Priyadarshini College of Engineering

Department of Post Graduation

Academic policy

In View of the smooth conduction of the Programme following Policy are decided.

1. The Student after admission will be reporting to the Department.
2. The Department should display the Time Table for the Candidate for PG.
3. Attendance is mandatory for the student, department will be keeping track of student attendance and it will be observed by the PG Coordinator.
4. The PG Academic Calender is to be followed by Student and the Department.
5. Student will be appearing for the Mid-Term tests and Sessional examination.
6. Student has to finalise the Project in coordination with Project Guide, and PG Coordinator.
7. The PG Coordinator will be submitting the Synopsis of the Project to the University.
8. The Student is required to Publish two papers in reputed Conference/Journals.
9. The Student has to write Project Thesis and Submit it to the University for Valuation.
10. The Student will facing the Defence before the University Expert panel.

28/09/2021

Dr. Prakash Prasad

All PG Coordinator

Dr. Shrikrishna Dhale

Principal

PRIYADARSHINI COLLEGE OF ENGINEERING, NAGPUR

M. Tech Third Semester Academic Calendar (2021-22)

Month	Day						No. of days	Activities
	Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**		
September 2021			1	2	3	4	-	10 : Ganesh Chaturthi 13: Mahalaxmi Pooja 14: Display of Time table 21: Commencement of online Classes 30 : Laxminarayan Day
	6	7	8	9	10	11	-	
	13	14	15	16	17	18	05	
	20	21	22	23	24	25	05	
	27	28	29	30			03	
October 2021					1	2	01	2: Gandhi Jayanti 6 : Pitrumoksha amavasya 15: Dussera 19: Eid Milad 29: Display of Assignment I 30: Display of cumulative Attendance and Communicate to Students about poor attendance(if any)
	4	5	6	7	8	9	04	
	11	12	13	14	15	16	05	
	18	19	20	21	22	23	04	
	25	26	27	28	29	30	06	
November 2021	1	2	3	4	5	6	00	1 to 7 Diwali Vacation (Duration as per decision of management) 15-20: MidTerm Examination 30: Display of cumulative Attendance and Communicate to Parents about poor attendance(if any)
	8	9	10	11	12	13	02	
	15	16	17	18	19	20	06	
	22	23	24	25	26	27	05	
	29	30					02	
December 2021			1	2	3	4	04	3: Display of Assignment-II 25: Christmas 27Dec -1 Jan 2022:Subject Seminars 31: Display of cumulative Attendance and Communicate to Parents about poor attendance(if any)
	6	7	8	9	10	11	05	
	13	14	15	16	17	18	06	
	20	21	22	23	24	25	05	
	27	28	29	30	31		05	
January						1	01	

2022	3	4	5	6	7	8	05	7: Last day of teaching & display of attendance (21 Sept - 7h Jan 2022) & final detention list of students 10-15: Sessional Examination. 17-29: Make up/Remedial classes
	10	11	12	13	14	15	06	
	17	18	19	20	21	22	05	
	24	25	26	27	28	29	05	
	31							

Total Number of Working Days : 95 (From 14th September)

*** The above calendar is subject to change as per calendar of Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur.**

Note :

1. Online Quiz is to be conducted on odd Saturdays based on the syllabus completed in that period.
2. Capability Enhancement and Development schemes to be implemented as per the requirement.
3. Make-up Classes/ Remedial Classes to be conducted as per requirement.
4. Minor variations are permissible as per the programs requirement.
5. Academics Review: Twice in a semester (3rd week of October& last week November -2021)
6. Co-curricular activities to be conducted on any Saturdays following the safety norms and guidelines for Covid-19. Online activities may be conducted as per requirement.
7. Stakeholders meeting : In the month of November 2021 on convenient dates of the department.

Prasad

Dr. P. S. Prasad

All PG Coordinator

Copy to: -

1. Principal PCE/ PIET/ PIGCE/ VP-PCE for kind information and guidance.
2. All Deans,for information.
3. All Hod(s): for information and n.a.
4. 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

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Master of Technology
Choice Base Credit System(CBCS)

I Semester M. Tech. (VLSI)

Subject Code	Subject	Teaching Scheme			Examination Scheme								
					Theory					Practical			
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment			University Assessment	College Assessment		
PGVLS101T	VLSI Subsystem Design	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS102T	Advanced Digital Signal Processing	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS103T	VLSI Circuits	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS104T	Elective-I	4	-	4	3	70	30	100	50	-	-	-	-
PGOPEN105T	Elective-II (Open)	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS106P	Laboratory -I Advanced Digital Signal Processing	-	2	1	-	-	-	-	-	50	50	100	50
PGVLS107P	Laboratory -II VLSI Circuits	-	2	1	-	-	-	-	-	50	50	100	50
Total		20	4		-	350	150	500	-	100	100	200	-
Semester Total		24		22	700 Marks								

Elective-I: 1. Mixed Signal Processing [PGVLS104/1T] 2. Low Power VLSI Design [PGVLS104/2T] 3. Embedded Systems [PGVLS104/3T]
Elective-II (Open): List of Open Elective-II [PGOPEN501T] is enclosed.

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Master of Technology
Choice Base Credit System(CBCS)

II Semester M. Tech. (VLSI)

Subject Code	Subject	Teaching Scheme			Examination Scheme								
					Theory					Practical			
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment			University Assessment	College Assessment		
PGVLS201T	Analog VLSI Design	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS202T	VLSI Testing	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS203T	Modeling of Digital System and Testing	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS204T	Elective-III	4	-	4	3	70	30	100	50	-	-	-	-
PGFD205T	Foundation-I	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS206P	Laboratory -I Analog VLSI Design	-	2	1	-	-	-	-	-	50	50	100	50
PGVLS207P	Laboratory -II Modeling of Digital System and Testing	-	2	1	-	-	-	-	-	50	50	100	50
Total		20	4		-	350	150	500	-	100	100	200	-
Semester Total		24		22	700 Marks								

Elective-III: 1.System on Chip [PGVLS204/1T] 2.Micro Electro Mechanical Switches (MEMS) [PGVLS204/2T] 3. High Speed Semiconductor Devices and Circuits [PGVLS204/3T]
Foundation-I: Research Methodology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Master of Technology
Choice Base Credit System(CBCS)

III Semester M. Tech. (VLSI)

Subject Code	Subject	Teaching Scheme			Examination Scheme								
					Theory					Practical			
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment			University Assessment	College Assessment		
PGOPEN301T	Elective-IV (Open)	4	-	4	3	70	30	100	50	-	-	-	-
PGFD302T	Foundation II	4	-	4	3	70	30	100	50	-	-	-	-
PGVLS303P	Project Seminar	-	8	8	-	-	-	-	-	-	200	200	100
Total		8	8		-	140	60	200	-	-	200	200	-
Semester Total		-		16	400 Marks								

Elective-IV (Open): List of Open Elective-IV [PGOPEN301T] is enclosed.
Foundation II: Project Planning and Management

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme of Master of Technology
Choice Base Credit System(CBCS)

IV Semester M. Tech. (VLSI)

Subject Code	Subject	Teaching Scheme			Examination Scheme								
					Theory					Practical			
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment			University Assessment	College Assessment		
PGVLS401P	Project	-	16	16	-	-	-	-	-	400	-	400	200
Total		-	16		-	-	-	-	-	400	-	400	-
Semester Total		-		16	400 Marks								

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme of Master of Technology
Choice Base Credit System (CBCS)

I Semester M. Tech. (VLSI)

S.N.	Code	Semester Subject Name	New Subject Code	CBCS Subject Name
1.	IFU-01	VLSI Subsystem Design(Th)	PGVLS101T	VLSI Subsystem Design
2.	IFU-04	Advanced Digital Signal Processing(Th)	PGVLS102T	Advanced Digital Signal Processing
3.	----------	----------	PGVLS103T	VLSI Circuits *
4.	IIIFU02(1)	Mixed Signal Processing(Th)	PGVLS104T/1T	Elective-I: Mixed Signal Processing
5.	IIFU05(2)	Low Power VLSI Design	PGVLS104T/2T	Elective-I: Low Power VLSI Design
6.	IFU-05	Embedded System-I(Th)	PGVLS104T/3T	Elective-I: Embedded Systems
7.	----------	----------	PGOPEN105T	Elective-II (Open): Biomedical Systems Engineering *
8.	----------	----------	PGOPEN105T	Elective-II (Open): Soft Computing Techniques *
9.	----------	----------	PGOPEN105T	Elective-II (Open): Digital Forensics*
10.	----------	----------	PGOPEN105T	Elective-II (Open): Nano Electronics*
11.	IFU-04	Advanced Digital Signal Processing(P)	PGVLS106P	Laboratory -I Advanced Digital Signal Processing
12.	----------	----------	PGVLS107P	Laboratory -II VLSI Circuits *
13.	IFU-01	VLSI Subsystem Design(P)	----------	----------
14.	IFU-02	Modeling of Digital System -1(Th)	----------	----------
15.	IFU-02	Modeling of Digital System -1(P)	----------	----------
16.	IFU-03	Switching Theory and Automata(Th)	----------	----------
17.	IFU-05	Embedded System-I(P)	----------	----------

The students who fail to clear any subject(s) of the I Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of I Semester(New CBCS Pattern) along with the additional subject marked with (*). The Theory and Practical College and University Assessment Marks of Old Pattern will be converted into the same proportion in New CBCS Pattern. The College Assessment Marks of the Additional Theory/Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the Theory/Practical subject of old pattern.

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme of Master of Technology
Choice Base Credit System (CBCS)

II Semester M. Tech. (VLSI)

S.N.	Code	Semester Subject Name	New Subject Code	CBCS Subject Name
1.	IIFU01	Analog VLSI Design(Th)	PGVLS201T	Analog VLSI Design
2.	IIIFU01	VLSI Testing(Th)	PGVLS202T	VLSI Testing
3.	IIFU02	Modeling of Digital System-II(Th)	PGVLS203T	Modeling of Digital System and Testing
4.	----------	----------	PGVLS204T/1T	Elective-III: System on Chip *
5.	----------	----------	PGVLS204T/2T	Elective-III: Micro Electro Mechanical Switches (MEMS) *
6.	----------	----------	PGVLS204T/3T	Elective-III: High Speed Semiconductor Devices and Circuits *
7.	----------	----------	PGFD205T	Foundation-I: Research Methodology*
8.	IIFU01	Analog VLSI Design(P)	PGVLS206P	Laboratory -I Analog VLSI Design
9.	IIFU02	Modeling of Digital System-II(P)	PGVLS207P	Laboratory -II Modeling of Digital System and Testing
10.	IIFU03	VLSI Signal Processing(Th)	----------	----------
11.	IIFU04	Digital Image Processing(Th)	----------	----------
12.	IIFU04	Digital Image Processing(P)	----------	----------
13.	IIFU05(1)	Advanced Computer Architecture(Th)	----------	----------
14.	IIFU05(3)	Embedded System-II	----------	----------

The students who fail to clear any subject(s) of the II Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of II Semester(New CBCS Pattern) along with the additional subject marked with (*). The Theory and Practical College and University Assessment Marks of Old Pattern will be converted into the same proportion in New CBCS Pattern. The College Assessment Marks of the Additional Theory/Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the Theory/Practical subject of old pattern.

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme of Master of Technology
Choice Base Credit System (CBCS)

III Semester M. Tech. (VLSI)

S.N.	Code	Semester Subject Name	New Subject Code	CBCS Subject Name
1.	----------	----------	PGOPEN301T	Elective-IV (Open): Wireless Sensor Network *
2.	----------	----------	PGOPEN301T	Elective-IV (Open): Bio-Informatics *
3.	----------	----------	PGOPEN301T	Elective-IV (Open): Artificial Intelligence and Robotics *
4.	----------	----------	PGFD302T	Foundation II: Project Planning and Management*
5.	IIIFU03	Project Seminar	PGVLS303P	Project Seminar
6.	IIIFU02(2)	Computer Communication Networks(Th)	----------	----------
7.	IIIFU02(3)	Computer Graphics(Th)	----------	----------

The students who fail to clear any subject(s) of the III Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of III Semester(New CBCS Pattern) along with the additional subject marked with (*). The Theory and Practical College and University Assessment Marks of Old Pattern will be converted into the same proportion in New CBCS Pattern. The College Assessment Marks of the Additional Theory/Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the Theory/Practical subject of old pattern.

R.T.M. Nagpur University
Scheme of Examination for
M. Tech. (VLSI) First Semester

PGVLS101T	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 (9)

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: (9)

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: (8)

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: (9)

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: (9)

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 Hill

PGVLS102T	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: (9)

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: (8)

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: (9)

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: (10)

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: (8)

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.

PGVLS103T	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.

Elective-I (Discipline Specific):

PGVLS104/1T	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: **(8)**

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: **(9)**

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: **(9)**

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: **(9)**

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: **(9)**

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

Elective-I (Discipline Specific):

PGVLS104/2T	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: (9)

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: (9)

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: (10)

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: (8)

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: (9)

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.

Elective-I (Discipline Specific):

PGVLS104/3T	Embedded Systems

Course Objectives:

1. To study fundamentals of 8051 microcontroller, PIC-16c6x/7x and ARM-7.
2. To study interfacing of different peripherals with microcontrollers based upon the embedded application.

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

1. Program an embedded system
2. Design, implement and test an embedded system.

UNIT I: **(8)**

Introduction to controllers, 8051 controller, Block Diagram &Architecture, 8051 Instruction Set, Addressing modes & programming, 8051 Timers, Serial I/O, Interrupts programming,

UNIT II: **(10)**

Memory Interfacing, Programming, Real time interfacing with LED, LED display, LCD display Enhanced Features: Dallas HSM & Atmel Micro-controllers, Architecture enhancements, control store and external memory, scratchpad RAM enhancements, Timers, Serial I/O, Analog I/O, Voltage comparators.

UNIT III: **(9)**

RISC Controller: PIC Micro-controllers–overview; features, PIC 16c6x/7x–architecture, file selection register, Memory organization, Addressing modes, Instruction set, Programming, PIC-18 Flash Micro-controllers. STATUS, OPTION_REG, PCON registers

UNIT IV: **(9)**

Memory Organization: Program & Data Memory, Data EEPROM & Flash Program EEPROM, Interrupts, I/O ports, Timers, Capture/Compare/PWM module, Master Synchronous Serial Port module, USART, ADC.

UNIT V: **(8)**

ARM Micro-controllers overview; features, ARM 7 –architecture, Thumb, Register Model, Addressing modes, Introduction to Embedded C Programming.

TEXT BOOKS:

1. Embedded system Design ,Steve Heath, Butterworth Helneman,2008,4th
2. The 8051 Microcontroller-architecture, Programming & Applications, Kenneth J.Ayala, Penram International & Thomson Aisa,2003,2nd
3. The 8051 Microcontroller and Embedded Systems, Mazidi and McKinley, Pearson Education, 2010, 2nd Edition.

REFERENCE BOOKS:

1. Programming Embedded Systems with C and GNU Development Tools, Michael Barr,

Anthony Massa, O'Reilly publishers, 2nd Edition
2. Real Time Interfacing to ARM, Cortex-M Microcontrollers, Embedded systems, Jonathan Valvano, 5th Edition

Laboratory-I:

PGVLS106P	Advanced Digital Signal Processing

Any EIGHT practicals are to be conducted based on the syllabus of Advanced Digital Signal Processing [PGVLS102T]

Laboratory-II:

PGVLS107P	VLSI Circuits

Any EIGHT practicals are to be conducted based on the syllabus of VLSI Circuits [PGVLS103T]

R.T.M. Nagpur University
Scheme of Examination for
M. Tech. (VLSI) Second Semester

PGVLS201T	Analog VLSI Design

Course Objectives:

1. To introduce the fundamental principles of VLSI circuit design and to examine the basic building blocks of large-scale circuits.
2. To learn about Device Modeling- Various types of analog systems- CMOS amplifiers and Comparators.

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

1. Understand the concepts of analog design and to design various analog systems including data converters- CMOS amplifiers- Comparators and Switched Capacitor Circuits.

UNIT I: **(9)**

Device modeling and simulation Modeling, MOS Models Diode model, Bipolar modes BSIM Spice models, Circuit simulations using Spice, Basic Building Blocks: Switches, Current sources and sinks, Current mirrors, Voltage and current references.

UNIT II: **(9)**

Amplifiers: MOS Inverting amplifier, Cascade amplifiers, Feedback amplifiers, Differential amplifiers, Frequency response, noise performance in Diff amplifiers, Output amplifiers.

UNIT III: **(8)**

CMOS Two stage OPAMP Design, Cascade OPAMPs, Simulation and Measurement of OPAMPs, Comparators.

UNIT IV: **(9)**

Analog signal processing, CMOS Digital to analog converters, Scaling and serial, cyclic, Analog to digital converters Serial, SAR, Parallel, Pipelined, sigma-delta converters.

UNIT V: **(9)**

Mixed signal Layout issues, Continuous time filters, Switched capacitor filters, Modulator and multipliers, PLL, Advance topics on Analog VLSI.

TEXT BOOKS:

1. VLSI Design Techniques for analog and digital circuits, R.L.Geiger, P.E.Allen, McGRaw Hill, 2008, 4th Edition
2. CMOS circuit design, Layout and simulation, J.Baker, D.E.Boyce, IEEE Press, 2003, 1st Edition

REFERENCE BOOKS:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits , McGraw-Hill, 2001

PGVLS202T	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 (9)

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 (9)

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 (8)

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 (9)

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 (9)

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

PGVLS203T	Modeling of Digital System and Testing

Course Objectives:

1. To learn different styles of modeling in Verilog.
2. To Study simulation of digital circuits.
3. To study basics of FPGA and its applications.
4. To learn fundamentals of testing of logic circuits.

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

1. Simulate different combinational and sequential circuits.
2. Test different logic circuits.

UNIT I: Verilog for System Design (9)

Introduction to HDL, Behavioural, Data flow, Structural Models, Simulation Cycles, Process, Concurrent Statements, Sequential Statements, Loops, Delay Models, Sequential Circuits, FSM Coding, Library, Packages, Functions, Procedures, Operator Inference, Writing Test bench.

UNIT II: Digital Circuit Simulation (9)

Design of combinational circuit building blocks: synthesis of logic functions using multiplexers, demultiplexers, binary encoders and priority encoders, code converters, arithmetic comparison circuits, SRAM Model

Design of Sequential Circuit Building block, Flip flops, registers with enable input, design of bit counting circuit.

UNIT III: Sequential Circuit Simulation (9)

Registers and counters: shift registers, Asynchronous counters and synchronous counters, reset synchronization, UART Model, shift and add multiplier, divider, clock synchronization, clock skew, switch debouncing, Design example - bus structure.

UNIT IV: Field Programmable Gate Arrays (8)

Introduction to FPGA, Logic Block Architecture, Routing Architecture, Programmable Interconnections, Design Flow, Xilinx Spartan architecture, Xilinx Virtex Architecture, Boundary Scan, Programming FPGA's, Constraint Editor, Static Timing Analysis, One hot encoding, Hardware-software co-simulation, Bus function models, Bus Functional Model (BFM) Simulation, Case Study: Xilinx Spartan III.

UNIT V: Testing of logic circuits (9)

Testing Philosophy, Role of Testing, fault model, complexity of a test set, Detection of single Multiple Faults in Combinational Logic Circuits, techniques for testing of sequential circuits, Design for testability.

TEXT BOOKS:

1. John F. Wakerly,"Digital Design principles and practices", 3rd edition, PHI publications
2. Zainalabedin Navabi, VHDL, analysis and modeling of digital systems, McGraw-Hill.
3. Ian Grout, Digital Systems Design with FPGAs and CPLDs, Elsevier

REFERENCE BOOKS:

1. Brown, Vranesic ―Fundamentals of digital logic design with VHDL, McGraw Hill
2. Michael John Sebastian Smith, Application-Specific Integrated Circuits, Addison Wesley

Elective-III (Discipline Specific):

PGVLS204/1T	System on Chip (SoC)

Course Objectives:

1. To study and understand different Hardware and Software System Design approaches.
2. To study the fundamentals of chip designing.
3. To learn different design customization techniques.

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

1. Describe various customization techniques for chip designing.

UNIT I: Introduction to systems approach:

System architecture, components of system, Hardware /software, Processor architecture, Memory addressing, interconnects

UNIT II: Chip basics, time, area, power reconfigurability

Design tradeoffs, requirements and specifications, Cycle time, Ideal and Practical Scaling, Area time power tradeoffs in processor design, Reliability, Configurability.

UNIT-III: Processors

Introduction, Processor selection for SOC design, Basic concepts in processor architecture, Robust Processors, vector, VLIW processor, Superscalar

UNIT-IV: Interconnects, Customization and Reconfiguration

Introduction, Bus basic architecture, SOC standard buses, AMBA, core connect, Analytic bus model, contention and shared buses, effect of bus transaction and contention, Introduction to NOC,SOC customization overview, Processor customization, Reconfigurable technologies.

UNIT V: ARM SOC Architecture

ARM architecture, Assembly language instruction set, architectural support for system development, ARM CPU cores.

TEXT BOOKS:

1. Michael J.Flynn , Wayne Luk, "Computer System Design-System on Chip",Wiley Publication

REFERENCE BOOKS:

2. Steve Furber, "ARM system on Chip Architecture", Pearson Education ltd, 2nd Edition

Elective-III (Discipline Specific):

PGVLS204/2T	Micro Electro Mechanical Switches (MEMS)

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: **(8)**

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

UNIT II: **(8)**

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: **(9)**

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: **(10)**

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: **(9)**

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.

Elective-III (Discipline Specific):

PGVLS204/3T	High Speed Semiconductor Devices and Circuits

Course Objectives:

1. To study crystal structure of Semiconductors.
2. To study different MOS devices and their characteristics.
3. To study Advanced Devices HBT and HEMT Devices
4. To study the fabrication process in detail.
5. To study different MOS Integration Techniques.

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

1. Identify different MOS devices for the specific application.
2. Fabrication of different MOS devices corresponding to the requirements.
3. Integrate different MOS devices.

UNIT I: Review of Crystal Structure: (9)

Crystal structure of important semiconductors (Si, GaAs, InP), electrons in periodic lattices, energy band diagram, carrier concentration and carrier transport phenomenon, electrical, optical, thermal and high field properties of semiconductors, Homojunction Devices, Homojunction Devices (BJT and FET): Structure, band diagram, operation, I–V and C–V characteristics (analytical expressions), small signal switching models.

UNIT II: MOS Devices: (9)

MOS Diode: Structure, band diagram, operation, C–V characteristics, effects of oxide charges, avalanche injection, high field effects and breakdown; Heterojunction Based MOSFET: Band diagram, structure, operation, I–V and C–V characteristics (analytical expressions), MOSFET breakdown and punch through, subthreshold current, scaling down; Alternate High k-dielectric Materials: HF–MOSFETs - SOI MOSFET - buried channel MOSFET - charge coupled devices.

UNIT III: Advanced Devices HBT and HEMT Devices: (8)

AlGaAs/ GaAs, InP and SiGe based HBT and HEMT structure, band diagram, operation, I–V and C–V characteristics (analytical expressions), small signal switching models, benefits of heterojunction transistor for high speed applications.

UNIT IV: (9)

Fabrication and Characterization Techniques Crystal Growth and Wafer Preparation: Epitaxy, diffusion, ion implantation, dielectric film deposition and oxidization techniques, masking and lithography techniques (optical, e-beam and other advanced lithography techniques), metallization

UNIT V: (9)

Bipolar and MOS integration techniques, interface passivation techniques; Characterization Techniques: Four probe and Hall Effect measurement, I–V and C–V for dopant profile characterization and DLTS.

TEXT BOOKS:

1. High Speed Semiconductor Devices , S.M.Sze, Willey, 1990
2. Nandita Das Gupta and Amitava Das Gupta, “Semiconductor Devices: Modeling and Technology”, Prentice Hall of India, 2004.

REFERENCE BOOKS:

1. M. S. Tyagi, “Introduction to Semiconductor Materials and Devices”, John Wiley and Sons, 2008.
2. J. Singh, “Semiconductor Devices: Basic Principles”, John Wiley and Sons, 2007.

Foundation-I

Laboratory-I:

PGVLS206P	Analog VLSI Design

Any EIGHT practicals are to be conducted based on the syllabus of Analog VLSI Design [PGVLS201T]

Laboratory-II:

PGVLS207P	Modeling of Digital System and Testing

Any EIGHT practicals are to be conducted based on the syllabus of Modeling of Digital System and Testing [PGVLS203T]

R.T.M. Nagpur University
Scheme of Examination for
M. Tech. (VLSI) Third Semester

Foundation-II

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

Rashtrasant Tukadoji MaharajNagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme for Master of Technology
in
Mechanical Engineering Design (MED)
Choice Base Credit System (CBCS)

I Semester

Subject code	Name of Subject	Teaching Scheme			Examination Scheme				
					Marks				
		Hours per Week		No. of Credits	Duration of Paper (Hrs.)	College Assessment	University Assessment	Total Marks	Minimum Passing Marks
		L	P						
PGMED101T	Advanced Mechanisms	4	-	4	3	30	70	100	50
PGMED102T	Dynamics of Machinery	4	-	4	3	30	70	100	50
PGMED103T	Mechanical Vibrations	4	-	4	3	30	70	100	50
PGMED104T	Elective -I (Discipline)	4	-	4	3	30	70	100	50
PGMED105T	Elective —II (Open)	4	-	4	3	30	70	100	50
PGMED106P	Advanced Mechanisms	-	2	1	-	50	50	100	50
PGMED107P	Mechanical Vibrations	-	2	1	-	50	50	100	50
Total		**20**	**4**	**-**	-	**-**	**-**	**-**	**-**
Semester Total		**24**		**22**				**700**	

Note:

I) List of Elective-I (Discipline)
   1) Computer Aided Mechanical Design
   2) Reliability, Maintainability & Wear

II) Elective-II (open) is to be selected from the list attached in Annexure-

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Course and Examination Scheme for Master of Technology
in
Mechanical Engineering Design (MED)
Choice Base Credit System (CBCS)

II Semester

Subject code	Name of Subject	Teaching Scheme			Examination Scheme				
					Marks				
		Hours per Week		No. of Credits	Duration of Paper (Hrs.)	College Assessment	University Assessment	Total Marks	Minimum Passing Marks
		L	P						
PGMED201T	Advanced Mechanical Drives	4	-	4	3	30	70	100	50
PGMED202T	Stress Analysis	4	-	4	3	30	70	100	50
PGMED203T	Design Of Mechanical Handling System	4	-	4	3	30	70	100	50
PGMED204T	Elective —III (Discipline)	4	-	4	3	30	70	100	50
PGMED205T	Foundation Courses -I	4	-	4	3	30	70	100	50
PGMED206P	Stress Analysis	-	2	1	-	50	50	100	50
PGMED207P	Finite Element Analysis	-	2	1	-	50	50	100	50
Total		**20**	**4**	**-**	**-**	**-**	**-**	**-**	**-**
Semester Total		**24**		**22**				**700**	

Note:

I) List of Elective-III (Discipline)
   1) Tribology And Bearing Design
   2) Design Of Hydraulic And Pneumatic System

Rashtrasant Tukadoji MaharajNagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme for Master of Technology
in
Mechanical Engineering Design (MED)
Choice Base Credit System (CBCS)

III Semester

Subject code	Name of Subject	Teaching Scheme			Examination Scheme				
					Marks				
		Hours per Week		No. of Credits	Duration of Paper (Hrs.)	College Assessment	University Assessment	Total Marks	Minimum Passing Marks
		L	P						
PGMED301T	Elective -IV (Open)	4	-	4	3	30	70	100	50
PGMED302T	Foundation Courses -II	4	-	4	3	30	70	100	50
PGMED303P	Project Seminar	-	3	8	-	200	-	200	100
Total		**8**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
Semester Total		**11**		**16**				**400**	

Note: Elective-IV (open) is to be selected from the list attached in Annexure-

Rashtrasant Tukadoji MaharajNagpur University, Nagpur
Faculty of Engineering & Technology
Course and Examination Scheme for Master of Technology
in
Mechanical Engineering Design (MED)
Choice Base Credit System (CBCS)

IV Semester

Subject code	Name of Subject	Teaching Scheme			Examination Scheme				
					Marks				
		Hours per Week		No. of Credits	Duration of Paper (Hrs.)	College Assessment	University Assessment	Total Marks	Minimum Passing Marks
		L	P						
PGMED401P	Project	-	6	16	-	-	400	400	200
Total		**-**	**6**	**-**	**-**	**-**	**-**	**-**	**-**
Semester Total		**6**		**16**				**400**	

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme for the Students of M. Tech. Mechanical Engineering Design from Old Semester Pattern to New CBCS Semester Pattern

I Semester M. Tech. Mechanical Engineering Design

Subject Code	Name of the subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGMED101T	Advanced Mechanisms	1MED-02	Advanced Mechanisms
PGMED102T	Dynamics of Machinery	1MED-03	Dynamics of Machinery
PGMED103T	Mechanical Vibrations	1MED-05	Vibration Analysis
PGMED104T	Elective -I (Discipline) 1) Computer Aided Mechanical Design	1MED-04	Computer Aided Mechanical Design
	2) Reliability, Maintainability & Wear	3MED-01	Reliability, Maintainability & Wear
PGMED105T	Elective —II (Open) 1) Robotics	2MED-03	Robotics
	2) Mechanization In Food Processing	3MED-02	Mechanization In Food Processing
PGMED106P	Advanced Mechanisms (Practical)	---	---
PGMED107P	Mechanical Vibrations (Practical)	1MED-05	Vibration Analysis (Practical)

II Semester M. Tech. Mechanical Engineering Design

Subject Code	Name of the subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGMED201T	Advanced Mechanical Drives	2MED-01	Advanced Mechanical Drives
PGMED202T	Stress Analysis	2MED-04	Stress Analysis
PGMED203T	Design of Mechanical Handling System	3MED-02	Design of Mechanical Handling System
PGMED204T	Elective —III (Discipline) 1)Tribology And Bearing Design	---	---
	2) Design of Hydraulic And Pneumatic System	3MED-02	Design of Hydraulic & Pneumatic Systems
PGMED205T	Foundation Courses -I	---	---
PGMED206P	Stress Analysis (Practical)	2MED-04	Stress Analysis (Practical)
PGMED207P	Finite Element Analysis (Practical)	2MED-05	Finite Element Analysis (Practical)

III Semester M. Tech. Mechanical Engineering Design

Subject Code	Name of the subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGMED301T	Elective -IV (Open) 1) Finite Element Analysis	2MED-05	Finite Element Analysis
	2) Optimization In Engineering Design	2MED-02	Optimization In Engineering Design
PGMED302T	Foundation Courses -II	---	---
PGMED303P	Project Seminar	3MED-03	Seminar on Project Spade Work & Research Methodology

IV Semester M. Tech. Mechanical Engineering Design

Subject Code	Name of the subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGMED401P	Project	---	Thesis

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Faculty of Engineering & Technology
Course and Examination Scheme of Master of Technology
Choice Base Credit System (CBCS)

I Semester M. Tech. (Mechanical Engineering Design)

Subject Code: - PGMED101T
Subject:-Advanced Mechanisms

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:

I 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.

II 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 .

III Optimal synthesis of planar mechanisms, Powells search methods least square method penalty function computer approach.

IV 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.

V 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

Subject Code: - PGMED102T
Subject: - Dynamics of Machinery

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:

I **Dynamics of Mechanisms:** Forces in mechanisms, friction in links connection, stress distribution in links. Various approaches for dynamic analysis: Lagranjes, Recursive Lagranjes.

II **Dynamic Motion Analysis:** Energy distribution method, the rate of change of energy method, Balancing of linkages and flywheel requirements. Lagranjian Euler formulation, Hamilton's Formulation, variation Mechanics.

III **Rotor Dynamics :** Torsional Vibration in reciprocating machines, Critical speed, bending vibration 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".

Subject Code: - PGMED103T
Subject: - Mechanical Vibrations

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:

I 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.

II Response of Systems to Arbitrary Periodic Excitation: Duhamel's integral impulse response function – shock spectra –Laplace and Fourier transform methods.

III 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.

IV Continuous Systems: Longitudinal and transverse vibration of beams-forced response of beams. Vibration of plates –finite element techniques in vibration analysis.

V Vibration Instrumentation: 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.

VI Noise Control : 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 :

1. J.S. Rao and K. Gupta Advanced theory of vibration.Willey Eastern.1992.
2. P.Srinivasan Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi 1982.
3. N. L. Meirovitch , Elements of vibration Analysis, Mc Graw Hill New York 1986.
4. J.P.Den Hartog Mechanical Vibration (4^{th} edition Mc Graw Hill, New York 1985.
5. Timoshenko, Engineering vibration.
6. Irwin & Garf , industrial Noise & Vibration Control.
7. R.A. Collacott, Vibration Monitoring and diagnosis, John Willey, New York, 1979.
8. M. Petyt , Introduction to Finite Element Vibration Analysis Cambridge University Press,Cambridge 1990.

Subject Code: - PGMED104T
Elective -I (Discipline)
Subject: Computer Aided Mechanical Design

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.

Syllabus:

I Introduction To CAD/CAM And Product Cycle: Role of Computers in the design process. Requirement of Hardware & Software in CAD. Representation of Line, Circle, & Other analytic curves, 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].

II 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.

III Geometric Modeling: Mathematical representation of Hermite cubic, Bezeir & B-spline curves. 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

Subject Code: - PGMED104T
Elective -I (Discipline)
Subject: Reliability, Maintainability & Wear

Course Objective:

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:

I Introduction to reliability availability and maintainability failure distributions, Weibull distribution and its applications to industries.

II Design and manufacturing for reliability, reliability assessment of mechanical systems FMES and FTA techniques.

III Monte carlo simulation method, markov chains in reliability. Maintenance policies and philosophies conditions based antennae , Vibration monitoring non destruction 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 Design
11. Hull B. , Jhon V. , Non Destructive testing.

Subject Code: - PGMED105T
Elective —II (Open)

Subject Code: - PGMED106P
Subject:-Advanced Mechanisms

List of Practical:

1. Synthesis using function generation.
2. Synthesis using path generation.
3. Synthesis using path generation & rigid body guidance.
4. Kinematic analysis and synthesis of spatial mechanisms.
5. Kinematic synthesis of robot arm.
6. Graphical approaches for synthesis of mechanisms.
7. Study of Powell's search methods.
8. Study of least square method.
9. One numerical on Freudenstein's equation

Subject Code: - PGMED107P
Subject: - Mechanical Vibrations

Based on syllabus of mechanical vibrations mention in subject code MT103T with emphasis on vibration measurement on equipment and machinery.

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II Semester M. Tech. (Mechanical Engineering Design)

Subject Code: - PGMED201T
Subject: - Advanced Mechanical Drives

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:

I **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.

II **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.

III **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.

IV **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.

V **PIV Drives:** Concept, Need, Classification & Types. Detailed kinematics & dynamics of 4/5 important drives.

VI **Couplings:** 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:

1. Gear, Spur Helical ,Worm by Earle Buckingham ,Mc-Graw Hill.
2. Rothebirt "Mechanical Design & Systems Handbook" Mc-Graw Hill
3. Handbook of shaft Alignment
4. M.P.Alexandrov, "MATEIALS HANDING EQUIPMENT", MIR Publications, Moscow 1981.
5. Fairs, "Mechanisms" McGraw Hill.
6. J.S. Beggs, " Mechanisms" Prentice Hall.
7. David W. South & Jon R. Mancuso" Mechanical Power Transmission Components" Marcel Dekker inc New York.

Subject Code: - PGMED202T
Subject: - Stress Analysis

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:

I 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.

II 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.

III Torsion: Torsion of non circular section , St. Venants theory, Membrane analogy , Torsion of thin walled tubes.

IV Experimental stress analysis by strain gauge & photo elasticity technique, strain rosettes, recording instruments, Brittle coating techniques, poloriscope, Isochromatic & isoclinic fringes, compensation techniques.

V Thermal stresses: Thermo elasticity, thin circular discs, thermal stresses in turbine rotors, Analysis of beams under thermal load.

VI 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".

Subject Code: - PGMED203T
Subject: - Design of Mechanical Handling System

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:

I Constructional features, operation, operational characteristics advantages Disadvantages, limitations, Design considerations of following conveying machines.

II 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.

Subject Code: - PGMED204T
Elective -III (Discipline)
Subject: Tribology and Bearing Design

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:

I 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 .

II 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

III 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

IV 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

Subject Code: - PGMED204T
Elective -III (Discipline)
Subject: Design of Hydraulic and Pneumatic System

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:

I Oil Hydraulic Systems: Hydraulic Power Generator, selection and specification of pumps, pump characteristics.

II Hydraulic Actuators: Linear & Rotary Actuators, Selection, Specification and Characteristics.

III Control & Regulation Elements: Pressure, direction and flow control valves, relief valves, non return and safety valves actuation systems.

IV 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.

V 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 .

VI Installation, Maintenance and Special Circuits: Pneumatic equipments, selection of components, design calculations, application, fault finding, hydro pneumatic automation, robotic circuits .

Tutorial: Based on above syllabus.

References:

1. Peter Rohner, "Fluid power logic circuits design" the Macmillan Press Limited ,1979.
2. Stewart,H.L., "Hydraulic and pneumatic power for production", Industrial press, New York 1955.
3. Walter Ernest, "Oil hydraulic power and industrial applications", Mc Graw Hill Book,Co 1962.
4. Pease ,D.A. "Basic fluid power", Prentice Hall ,1987.

Subject Code: - PGMED205T
Subject: - Foundation Courses –I

Subject Code: - PGMED206P
Subject: - Stress Analysis

List of Practical:

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.

Subject Code: - PGMED206P
Subject: - Finite Element Analysis

Practical on the standard CAE packages like ANSYS, NASTRAN, ABAQUS,MATLAB, CATIA, UNIGRAPHICS, PRO-E or any other relevant software.

List of Practical:

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.

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III Semester M. Tech. (Mechanical Engineering Design)

Subject Code: - PGMED301T
Elective -IV (Open)

Subject Code: - PGMED302T
Subject: - Foundation Courses –II

Subject Code: - PGMED303P
Subject: - Project Seminar

Research Concept :- process of growth of knowledge Mechanical & Industrial Engineering Department generation/realization of new facts , Establishing logic for the generated facts, Scope of quantification of cause effect relationship , Evaluation of hypotheses.

Approach Of Formulation Of The Research Task: - Literature review: Sources, Discussions Field studies, Critical analysis of generated facts. Hypothetical proposals for future development, Constraints for proposal selection, Prioritization.

Research Approaches: Conceptual research, Theoretical research, applied research, Experimental research: Experimental validation of proposed logic, Experimentation to generate design data.

Modeling & Simulation: Concept of modeling, Concept of simulation, Types of simulation (quantitative Experimental, Computer , Fuzzy based , statistical) Process of Model optimization.

Formulation of Hypothesis
Literature survey work of the topic selected for dissertation.

References :

1. T.S. Wilkinson & P.L. Bhandarkar , Methods & Techniques of Social Research" Himalaya Publishing , Bombay.
2. Averill M.Law & W. David Kelton "Simulation,Modelling & Analysis"
3. H. Schenck, Jr. "Theories of Engg. Experimentation" Mc-graw Hill "Design of Experiments" Montgomery.
4. Bart Kasko & Klir "Nural Network & Fuzzy Systems" Prentice Hall T.J.Roft" Fuzzy logic with Engg. . Application "Tata mc-Graw Hill " Fuzzy sets, Uncertainties & Information" Prentice Hall.
5. S.S. Rao "Optimization Theory & Applications" Wiley Eastern Back Volimes of Journal
6. "Modelling & Simulation" AMSE Press France .

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IV Semester M. Tech. (Mechanical Engineering Design)

Subject Code: - PGMED401P
Subject: - Project

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
Industrial Drives and Control (IDC)

Of
RASHTRASANT TUKDOJI MAHARAJ
NAGPUR UNIVERSITY, NAGPUR

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
I Semester M. Tech. CBCS Industrial Drives and Control (IDC)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment		
PGIDC 101T	Advanced Power Electronics	4	-	4	3	70	30	100	50
PGIDC 102T	DC Drives	4	-	4	3	70	30	100	50
PGIDC 103T	Advanced Control Theory	4	-	4	3	70	30	100	50
PGIDC 104T	Elective –I (Core)	4	-	4	3	70	30	100	50
PGOPEN 105T	Elective –II (Open)	4	-	4	3	70	30	100	50
PGIDC 106P	Advanced Power Electronics	-	2	1	-	50	50	100	50
PGIDC 107P	D.C. Drives	-	2	1	-	50	50	100	50
Total		20	4		-	450	250	700	-
Semester Total		24		22	700 Marks				
Elective –I (Core)					1.Analysis of Electrical Machines 2. Application of Microcontroller in Electrical System 3. Micro and Smart Grid				
Elective-II (Open)					List of Open Electives from various discipline is attached				

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
II Semester M. Tech. CBCS Industrial Drives and Control (IDC)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment		
PGIDC 201T	Drives System Design	4	-	4	3	70	30	100	50
PGIDC 202T	AC Drives	4	-	4	3	70	30	100	50
PGIDC 203T	Electrical Transportation	4	-	4	3	70	30	100	50
PGIDC 204T	Elective – III (Core)	4	-	4	3	70	30	100	50
PGFD 205T	Research Methodology	4	-	4	3	70	30	100	50
PGIDC 206P	A.C. Drives	-	2	1	-	50	50	100	50
PGIDC 207P	Computer Aided Design	-	2	1	-	50	50	100	50
Total		20	4		-	450	250	700	-
Semester Total		24		22	700 Marks				
Elective –III (Core)					1. Energy Audit and Management 2. Converter for Non Conventional Energy Sources 3. Process control and Instrumentation				

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
III Semester M. Tech. CBCS Industrial Drives and Control (IDC)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment		
PGOPEN 301T	Elective –IV (Open)	4	-	4	3	70	30	100	50
PGFD 302T	Project Planning and Management	4	-	4	3	70	30	100	50
PGIDC 303P	Project Seminar	-	8	8	-	--	200	200	100
Total		8	8	16	-	140	260	400	-
Semester Total		16		16	400 Marks				
Elective-IV (Open)					List of Open Electives from various discipline is attached				

Note: For the teaching work load calculation for Project Seminar, work load will be 3 hours per week per project

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
IV Semester M. Tech. CBCS Industrial Drives and Control (IDC)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment		
PGIDC 401P	Project	-	16	16	-	400	--	400	200
Semester Total		16		16	400 Marks				

Note: For the teaching work load calculation for project, work load will be 6 hours per week per project

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I Semester M. Tech. Industrial Drives and Control (IDC)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGIDC 101T	Advanced Power Electronics	1S-IDC-02	Advanced Power Electronics (Theory)
PGIDC 102T	DC Drives	1S-IDC-05	D.C. Drives (Theory)
PGIDC 103T	Advanced Control Theory	1S-IDC-03	Advanced Control System (Theory)
PGIDC 104T	Elective –I (Core) Analysis of Electrical Machines (Theory)/ Application of Micro Controller in Electrical System	1S-IDC-04/ 1S-IDC-01	Analysis of Electrical Machines (Theory)/ Micro Controller & its Applications (Theory)
PGOPEN 105T	Elective –II (Open) Artificial Intelligence	2S-IDC-02	Artificial Neural Network & Fuzzy Logic (Theory)
PGIDC 106P	Advanced Power Electronics	1S-IDC-02	Advanced Power Electronics (Practical)
PGIDC 107P	D.C. Drives	1S-IDC-05	D.C. Drives (Practical)

The Students who fail to clear any subject(s) of the I Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of I Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
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II Semester M. Tech. Industrial Drives and Control (IDC)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGIDC 201T	Drives System Design	2S-IDC-05	Elective –I (Theory) Drive System Design and Simulation
	Drives System Design *		Elective –I (Theory) any other Elective other than Drive System Design and Simulation
PGIDC 202T	AC Drives	2S-IDC-03	AC Drives (Theory)
PGIDC 203T	Electrical Transportation*	--	--
PGIDC 204T	Elective –III (Core) Process control and Instrumentation theory)	3S-IDC-02	Elective-II (Theory) Process Control and Instrumentation
	Elective –III (Core) Energy Audit and Management (Theory)		Elective-II (Theory) Management Information System
	Elective –III (Core) *		Elective-II (Theory) Mechatronics
PGFD 205T	Research Methodology*	--	--
PGIDC 206P	A.C. Drives	2S-IDC-03	AC Drives (Practical)
PGIDC 207P	Computer Aided Design	2S-IDC-03	Computer Aided Design of Electrical Drives (Practical)
--	--	2S-IDC-04	Digital Signal Processing (Theory)

The Students who fail to clear any subject(s) of the II Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of II Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

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III Semester M. Tech. Industrial Drives and Control (IDC)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGOPEN 301T	Elective –IV (Open) Digital Control System	2S-IDC-01	Digital Control System (Theory)
PGFD 302T	Project Planning and Management*	--	--
PGIDC 303P	Project Seminar	EIDC 301T	Elective –IV (Open)*

The Students who fail to clear any subject(s) of the III Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of III Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

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Absorption Scheme for the students of M.Tech. Industrial Drives and Control (IDC) from Old Semester pattern to New CBCS Semester Pattern
IV Semester M. Tech. Industrial Drives and Control (IDC)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGIDC 401P	Project	4S-IDC-01	Project Phase –II (Dissertation Viva Voce)

The Students who fail to clear any subject(s) of the IV Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of IV Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

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PGIDC101T/PG IPS101T/PGPEPS 101T

Advanced Power Electronics

(Common to M.Tech CBCS IDC, M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To understand the characteristics, capabilities, ratings, limitations and protection of various power semiconductor switches used for various Power Electronic applications.

To understand the performance and analysis of low frequency switched and high frequency switched AC to AC, DC to DC and DC to AC power electronic converters for various applications.

To understand various control schemes and soft switching techniques in industrial applications.

Describe the structure of Electric Drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology.

Study and understand the different types of drives and selection of drive and power converter for particular application.

Study and understand the operation of electric motor drives controlled from a power electronic converter and to introduce the design concepts of controllers for closed loop operation.

Study and understand special motor drives and their control.

Course Outcome:

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

Develop in depth knowledge of advanced power electronics devices.

Study, design and analyze the ac to ac converters.

Study, design and analyze dc to dc converters with their applications.

Understand and analyze various resonant and soft switching techniques for converters.

Study, design and analyze the dc to ac converters.

Understand the operation of modern power converters and multilevel inverters.

Understand the basic principles of power electronics in drives and its control, types of drives and basic requirements placed by mechanical systems on electric drives.

Understand the operation of 1ϕ & 3ϕ converter drives for separately excited & series DC motors.

Learn speed control of induction motor drives in an energy efficient manner using power electronics.

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, multi resonant 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 zero sequence signal injection with industrial applications.

Text Books:

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

Reference Books:

1. "Power Electronics" Cyril W Lander ,MHL

2. "Power Electronics", Ned Mohan, Tora M. Udeland, William P. Riobbins, John Wiley & sons

3. Related IEEE Papers / NPTEL Lectures.

PGIDC102T

DC Drives

Course objective:

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

Course Outcomes:

After the completion of this course, the students shall be able to:
Improvise the existing control techniques to suit the application
Identify suitable power converter from the available configurations.
Design controllers for closed-loop operation of a separately excited DC motor drive with symmetrical optimization technique

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. The machine matrices, the 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-IV Power Factor Improvement:

PF improvement of single phase 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.

Unit-V Three Phase SCR Drives:

Principle and operation of semi converter, 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.

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 , New York .

3) Electrical Drives : Vedam Subramanian.

4) Electrical Motors Drives (Modeling Analysis and Control) by -R. Krishnan, Practice Hall India.

PGIDC103T/PGPEPS103T

ADVANCE CONTROL THEORY

(Common to M.Tech CBCS IDC and M.Tech CBCS PEPS)

Course Objective:

To understand and analyse electromechanical systems by mathematical modeling.
To Determine Transient and Steady State behavior of systems using standard test signals.
To understand linear and non-linear systems for steady state errors, absolute stability and relative stability
To Identify and design a control system satisfying requirements..

Course Outcomes:

After the completion of this course, the students shall be able to:
Develop mathematical models of physical systems.
Design optimal controllers for physical systems including power electronic and power systems.
Analyze the issues related to the stability of automatic control systems.
Design complex nonlinear systems by linearizing them

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 & Jury's Test.

Unit-III

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

Unit-IV Lyapunov Stability Analysis:

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

Unit-V Optimal Control:
Parameter optimization techniques, Lagrange parameter techniques, Calculus of variations, Unconstrained and Constrained minimization of functional, Two point boundary value problems, Pontrygin's minimum principle, Optimal regulator and tracking problems, Optimal digital control systems.

Reference Books:

1. M.Gopal.; Digital Control and State Variable Methods; Tata McGraw Hill, New Delhi, 1997.

2. D.E. Kirk.; Optimal Control Theory; Prentice Hall, 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

PGIDC104T Elective I-(1)

Analysis of Electrical Machines

Course objective:

To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque.
To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.
To provide the knowledge of theory of transformation of three phase variables to two phase variables.
To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modeling and digital computer simulation.
To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling and digital computer simulation.

Course Outcomes:

After the completion of this course, the students shall be able to:
Develop models for linear and nonlinear magnetic circuits
Determine the developed torque in an electrical machine using the concepts of field Energy and co-energy and determine the dynamic model of a DC machine
Determine the dynamic model of an induction machine based on the dq0 Transformation and determine instantaneous torque developed in an induction Machine- which leads to advanced control strategies such as vector control and direct torque control
Determine the torque developed in a salient pole synchronous machine using the Park's transformation and identify contribution of saliency torque- damping torque and excitation torque

Unit-I

Theory of transformation:

Reference frame, electrical network terminology – mesh network – 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 – solution of electrodynamical Equations.Voltage & Torque equation under acceleration – motional impedance matrix ofGeneralized machines, state model of generalized machine,State model of 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 Normalisation, Park's Transformation , Flux linkage equations, Voltage & Current equations, Formulation of State –space equations, Equivalent circuit, Subtransient & Transient inductances and time constants, Simplified models of Synchronous machines.

Unit-IV

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

Unit-V

Linear Model Of Syschronous Machines: Linearisation of 1) Generator state space current model 2) Load equation for the one machine problem & 3) Flux linkage model , Simplified linear model & it's statespace representation

REFERENCE BOOKS:

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

PGIDC104T /PGIPS104T/PGPEPS104T Elective I-(2)

Application of Microcontroller in Electrical System

(Common to M.Tech CBCS IDC , M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To understand Microprocessor types and its programming.
To understand various interfacing circuits necessary for various applications.
To understand various interfacing concepts.
To understand basic concepts of Microcontroller.

Course Outcome:

After the completion of this course, the students shall be able to,
Understand the causes, effects and remedies of power quality problems.
To design a system, component or process as per needs and specifications
To Write Assembly language program for 8051 Microcontroller to achieve solution to given task.
To learn functioning of Signal conditioning using specific circuits/ transducers and to measure electrical ornon-electrical quantities using processor.
To apply 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, Assembly Language Programming and their application,Interfacing to External Memory,Programming Techniques for looping, indexing,counting & bit manipulation,

Unit-III: Basic I/O Interfacing Concept:

Memory mapped I/O programmable peripherals,I/O mapped I/O programmable peripherals,Introduction to PPI 8254/8255, Architecture,Modes of operation of 8255,Interfacing of peripherals with 8255,Introduction to PIC 8259, Architecture,Modes of operation of 8259,Interfacing of peripherals with 8259,Interfacing of keyboard & 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, FFT etc.

Unit-V: Microcontroller dsPIC33EP256MC202

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.

Text Books:

1. Hall: Microprocessor & Interfacing,: Programming & Hardware; Mc-Graw Hill Books.
2. Gaonkar: Microprocessor Architecture, programming Application with 8085,penram international publishing(India)
3. Texas Instruments DSPs.
4. Bhupendra Singh Chhabra: 8086/8088 Microprocessor Architecture Programming, Design & Interfacing, Dhanpat Rai & Sons.
5. Ramakant Gaikwad: Op-amps & Linear IC's; Prentice Hall of India
6. Kenneth J. Ayala: The 8051 Microcontroller-Architecture, Programming & Application: penram international publishing(India)
7. Muhammad Ali Mazidi: The 8051 Microcontroller and Embedded Systems Using Assembly & C:Second Edition : Pearson Publication.
8. Data sheets of dspIC33EPMC202.

PGIDC104T /PGIPS104T/PGPEPS104T Elective I-(3)

Micro and Smart grid

(Common to M.Tech CBCS IDC , M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objectives:

To understand fundamental concepts of Microgrids, its Power Electronics Interface, protection and islanding issues

To understand various Power quality issues in Microgrid and introduction to smart grid technologies

To understand Renewable Energy and its storage options for smart grid technologies.

To understand smart grid measurement & communication Technology

Course Outcomes:

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

Microgrid concepts, Power Electronics interface in AC & DC microgrids, Communication infrastructure, modes of operation and control, Protection and islanding issues, etc

Power quality issues in microgrids like modeling and stability analysis, regulatory standards and economics and basic smart grid concepts

Load and generation Power flow analysis, economic dispatch and unit commitment problems and various verticals of smart grid

Smart grid communication and measurement technologies like Phasor Measurement Unit(PMU),Smart meters, Wide Area Monitoring system(WAMS) etc

Penetration of Renewable Energy Sources in smart grid and associated issues and their applications in Electric vehicles etc

Unit-I: MICROGRIDS

Concept and definition of microgrid, microgrid drivers and benefits, review of 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 islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques

Unit-II: POWER QUALITY ISSUES IN MICROGRIDS

Power quality issues in microgrids- Modeling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids.

Unit-III: INTRODUCTION TO SMART GRID

Basics of Power Systems: Load and Generation Power Flow Analysis, Economic Dispatch and Unit Commitment Problems, Smart Grid: Definition, Applications, Government and Industry, Standardization, Functions of Smart Grid Components-Wholesale energy market in smart grid-smart vehicles in smart grid.

Unit-IV: SMART GRID COMMUNICATIONS AND MEASUREMENT TECHNOLOGY

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

UNIT V - RENEWABLE ENERGY AND STORAGE

Renewable Energy Resources-Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids-PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources.

Text books/References:

1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012.

2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & sons inc, 2012.

3. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.

4. Clark W.Gellings, "The smart grid: Enabling energy efficiency and demand response", Fairmont Press Inc, 2009.

PGIDC 201T

Drives System Design

Course objective:

Study of instantaneous power in various frames of reference
Study of various DC-DC converter in CCM and DCM and the effect of variation of the controller parameters
Study on the Sine-triangle PWM scheme for a 3-phase VSI
Study on the switching and conduction power losses in generic power electronic converters

Course Outcomes:

After the completion of this course, the students shall be able to:
Understand the back ground processes related to the numerical solution used in generic simulators
Choose the numerical solver to be used for a given type of analysis
Understand the reason for convergence problems occurring during simulation and to avoid them
Simulate the behavior of Power Converters, DC and AC drive

Unit-I

Systems, Models and the Concept of State: Environment and Variables ,The State of a System, Classification of Systems , Mathematical Models of Continuous-time Linear Lumped Parameter Time-invariant Systems ,Discrete-time Systems.

Unit-II

Linear Approximation of Nonlinear Systems, Topological Models of Systems, State Diagrams, A Generalized Approach to Modelling-The Principles of Conservation and Analogy, Mechanical Systems, Electrical and Electromechanical Systems.

Unit-III

Time-domain Analysis- Input-output Approach, Discrete Signal Models, Discrete-time Convolution, Response of Linear Discrete-time Systems, Continuous (Analog) Signal Models ,Continuous-time Convolution, Response of Linear Continuous-time Systems , Convolution/Deconvolution .

Unit-IV

Time-domain Analysis: State Variable Approach, The Solution of State Equations-Discrete-time Systems, Computation of State Transition Matrix by Canonical Transformation, Computation of State Transition Matrix by Technique based on Cayley-Hamilton Theorem, The Solution of State Equations-Continuous-time Systems, Numerical Method for Solution of Continuous-time State.

UNIT-V

Modelling & Analysis Of D.C. Machines: Modeling and Analysis of Permanent-Magnet Direct-Current Generators driven by Permanent-Magnet Direct-Current Motors. Model Development and Analysis of Ward-Leonard Systems with Direct-Current Electric Machines.

Reference Books:

1) System Modelling & Analysis By I .J. Nagrath & M. Gopal :Tata Macgraw Hill.
2) Electromechanical System,Electric Machines,&Applied Mechatronics : Sergey E. Lyshevski.

PGIDC202T

A.C.Drives

Course objective:

Study of torque produced in an induction machine in *'abc'* and *'qd0'* frames of reference with sinusoidal source and with a 3-Ph VSI with V/f control.
Study on the switching and conduction power losses in generic power electronic converters
Study on the design of controllers for a V/f controlled induction motor drive with slip-compensation technique
Study of a vector controlled 3-Ph induction motor drive with three-level inverters
Study of State Space Averaging Technique.

Course Outcomes:

After the completion of this course, the students shall be able to:
Design a V/Hz controller with sine-triangle modulation for a VSI driven 3-Ph induction motor drive
Model existing and modified power converters under small signal and steady state condition
Develop power converters with better performance for challenging applications
Analyze and design power converters and feedback loops

Unit - I

Brief review of DC to AC inverter circuit, single phase and 3 phase current inverter, Load commutated inverter , AC to AC cyclo-converter

Unit – II

Speed control of 3 phase Induction Motors by AC Power controllers : Static Rotor Resistance Control Slip energy recovery schemes – Static Kramer Drive – Static Scherbius drive – closed loop control schemes using the above special control techniques

Unit – III

Speed control of 3 phase Induction motors using Voltage source inverters, Current source Inverters

Unit – IV

Voltage / Frequency Controller: Open loop speed control, closed loop speed control , low frequency performance with Increased Volts/ Hz , optimum efficiency operation

Unit – V

Speed control of 3- phase Induction motor By Vector Control methods – Basic concepts of Direct and Indirect methods of control performance and analysis of Induction motors with non – sinusoidal supply sources.

REFERENCE BOOKS:

1.S. B. Devan , G. R. Slemon , A .Straughen : Power semicondutor Drives, Wiley Interscience, 1984

2.V. Subramanian : Thyristor control of Electric Drives, Tata Mc Graw Hill, 1988

3.B. K. Bose : Power Electronics And AC Drives, Prentice Hall,1986

4.Thyristor Control of AC Motors By J .M. D. Murphy, Pargamm Press , New York

5.Control Of Electrical Drives : W. Leonhard Springer-Verlag.

7.Electrical Motors Drives (Modeling Analysis and Control) by -R. Krishnan, Practice Hall

PGIDC203T

Electrical Transportation

Course objective:

To make students understand the importance and various modes of electric transportation systems such as electric traction, hybrid vehicle and elevators etc.

To differentiate various source of energy used in transportation and their performance characteristics.

To impart knowledge about different power and energy converters.

To classify the different controls used in electric vehicles.

To demonstrate the knowledge about electric cars and elevators.

Course Outcomes:

After the completion of this course, the students shall be able to:
Select between alternative modes for electric transportation system.

Explain various types of energy storage devices and their impact on electrified transportation.

Explain various power and energy converters in transportation system.

Analyze different control systems used in electric vehicles.

Describe different characteristics of electric car and elevators

Unit 01: General Review of Transportation :

Need and importance of mobility, various modes of transportation, evolution of transportation system, Horse carriages to steam engines to internal combustion engines to electric vehicles, advantages and disadvantages of electric mobility, various application of electric mobility such as electrical traction, hybrid electric and electric vehicles, elevators, personal mobility and special applications such as wheel chairs, future concepts.

Unit 02: EV- Basic Building Blocks:

Various sources of energy used in transportation and their characteristics, Conventional vehicle power transmission systems. Energy conversions module integrations and their operation. Different types of Batteries & their operation. Types of batteries, their characteristics, charging and discharging of batteries, round trip efficiency, ability to deliver instantaneous power, load cycle and its effect on battery performance, environmental impact of batteries, power quality issues related to charging of batteries. Different load characteristics (Specifically road characteristics)

Unit 03: Power module & Energy converters):
Need for power converters, basic power electronic blocks, AC/DC, DC/DC, DC/AC modules. Types of mechanical drives, conversion of electrical energy into mechanical energy, characteristics of various types of drives, BLDC machines, AC machines, DC machines, mechanical drive / power train

Unit 04: Control system and instrumentation:
Function of instrumentation and control system, speed control, acceleration characteristics, mechanical steering versus electric steering, motion control, driverless vehicles, road safety and traffic control and monitoring, emerging trends

Unit 05: Electric cars:
Emerging trend, typical power train architecture, hybrid cars, acceleration and speed characteristics, **Traction** Introduction to Modern AC traction for high speed rail application, their control and performance under different operating conditions. Comparison of AC/DC traction. **Elevators** Load characteristics of elevator systems, Introduction to control schemes in elevators with new power-electronics controlled drives, considerations for energy efficient systems. Special vehicles, basic concepts and emerging trend .

Text Books:

1. James Larminie and John Lowry, "Electrical Vehicle" John Wiley & Sons, 2012.

2. Mark Warner, "The Electric Vehicle Conversion handbook" –HP Books, 2011.

3. Iqbal Husain, "Electric & Hybrid Vehicles-Design Fundamentals", Second edition, CRC press

4. D. A. J. Rand, R. Woods R. M. Dell, "Batteries for Electric Vehicles", New York, John Wiley and Sons.

Reference Books:

1. Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and Design", CRC Press, 2009.

2. Burch Edward P., "Electric Traction for Railway Trains" McGraw Hill, 1911.

3. H.Partab, "Modern Electric Traction"–Dhanpat Rai & Sons, 1973.

4. Barney, George C., "Elevators Technology" international Association of Elevator Engineers by Ellis Harwood, 1986.

PGIDC204T/ PGIPS204 T /PGPEPS 204T Elective III-(1)

Energy Audit and Management

(Common to M.Tech CBCS IDC , M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To understand the present scenario of energy utilization, management and corresponding ACT of regulatory commission

To understand the process billing and power factor improvements to achieve energy efficient systems.

To understand role and responsibilities as energy auditors and energy manager in industrial applications.

Course Outcome:

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

An ability to develop in depth knowledge for energy balance and understand the various acts for the same

To carry out energy audits for optimal use of energy.

An ability to understand billing process for various industrial applications and selection of the factors for better utilization of energy.

Understand energy conservation in thermal power station.

Carry out performance analysisof electrical appliances and related case studies for improvement.

Unit-I- Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance

Unit II- Energy Management & Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit Instruments energy management, Roles and responsibilities of energy Manager and Accountability, Financial analysis techniques, Financing options, Energy performance contracts and role of ESCOs. Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques energy consumption, Production, Cumulative sum of differences.

Unit III-Energy Efficiency in Electrical system: Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, Energy efficient transformers; Induction motors efficiency, motor retrofitting, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Energy efficiency measures in lighting system, Electronic ballast, Occupancy sensors, and Energy efficient lighting controls.

Factors affecting selection of DG system, Energy performance assessment of diesel conservation avenues

Unit IV:-Energy Conservation in Thermal Systems -Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler, Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery. Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria.Introduction, Mechanism of fluidized bed combustion, Advantages, Types of FBC boilers, Operational features, Retrofitting FBC system to conventional boilers, saving potential. HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of Waste heat recovery for Energy saving opportunities

Unit V: Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, Fans and pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method. Financial Analysis: simple payback period, NPV, IRR,

Text Books:

1. Handbook of Electrical Installation Practice. , By Geofry Stokes, Blackwell Science

2. Designing with light: Lighting Handbook., By Anil Valia, Lighting System

3. Energy Management Handbook., By W.C. Turner, JohnWiley and Sons

4. Handbook on Energy Audits and Management.Edited by Amit Kumar Tyagi, Tata Energy Research Institute (TERI).

5. Energy Management Principles., By C.B.Smith, Pergamon Press

6. Energy Conservation Guidebook., Dale R. Patrick, Stephen Fardo, Ray E.Richardson,Fairmont Press 7. Handbook of Energy Audits., By Albert Thumann,William J. Younger, Terry Niehus, CRC Press

PGIDC204T/ PGIPS204 T /PGPEPS 204T Elective III-(2)

Converters for Non Conventional Energy Sources

(Common to M.Tech CBCS IDC , M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To introduce to students the importance of Advanced Power for conversion of power in various forms

To understand basic operation and control of pulse-width modulated inverters (PWM).

Course Outcome:

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

An ability to develop in depth knowledge for WEC and PV based system.

An ability to develop in depth knowledge for analysis of grid connected WEC and PV system.

Able to understand the various power electronic converter topologies.

Able to use the basics of various converter topologies in the photovoltaic system operation.

Able to use the basics of various converter topologies in the wind energy conversion system.

UNIT- 1: Introduction

Wind Energy Conversion (WEC) system, Photovoltaic (PV) based Power conversion system. Introduction to converter in WEC and PV system.Modes of Operation of Converters; Grid Connection Mode, Stand-Alone Mode,Battery Charging Mode.

UNIT- 2: Analysis of Wind and PV Systems:

Standalone operation of fixed and variable speed wind energy conversion systems and solar PV system. Gridconnection Issues,operation of Grid integrated PMSG, SCIG and DFIG Based WECS.Grid Integrated solar PV system.

UNIT- 3: Converter Topologies

Topologiesfor two-Level Converter and three level converters.Modulation Strategies-Pulse WidthModulation, Carrier-Based Strategies, Space Vector Strategies.

UNIT- 4: Photovoltaic Inverter Structures

Inverter Structures Derived from H-Bridge Topology; Basic Full-Bridge Inverter, H5 Inverter (SMA), HERIC Inverter (Sunways), REFU Inverter Summary of H-Bridge Derived Topologies. Inverter Structures Derived from NPC Topology Neutral Point Clamped (NPC) Half-Bridge Inverter;NPC Inverter, Summary of NPC-Derived Inverter Topologies, Three-Phase PV Inverters, Control Structures, Conclusions and Future Trends.

UNIT-5: Converter Structures for Wind Turbine Systems

Introduction, WTS Power Configurations, Grid Power Converter Topologies; Single-Cell Voltage source converters, Multicell (Interleaved or Cascaded) converters and back to back converters, WTS Control; Generator-Side Control Grid side Control, Future trends in wind conversion system converters.

Text Books:

1. Modern Power Electronics by P.C. Sen AH Wheeler Publication
2. Power Electronics hand book By Rashid M.H. Academic Press
3. Non Conventional Energy Sources by G.D.Rai Khanna Publishers.
4. Grid Converter for Photovoltaic and Wind Power Systems by Remus Teodorescu,Marco Liserre, Pedro Rodr´ ıguez IEEE Press John Viley and Sons
5. Power Electronics Converter for Microgrids by Suleiman M. Sharkh, Mohammad A. Abusara, Georgios I. Orfanoudakis IEEE Press John Wiley and Sons
6. Power Electronics by Ned Mohan, Tora M. Udeland,William P. Robbins John Wiley and Sons
7. Non Conventional Energy Sources by B.H.Khan Mc Graw Hill

PGIDC204T Elective III-(3)

Process Control & Digital Instrumentation

Course objective:

To learn about measurements and its relation with instrumentation system

To familiarize with the concepts of design and measurement of electronic instrumentation.

To give the students a comprehension of Process Control Instrumentation Design.

To give the students a comprehension of the relation between Instrumentation and controller design in industrial applications.

To make the students able to analyze the control loops and to achieve the control actions with different Controllers

Course Outcomes:

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

Illustrate the concepts of signal integrity design issues, limitations of various measurement equipments.

Analyze various measuring techniques for various digital and analog signals.

Compare different types of Measurement protocols.

Illustrate the concepts of design and measurements of microwave, virtual and digital instrumentation

Unit I Introduction:

Process control- Design aspects, hardware & development of a mathematical model. Control strategies. Classical control approach-Transfer functions and input/output models. Modern control approach- State space model. Basic components of process control systems- Sensors, Transmitters, Control valves-Types, Control valve action, Sizing, selection of design pressure drop, Control valve gain, Flow characteristics. Feedback controllers- (P, PI, PID, PD). Digital controllers & Reset Windup.

Unit II Dynamic behavior of Process Control:

First order dynamic systems- Thermal process, Gas process, Level process, Chemical reactor & Dead time. Second order dynamic systems- Interacting & Non interacting multi-capacity stirred tank heater system. Higher order dynamic systems- Tanks in Series- Non-interacting/ Interacting system & Thermal process. Response of process control systems to different types of forcing functions.

Unit III Analysis and design of Feedback Control Systems:

Introduction to feedback control loop for Temperature control of Heat exchanger-Steady state closed loop response. Stability analysis of Feedback systems. Effect of dead time. Tuning of Feedback controllers. Design of Feedback control systems using frequency response techniques-Ziegler-Nichols tuning technique.

Unit IV Analysis and design of Advanced Control Systems:
Introduction to Computing Relays. Ratio Control- Blending Liquid Flow Process Control System. Cascade Control-Heat Exchanger Temperature Control System. Feed-forward Control-Drum Boiler, Distillation Column & CSTR.
Override and Selective Control-Temperature Control of Plug-Flow Reactor & Hot Oil System. Multivariable Process Control- Hot Oil System, Blending System, Chemical reactor, Evaporator, Paper Machine & Distillation Column. Adaptive and Inferential Control systems.

Unit V Analog and Digital Signal Conditioning:
Principles of Analog signal conditioning-Conversions, Filtering & Impedance matching, Concept of loading. Operational Amplifier circuits in Instrumentation. Principles of Digital signal conditioning- Converters (Comparators, DAC's, ADC's, Frequency-Based Converters). Data-Acquisition Systems-DAS Hardware/Software. Thermal Sensors- Metal resistance versus Temperature devices, Thermostats, Thermocouples, Bimetal Strips, Thermometers & Solid State Temperature Sensors. Mechanical Sensors- Position Sensors, Strain Sensors, Motion Sensors, Pressure Sensors & Flow Sensors. Optical Sensors-Photo detectors, Pyrometers & Optical Sources. Non-Contact type of Sensors. Final Control Operations- Analog /Digital Electrical/Pneumatic Signals, Electrical/Pneumatic/Hydraulic Actuators, Fluid valves/Mechanical/Electrical Final Control Elements.

REFERENCE BOOKS:

1. Chemical Process Control- An Introduction to Theory & Practice by- George Stephanopoulos, Prentice-Hall of India Private Limited New Delhi-2001.

2. Process Control Systems- Application, Design and Tuning- by F. G. Shinskey, Third Edition, Tata Mcgraw-Hill International Edition Singapore-1988.

3. Process Control by-Peter Harriott, Tata McGraw-Hill Publishing Co. Ltd. New Delhi-1997.

4. Principles of Process Control by D. Patranabis, Second Edition, Tata Mcgraw-Hill Publishing Co. Ltd. New Delhi-1998.

5. Process Control Instrumentation Technology by- Curtis D. Johnson, Seventh Edition, Prentice-Hall of India Private Limited New Delhi-2002.

PGOPEN 105T Open Elective II

Artificial Intelligence

(Open Elective II from Electrical Engineering Board)

Course Objectives:

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

Course Outcomes:

After the completion of this course, the students shall be able to:
Design and implement key components of intelligent agents and expert systems.
To apply knowledge representation techniques and problem solving strategies to common AI applications.
Apply and integrate various artificial intelligence techniques in intelligent system
Development as well as understand the importance of maintaining intelligent systems.
Build rule-based and other knowledge-intensive problem solvers.

Unit 01: 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

Unit 02: Classification Taxonomy of ANN:

Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules. Perceptron Models: Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem. Multilayer feed forward Neural Networks

Unit 03: Memory:

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

Unit 04: Introduction to Fuzzy Logic system:
Fuzzy versus crisp, fuzzy sets: membership function, Basic fuzzy set operations, properties of fuzzy sets, fuzzy relations. Fuzzy Control**,** Predicate logic (Interpretation of predicate logic formula, Inference in predicate logic), fuzzy logic (Fuzzy quantifiers, fuzzy Inference), fuzzy rule based system, defuzzification methods

Unit 05: Introduction to other intelligent tools:
Introduction to Genetic Algorithm: biological background, GA operators, selection, encoding, crossover, mutation, chromosome. Expert System: software architecture, rule base system.

Text Books:

1. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson Education

2. S. Rajsekaram, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis & Applications", Practice Hall India

3. James A. Anderson, "An Introduction to Neural Networks", Practice Hall India Publication

4. Mohamed H. Hassoun, "Fundamentals of Artificial Neural Network", Practice Hall India

Reference books:

1. Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, "AI Techniques in Power System", IEE London U.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

PGOPEN 105T Open Elective II

Utilization of Electrical Energy

(Open Elective II from Electrical Engineering Board)

Course Objective:

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

Course Outcome:

To select their electric drive system based on application and availability of power source.
Apply power electronics technology in efficient utilization of electrical heating
Apply power electronics technology in efficient utilization of electrical welding
Create lighting system using illumination fundamentals and various illumination Technologies.
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 flood ighting.

UNIT-V ELECTRIC TRACTION:

System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostatic braking and regenerative braking, Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves. Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and braking retardation adhesive weight and coefficient of adhesion.

TEXT BOOKS:

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

2. C.L. Wadhwa, "Generation, Distribution and Utilization of electrical Energy", New Age International (P) Limited Publishers, 3rd Edition, 2010.

REFERENCES:

1. N.V. Suryanarayana, "Utilization of Electrical Power including Electric drives and Electric traction", New Age International (P) Limited Publishers, 1st Edition,1994.

2. E. Open Shaw Taylor, "Utilization of Electric Energy", Orient Longman,1st Edition,1937.

PGOPEN 301T Open Elective IV

PLC & SCADA

(Open Elective IV from Electrical Engineering Board)

Course Objective:

To understand the present scenario of energy utilization, management and corresponding ACT of regulatory commission

Students should understand the role of automation to make the distribution system more smart, reliableand efficient. They should correlate this aspect with required modern technology of PLC basedcomponents and SCADA.

Students should deal with the all inclusive role of SCADA and PLC in real time application.

Course Outcome:

Students will take part in all sorts of PLC system.

Students will be in condition to deal with the problems of PLC programming.

They will find out the real time schedule of operation of advanced PLC function.

Students will be in condition to deal with various PLC application.

They will handle the problems related with automation and SCADA

.

Unit 01: Introduction to PLC

Role of automation in Industries, benefits of automation, Necessity of PLC, History and evolution of PLC, Definition, types, selection criterion, Overall PLC system, PLC Input and output modules (along with Interfaces), CPU, programmers and monitors, power supplies, Solid state memory , advantages and disadvantages

Unit 02: Programming of PLC

Programming equipment, Various techniques of programming, Ladder diagram fundamentals, proper construction of ladder diagram, basic components and their symbols in ladder diagram, MCR (master control relay) and control zones, Boolean logic and relay logic Timer and counter-types along with timing diagrams, shift registers, sequencer function, latch instruction Arithmetic and logical instruction with various examples

Unit 03: Advance PLC function

Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices, programming ON/OFF Inputs to produce ON/OFF outputs. Analog PLC operation, PID control of continuous processes, simple closed loop systems, problems with simple closed loop systems, closed loop system using Proportional, Integral & Derivative (PID), PLC interface, and Industrial process example.

Unit 04: Applications of PLC

PLC interface to various circuits : Encoders, transducer and advanced sensors (Thermal, Optical, Magnetic, Electromechanical, Flow, Level sensors) Measurement of temperature, flow, pressure, force, displacement, speed, level Developing a ladder logic for Sequencing of motors, Tank level control, ON OFF temperature control, elevator, bottle filling plant, car parking Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

Unit 05: SCADA Systems:

Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, Communication requirements, Desirable Properties of SCADA system, features, advantages, disadvantages and applications of SCADA. SCADA Architectures (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation (Automatic substation control and power distribution), Petroleum Refining Process, Water Purification System, Chemical Plant. Interfacing of SCADA with PLC.

Text Books:

1. Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson, 2nd Edition

2. John R. Hackworth, Frederick D., Hackworth Jr., “Programmable Logic Controllers Programming Methods and Applications”, PHI Publishers

3. John W. Webb, Ronald A. Reis, “Programmable Logic Controllers: Principles and Application”, PHI Learning, New Delhi, 5th Edition

4. Ronald L. Krutz, “Securing SCADA System”, Wiley Publications.

5. Stuart A Boyer, “SCADA supervisory control and data acquisition”, ISA, 4th Revised edition

6. Sunil S. Rao, “Switchgear and Protections”, Khanna Publications.

7. L.A. Bryan, E. A. Bryan, “Programmable Controllers Theory and Implementation” Industrial Text Company Publication, Second Edition

Reference books:

1. Batten G. L., “Programmable Controllers”, McGraw Hill Inc., Second Edition

2. Bennett Stuart, “Real Time Computer Control”, Prentice Hall, 1988

3. Doebelin E. O., “Measurement Systems”, McGraw-Hill International Editions, Fourth Edition, 1990

4. 4. Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols”, ELSEVIER

5. Krishna Kant, “Computer Based Industrial Control”, PHI

6. M. Chidambaram, “Computer Control of Process”, Narosha Publishing

7. P. K. Srivstava, “Programmable Logic Controllers with Applications”, BPB Publications

8. Poppovik, Bhatkar, “Distributed Computer Control for Industrial Automation”, Dekkar Publications

9. S. K. Singh, “Computer Aided Process Control”, PHI

10. Webb J. W, “Programmable Controllers”, Merrill Publishing Company, 1988

PGOPEN 301T Open Elective IV

Digital Control System

(Open Elective IV from Electrical Engineering Board)

Course Objective:

The course will develop the capability of analyzing the stability of a system and of designing simplecontrollers to regulate system behavior.

The course will introduce different optimization techniques to achieve desired performance.

The course will give an idea about digital controller and technique for stability analysis of Digital Control System.

Course Outcome:

Students will be able to analyze discrete time control system and signals

Students will be able to derive and design various stability techniques for improving performance of the system

Students will be able to analyze continuous time system using state space technique.

students will be able to derive and describe pole placement by state variable technique and condition for controllability and observability of the system

Students will be in condition to deal with various Digital control system applications.

Unit 01: Discrete systems and Signals

Standard discrete test signals, Basic operations on signals. Classification of discrete systems. Detail analysis of frequency aliasing & quantization, Brief review of Sampling theorem, Ideal low pass filter. Transfer function of ZOH, Frequency domain characteristics of ZOH, First order hold, frequency domain characteristics of first order hold.

Unit 02: Stability Analysis

Brief review of pulse transfer function, mapping between S-plane and Z-plane, constant frequency loci and constant damping ratio loci. Stability analysis of closed loop system in the Z-Plane. Jury's stability test, Stability analysis by use of Bilinear transformation & Routh Stability Criterion. Digital compensator design using frequency response (Bode plot).

Unit 03: State - Space analysis

Conversion of Pulse transfer functions to State space model and vice a versa. Solution of LTI Discrete –time state equation; State Transition Matrix (STM) and properties of STM; Computation of STM by Z-transform method, by power series expansion method, by Cayley Hamilton theorem, by Similarity transformation method, Discretization of continuous time state space equation.

Unit 04: Design using state space

Controllability and observability of linear time invariant discrete-data system, Tests for Controllability and obervability; Principal of Duality; Effect of pole- zero cancellation; Relationship between controllability, observability and stability. Pole placement design using linear state-feedback. State estimation and full order observer design. Ackermann's formula.

Unit 05: Digital control system applications

Hybrid system simulation, Computer program structure for simulation of discrete time control of continuous time plant. Digital temperature control, position control, Stepper motor control, Block diagram presentation and control algorithms.

Text Books:

1. K. Ogata, "Discrete Time Control System", 2nd Edition, PHI Learning Pvt. Ltd. 2009

2. B. C. Kuo, "Digital Control Systems", 2nd Edition, Oxford University Press

3. M. Gopal, "Digital Control Engineering", New Age International Publishers

4. M. Gopal, "Digital Control and State Variable Methods", 3rd Edition The McGraw Hill Co.

Reference books:

1. Load D. Landau, Gianluca Zito, 'Digital Control Systems: design, Identification and Implementation' Springer.

2. Mohammed Santina, Allen Stubberud, Gene Hostetter 'Digital control System Design', Sanders College publishing.

3. K.J. Astrom, B Wittenmark 'Computer Controlled Systems: Theory and Design' Prentice-Hall Inc New Jersey , 2011 Dover .

PGFD205T Foundation Course -I

Research Methodology

Course objective:

1. Introduction to philosophy of research.
2. Understand process to formulate research questions / idea
3. Understand process of planning of research time, resource
4. Understand different statistical analysis methods
5. Develop thesis and report writing.

Course outcome:

1. Knowledge on various kinds of research questions and research designs
2. Formulate research problems (task) and develop a sufficiently coherent research design
3. Assess the appropriateness of different kinds of research designs
4. Knowledge on qualitative, quantitative and mixed methods of research, as well as relevant ethical and philosophical considerations
5. Develop independent thinking for critically analyzing research reports

Unit 1 Research Foundation

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

Unit 2 Review of Literature

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

Unit 3 Planning of Research

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

Unit 4 Processing of Data and Statistical Analysis of Data

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

Unit 5 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, Use of LATEX Indexing of Journals, Impact factor and social Media for Researchers.

Reference Book:

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: 8184880936

6. SPSS online manual

PGFD302T Foundation Course -II

Project Planning and Management

Project Management (PM) will provide students with the opportunity to gain a systematic and comprehensive understanding of key concepts and skills essential to project management in international affairs. By examining the project cycle using potential projects, students will learn techniques and tools used in formulating and managing projects and programs for desired impact.

By course end, students will be familiar with aid and development of project works, language and terminology used, different project structures, implementation practices, and strategies to address potential conflicts and obstacles. More importantly, students will have developed skills - strategic design, needs assessment, implementation, proposal and report writing, budgeting, monitoring and evaluation, advocacy, and others - that practitioners need to be effective in a range of professional contexts.

Course Philosophy: This is a course that will utilize learning techniques to provide students with opportunities to practice and process what they learn. This course attempts to cover skills that are relevant and current in international program work.

Learning Objectives: By course end students will be able to, within the above-stated limitations:

1. Conduct a basic needs assessment for a proposed project
2. Develop a project proposal
3. Develop a logical framework
4. Develop measureable indicators
5. Have ability to insert Monitoring and Evaluation into a project
6. Develop a grant proposal
7. Develop a project budget

As part of comprehensive preparation for the subject, by end of semester students will prepare an analytical and operational concept note that demonstrates:

1. Comprehensive understanding of the *context* in which they will work, including socio-political, economic, and cultural aspects.
2. Understanding of the *issue* they will work on, the causes, and its variations across contexts.
3. Strategies that have been used to tackle the problem(s) - the usual ones, and innovative ones. Students can introduce also other possible solutions worth exploring.

Benefits

- Establish measures of success
- Quantify value commensurate with cost
- Optimize use of organizational resources
- Incorporate quality principles
- Put strategic plans into practice

- Ensure fast time-to-market Project Manager
- Reduced cost to deliver solutions
- Lower risk of slipping schedule
- Repeatable successes on projects
- Crisis prevention
- Early problem identification and risk mitigation
- Structured approach to Project Management
- More predictable results
- Improved resource productivity and satisfaction
- Project success that builds business success

Course Contents

Unit 1 : ***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 Management Philosophy, Project Management Principles

Unit 2 : Project Identification and Selection:

Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point ***Project Planning:*** Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (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 Estimate and Budgets, Cost Forecasts ***Project Risk Management:*** Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks

Unit 4 : ***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

Unit 5 : ***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 for Closing the Project, Project Termination, Project Follow-up ***Project Management Software:*** Introduction, Advantages of Using Project Management Software, Common Features Available In Most of the Project Management Software, Project 2000.

Reference Books:

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, by John W. Creswell, 3rd Edition , Sage publication, 2013.

3. Evaluation: A Systematic Approach, Peter H. Rossi, Mark W. Lipsey, and Howard E. Freeman, 7th edition , Sage publications, 2007.

4. Handbook 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. McDavid and Laura R. L. Hawthorn, Sage Publication, 2013.

6. Evaluation, Carol H. Weiss, 2nd Edition, ABE books, 1997.

7. Case Study Research: Design and Methods, Robert K. Yin, 3rd Edition, Sage Publications, 2011

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