues. Handling qualities. Maneu verability requirements. Aircraft design; UAV system design. UAV system identification	6
3.	UAV aerodynamics, structures and propulsion, performance and stability analysis.	7
4.	UAV project life cycles. Stages of Aircraft design. Initialsizing: aircrafts and of UAVs.	6
5.	Ground control systems.Ground and flight testing of UAVs. UAV guidance and Navigation. Design for reliability.	5
6.	Wind Tunnel Testing, Aerodynamic Characterization through Wind Tunnel Testing.	6
Total		36

References/Suggested Books:

1. "Introduction to Flight",by JohnD. Anderson
2. "Performance, Stability, Dynamics, and Control of Airplanes", by Bandu N.Pamadi.
3. "Aircraft performance and design",by John D. Anderson.
4. "Unmanned Aircraft Design A review of fundamentals", by Mohammad. H.Sadraey
5. "Aircraft Design: A Conceptual Approach",by Daniel P.Raymer.
6. "Unmanned Aircraft Systems: UAVs Design Development and Deployment",by Reg Austin.
7. "Small Unmanned Fixed-wing Aircraft Design: A Practical Approach",by Andrew J.Keane and James P.Scanlan.
8. Literature/books suggested by respective course Lecturers.

- **Course Title** : **Naval Ocean Analysis and Prediction Course**
  Code :**23PDTAT245T**
  Teaching Scheme :**L: 3,T:0,P:0** **Credits:3**

Course Objectives:

The course is intended to provide understanding of the science and art of Naval Ocean. They will learn methods of analysis of ocean data, to model Naval ocean, to generate global ocean circulation prediction system, Shallow Water Analysis and Forecast System (SWAFS).

Course Outcomes:

At the end of the course the student should be able to:

- Understand and develop the Navy Ocean modeling and prediction program.
- Understand the need to evaluate ocean models and prediction systems for operational and tactical applications.
- Understand and predict environmental a conditions in the coastal ocean.

Course Content:

S.no.	**Contents**	**Contact Hrs.**
1.	Advanced knowledge of the Indian Navy ocean analysis and prediction systems.	6
2.	Naval Ocean Modeling Program (NOMP), Naval ocean data systems.	5
3.	Atmospheric forcing systems, data as simulation systems.	6
4.	Optimal Thermal Interpolation System(OTIS), Thermal Ocean Prediction Systems(TOPS).	6
5.	Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formula for estimatingair-sea fluxes.	7
6.	The global ocean circulation prediction system, Shallow Water Analysis and Forecast System(SWAFS), Knowledge of ocean eddies.	6
Total		36

References/Suggested Books:

1. Indian Navy:Ocean of opportunities (Defence Series Books) Author: by PRANAVZOPE
2. Elements of Ocean Engineering.Author Robert E. Randall
3. Ocean Modelling for Beginners - Using Open-Source Software. Author Jochen Kaempf.
4. Literature/books suggested by respective course Lecturers.

- **CourseTitle : Modeling &Simulation of Laser Matter**
  InteractionCourseCode :DT-EL4-03
  TeachingScheme :L: 3,T:0, P:0 Credits:3

Course Objectives:

The course is intended to provide understanding on the high power laser beaminteraction with metals and composite materials, physics based models for the lethality modeling, damage mechanism & damage threshold measurement techniques and performance evaluation of high power laser systems.

Course Outcomes:

At the end of the course the student should be able to:

- Understand of the laser matterinter action.
- Develop physics-based model for evaluation of effect of laser on metals and composites.
- Understand the laser parameter measurement techniques.
- Analyze the performance of high-power laser systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Laser beam characteristics, Laser lethality modeling & simulation with metal targets & composite materials.	5
2.	Physics based models for vulnerability assessment, Effect of laser on metals & composite materials.	7
3.	Measurement and Characterization of Damage Thresholds, Mechanisms of Damage, Exposure Limitsand Their Interpretation.	7
4.	Analysis Tools for the Estimation of Hazards, Laser parameters measurement techniques.	6
5.	Tools to analyze and predict Laser System performance under different condition slikeland, sea air,etc.	5
6.	Introduction of full scale end to end modeling of laser system performance.	6
Total		36

References/Suggested Books:

1. “High Power Laser-Matter Interaction”, by Mulser, Peter, Bauer, Dieter.Publisher : Springer.
2. Literature/books suggested by respective course Lecturers.

 Course Title : **Computational Aerodynamics Course**
Code :**DT-EL4-04**
Teaching Scheme :**L: 3,T:0,P:0** **Credits:3**

Course Objectives:

The course is intended to provide learning on the computational aerodynamics, numerical methods for solving systems of equations, numerical modelling of fluids, CFD analysis, turbulence modelling.

Course Outcomes:

At the end of the course the student shouldbe able to:

- Understand the CFD analysis, fluid mechanics, heat transfer analysis, numerical modeling of fluids.
- Generate numerical model related to fluid dynamics
- To do the pre and post processing of CFD analysis.

CourseContent:

Unit	Contents	Contact Hrs.
1.	Introduction to fluid mechanics & heat transfer,	5
2.	Introduction to numerical analysis, Discretisation approaches: finite difference, finite volume, finite element and spectral methods,	6
3.	Numerical methods for algebraic equations/systems of equations, Numerical schemes for hyperbolic, parabolic and elliptic systems and for fluid dynamics,	6
4.	CFD analysis	7
5.	Numerical modeling of compressible & in-compressible flow, turbulence modeling,	6
6.	Grid generation/CAD,data analysis and uncertainties.	6
Total		40

References/Suggested Books:

1. "A Textbook of HeatTransfer Paperback",by S.P.Sukhatme.Publisher:Univer-sities Press.
2. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method",by H.Versteeg.Publisher:Pearson.
3. "Computational Fluid Dynamics the Basics with Applications", by John D. Ander-son, Jr.Publisher:McGraw Hill Education.
4. "Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cam-bridge-iisc)", by C. S. Jog.Publisher: Cambridge University Press;3rd edition.
5. "Numerical Modeling and Computer Simulation", Edited by Dragan Cvetković, publisher intech open.
6. Literature/books suggested by respective course Lecturers.

- **Course Title :Launch Vehicle Design & Analysis**

CourseCode :DT-EL4-05

Teaching Scheme :L: 3,T:0,P:0 Credits:3

Course Objectives:

The course is intended to provide learning on the launch vehicle designand analysis, components and subsystems of the launch vehicle, propulsion systems.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the launch vehicle requirements, its functioning.
- Designandanalysisoflaunch vehicles.
- Understand the propellant requirement for launch vehicles.

Course Content:

Unit	Contents	Contact Hrs.
1	Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices.	6
2	Performance analysis, operating characteristics and propellant selection criteria for air breathing and solid	5
3	Liquid and nuclear rocket motor propulsion systems.	7
4	Advanced cycles and concepts are presented. Design of components and subsystems	7
5	FE modelling:Idealization,Discretization,Meshingand Post Processing,	6
6	Tracking and controlling errors, Nonlinear analysis in FEM, Launch dynamic analysis.	5
	Total	36

References/Suggested Books:

1. “Design of Rockets and Space Launch Vehicles”, by Don Edberg, Willie Costa. Publisher: American Institute of Aeronautics & Ast.(August21, 2020)
2. “Modern Engineering for Design of Liquid Propellant Rocket Engines (Progressin Astronautics and Aeronautics)”,by Dieter K Huzel,David H Huang. Publisher
   : AIAA (American Institute of Aeronautics & Astronautics); Revised, Subsequent edition.
3. “Fundamentals of Astrodynamics 1st Edition”,by Roger R.Bate, Donald D. Mueller. Publisher: The American Design Ethic, MIT, USA.
4. “Commercial Launch Vehicle Design”, by Nickolay Mykola Zosimovych. Publish-er: Lap Lambert Academic Publishing.
5. “Space Vehicle Design,Second Edition”,by Michael D.Griffin and James R.French. Publisher The American Institute of Aeronautics and Astronautics, Inc.
6. Literature/books suggested by respective course Lecturers.

- **Course Title** : **Acquisition, Tracking & Pointing Technology Course**

Code :**DT-EL4-06**

Teaching Scheme :**L: 3,T:0, P:0** **Credits:3**

Course Objectives:

The course is intended to provide learning on the acquisition, tracking & pointing technologies, development of tracking algorithms, design and analysis of tracking systems.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the concepts and basic systems requirements tracking systems.
- Understand the system configurations and critical component characteristics required in the design of stabilized pointing and tracking systems, along with an introduction to some more advanced concepts.
- Understand the control system and algorithm techniques and practices com-monly utilized in the design of tracking systems.

Course Content:

Unit	**Contents**	**Contact Hrs.**
1.	Acquisition, tracking, andpointing (ATP) design formilitary systems	6
2.	Target tracking and related mathematics, SNR requirement, the Johnson criteria, probability of estimation, detection criteria	6
3.	Tracking algorithms, track filters, multi target tracking,	6
4.	Electronic counter measures against modern target tracking radars	7
5.	Multiplat form-multi-sensor-multi target tracking	6
6.	Doppler and Electro-Optical methods of tracking	5
Total		36

References/Suggested Books:

1. "Acquisition, Tracking, Pointing, and Laser Systems Technologies XXI (Proceedings of SPIE)"30 October 2007 by StevenL.Chodos (Editor), William E.Thompson (Editor).
2. "Acquisition, Tracking, and Pointing, January 2017 In book: Free Space Optical Communication",by Hemani Kaushal,V k Jain and Subrat Kar. Publisher: Springer India.
3. Literature/books suggested by respective course Lecturers.

- **Course Title : Data acquisition, tracking & post flight analysis Course**
  Code :DT-EL4-07
  Teaching Scheme :L: 3,T:0, P:0 Credits:3

Course Objectives:

The course is intended to provide learning on the various aspects of flight trials, measurements & calibration, Generation & analysis of Data.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the interfaces used in data acquisition and stand alone instruments toreal-world signals.
- Understand the Sensors and transducers, Data acquisition hardware and data acquisitions of tware
- Carry out post flight analysis.

Course Content:

Unit	Contents	Contact Hrs.
1.	Importance of Flight Trials in Missile Development, Facilities, Safety Requirements	4
2.	Methods of Measurement, Introduction to Measuring Instruments: Functional elements of an instrument	6
3.	Static and Dynamic Characteristics, Zero, First and Second order of Instruments and their response	6
4.	Calibration of Instruments	5
5.	Sensors and Transducers: Passive and Active types, their uses inmeasurement of acceleration, angle, vibration, pressure, flow and temperature, strain etc.,	8
6.	Methods for post flight data analysis.	7
	Total	36

References/Suggested Books:

1. "Advances in Missile Guidance, Control, and Estimation: 47 (Automation and Control Engineering)",by editors S.N.Balakrishnan, A.Tsourdos,B.A.White.
2. "Calibration Handbook of Measuring Instruments 1st Edition", by Alessandro Brunelli. Publisher: International Society of Automation.
3. "Calibration Book", by Janne Kivilaakso, Antero Pitkäkoski Jori Valli, Mike John-son, Nobuo Inamoto Arja Aukia Masaki Saito. Publisher:Vaisala Oyj.
4. "Sensors and Transducers", by Patranabis D. Publisher : Prentice Hall India Learning Private Limited.
5. "Sensors And Transducers Paper back",by Ian Sinclair. Publisher:Elsevier.
6. Literature/books suggested by respective course Lecturers.

- **Course Title** **: Air Independent Propulsion and Batteries Course**

Code **:DT-EL4-08**

Teaching Scheme **:L: 3,T:0, P:0** **Credits:3**

Course Objective

The course is intended to provide learning on the air independent propulsion systems, hybrid electric vehicles, power requirement of the vehicles, energy storage systems.

Course Outcome:

At the end of the course the student should be able to:

- Understand the requirements of air independent propulsion systems.
- Design and analysis of hybrid electric drive trains.
- Design and analysis Energy storage systems for hybrid electric vehicles.

Course Content:

Unit	Contents	Contact Hrs.
1	Introduction to Hybrid Electric Vehicles: Impact of modern drive-trains on energy supplies;	6
2	Hybrid Electric Drive-trains: hybrid traction, various hybrid drive-train topologies, power flow control, fuel efficiency analysis;	7
3	Electric Drive-trains: electric traction, electric drive-train topologies, power flow control inelectric drive-train topologies, fuel efficiency analysis;	7
4	Electric Propulsion unit: electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives,Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives,drive system efficiency;	6
5	Energy Storage: Introduction to Energy Storage Requirements in Hybridand Electric Vehicles,	6
6	Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Fly wheel based energy storage and its analysis, Hybridization of different energy storage devices.	6
	Total	36

References/Suggested Books:

1. "Hybrid Electric Vehicles: Principles and Applications with Practical Perspec-tives",by Chris Mi,M.Abul Masrur. Publisher: Wiley.
2. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Second Edition (Power Electronics and Applications Series)",by Mehrdad Ehsani, Yimin Gao, Ali Emadi, Publisher: Standards media.
3. Literature/books suggested by respective course Lecturers.

- **CourseTitle : Advanced digital modulation technologies & standards Course Code :DT-EL4-09**

Teaching Scheme :L: 3,T:0,P:0 Credits: 3

Course Objectives:

The objective of this course is to provide knowledge on the engineering principles, theories and practices of a digital communication system. The course will deal with the design principles of transmitter and receiversoas to establishare liable communication link.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the design digital communication systems.
- Understand the transmitter, receiver communications system models, voice source coding– pulse code modulation, delta modulation and vocoders.
- Understand the requirement of cellular communication.

Course Content:

Unit	Contents	Contact Hrs.
1.	Design of digital communication system, transmitter and receiver communications system model	6
2.	Voice source coding– pulse code modulation, delta modulation, vocoders	6
3.	Digital modulation— Amplitude-shift,Frequency-shift,Phase-shift, differential phase-shift, Quadrature phase-shift, Quadrature phase-shift, and Minimum- shift keying, Quadrature amplitude modulation	8
4.	Communications channel—Multi path effects, fading and diversity, models of Egliand Murphy	6
5.	Receivers—superheterodyne systems, balanced and unbalanced mixers, frequency synthesizers, Link budget analysis	5
6.	Introduction to cellular communication —CDMA,OFDM, MIMO, Introduction to digital modulation standards.	5
	Total	36

References/Suggested Books:

- "Communication Systems",by, Haykin,S.Publisher:John Wiley & Sons.
- "Modern Digital and Analog CommunicationSystems",by,Lathi,B.P.and Ding, Z. Publisher: Oxford University Press.
- "Signal Processing for Wireless Communication Systems", by H. Vincent Poor, Lang Tong, Publisher: Springers.
- "Digital Communication: Fundamentals and Applications",by Sklar,B.,and Ray, P.K. Dorling Kindersley.
- "Communication Systems: An Introduction to Signals and Noise in Electrical Communication", by Carlson, A.B., Crilly, P.B. and Rutledge, J.C Publisher: McGraw-Hill.
- "Detection, Estimation and Modulation Theory Part I", by Van Trees, H.L. Pub-lisher: Wiley Interscience.
- "Information Theory, Coding and Cryptography",by Bose,R.TataMc Graw-Hill.
- "Digital Communication", by Barry, J.R., Lee, E.A. and Messerschmitt, D.G.Kluwer.
- "Principles of Digital Transmission: Wireless Applications",by Benedetto, S. and Biglieri, E. Publisher: Springer.
- Literature/books suggested by respective course Lecturers.

- **Course Title** **: Trajectories modelling& simulation Course**

Code **:DT-EL4-10**

Teaching Scheme **:L: 3,T:0,P:0** **Credits:3**

Course Objectives:

The course is intended to provide the understanding of flight dynamics, trajectory design analysis, flight performance analysis and practical implications of trajectory planning.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the flight trajectories design requirements.
- Evaluate and predict the flight performance for different trajectories.
- Understand the practical implications while trajectory design.
- Carryout MATLAB based simulation for trajectory modelling.

Course Content:

Unit	Contents	Contact Hrs.
1.	Flight Dynamics, Flight envelope limitations. Aerodynamic sizing-equations of motion. Accuracy of simplified equations of motion, orbital mechanics.	6
2.	Role of rocket propulsion in orbital trajectories and maneu vers, Maximizing missile flight performance. Benefits of flight trajectory shaping.	7
3.	Flight performance prediction of boost, climb,cruise,coast,steady descent, ballistic, maneuvering,divert,andhoming flight.	7
4.	Practical implementation of integrated trajectory planning, Agility in maneuvering trajectories.	5
5.	Multiplier theory and its use in solving practical problems covered from areal-time computational view point, No-flyzones and engineering requirements, formulation as a mathematical mixture of state and decision-variable constraints.	5
6.	ExtensiveMATLAB-basedmini-projects.	6
	Total	36

References/Suggested Books:

1. “Flight Dynamics”, by Robert F.Stengel.Publisher: Princeton University Press.
2. Literature/books suggested by respective course Lecturers.
3.

- **Course Title** : **Sensor Technology**
  CourseCode :**DT-EL4-11**
  Teaching Scheme :**L: 3,T:0, P:0** **Credits:3**

Course Objectives:

The main objective of the course is to provide learning on the basic physical principles and characteristic features in sensor technology, design, function and applications of different sensors.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the basic principles of sensor systems required for satellites and tactical aircraft.
- Understand the atmospheric propagation and its impact on the performance of sensors
- Troubleshoot,repair/replace a faulty sensorin optimize process efficiency.

Course Content:

Unit	Contents	Contact Hrs.
1	Physical principles underlying the sensor system needed for satellites and tactical aircraft, as well as limitations imposed by the atmosphere and operating environment on these systems and their Communication links,	6
2	Phase darray and pulsed compressed radars, imaging synthetic Aperture and inverse synthetic aperture radars	5
3	Atmospheric propagation of signal.Noise resources and thermal radiation	5
4	Principles of semiconductor devices.Optical and infrared imaging Detector systems.	8
5	Detector resolution limitations and bandwidth requirements, Relationship between signals and noise.	6
6	The characteristics of critical sensor functions (including detection, estimation, imaging, and tracking).	6
	Total	**36**

References/Suggested Books:

1. “Hand book of Modern Sensors”,by Jacob Fraden. Publisher: Springer.
2. “Micro sensors, Principles and Applications”,by J.W.Gardner.Publisher :Wiley.
3. “Semiconductor Sensors”,by S. M.Sze. Publisher: Wiley.
4. Literature/books suggested by respective course Lecturers.