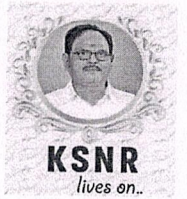

Department of Electrical and Electronics Engineering

BoS Meeting

Minutes of the Meeting

Date	03.08.2022	**Day**	Wednesday
Time	11.30 AM to 12.30 PM	**Venue**	Virtual Meeting – Google Meet Link: https://meet.google.com/aja-qetr-dkc
Dept,	9th BoS Meeting	**Convener**	Dr. K. AMARESH

Number of Participants: 13

S. No.	Name	Designation	Members	Signature	S. No.	Name	Designation	Members	Signature
1	Dr. K. Amaresh	Professor & HoD	Chairman		8	Mr. K. Kalyan Kumar	Assistant Professor	Member	
2	Mr. M. Bhaskar Reddy	Associate Professor	Member		9	Mr. P. Durga Prasad	Assistant Professor	Member	
3	Mr. K. Rama Mohan Reddy	Associate Professor	Member		10	Mr. T. Kishore Kumar	Assistant Professor	Member	
4	Dr. T. Mariprasath	Associate Professor	Member		11	Dr. N. Visali	Professor & HoD (JNTUACE, Ananthapuramu)	University Nominee	
5	Dr. M. S. Priyadarshini	Associate Professor	Member		12	Dr. G. Yesuratnam	Professor & HoD, (Osmania University)	Subject Expert	
6	Dr. C. Kumar Reddy	Associate Professor	Member		13	Dr. T. Gowri Manohar	Professor & HoD, (SV University)	Subject Expert	
7	Mrs. Saleha Tabassum	Assistant Professor	Member						

Minutes of the Meeting:

Dr. K. Amaresh welcomed all the members to the online meeting and presented the agenda of the 9th BoS meeting. The resolutions are:

S. No.	Item	Presenter and discussion	Resolution
1	B. Tech. (R20) – V and VI Semester Syllabus - Discussion on action taken report as per suggestions given by stakeholders	HoD explained in detail B. Tech. (R20UG) V and VI Semester Syllabus framed based on feedback from all stakeholders and Department Review Committee report to the BoS members and asked for valuable suggestions.	BoS members verified new courses, Value added courses, Certification Courses, Skill Courses, Employability and Entrepreneurship courses In B. Tech (R20UG) V and VI Semester syllabus, the following are the modifications: (i) In Power Electronics Lab, list of experiments to be reduced from 14 to 10. (ii) The title of LABVIEW Programming is to be changed as Advanced Programming Lab
2	M. Tech. (R22) – Course Structure and Syllabus - Discussion on action taken report as per suggestions given by stakeholders	HoD explained about M. Tech. (R22) Course Structure and Syllabus framed based on feedback from all stakeholders and Department Review Committee report to the BoS members and asked for valuable suggestions	In M. Tech (R22) I to IV Semester syllabus, the following are the modifications (i) In Power System – I Lab, four fault based experiments to be reduced to three experiments and introduce a new experiment i.e., determination of regulation of a 220KV transmission line model. (ii) In Power System Transients subject, modeling concepts should be placed in Unit V instead of Unit II.
3	Open Elective Courses and its Syllabus- Discussion on action taken report as per suggestions given by stakeholders	HoD briefed out Open Elective Courses and its Syllabus formed based on feedback from all stakeholders, action taken report and Department Review Committee inputs.	In Open Electives, the following are the suggestions given by the members (i) In Modern Control Theory, some of the topics are to be changed as per student branch perspective. (ii) MATLAB Programming title to be changed as Programming Fundamentals for Numerical Computations
4	Minor & Honor Degree Courses Structure and Syllabus	Minor & Honor Degree Courses Structure and Syllabus were explained by HoD to all members.	No changes in the Minor and Honor degree under R20 UG regulations.

5.	Any other discussion with the permission of chair	The BoS members appreciated the inputs given by Department Review Committee and valuable suggestions of stakeholders the structure and syllabus of R20UG, Minor and Honor degree, new courses, Value added courses, Certification Courses, Skill Courses, Employability and Entrepreneurship courses and R22PG,

Dr. K. Amaresh, HoD & BoS chairman of EEE department conveyed thanks to all internal and external BoS members for giving suggestions and inputs for B. Tech curriculum. As per Department Review Committee report feedback of stakeholders and suggestions given by the BoS members necessary modifications have been incorporated in the structure and syllabus of R20 – UG, R22 – PG, Minor and Honor degree.

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KSRM COLLEGE OF ENGINEERING
IDEAS TO INNOVATIONS
ESTD 1980

HOD EEE <hod.eee@ksrmce.ac.in>

9th BoS Meeting

HOD EEE <hod.eee@ksrmce.ac.in> 3 August 2022 at 10:47
To: nvisali@gmail.com, Yesuratnam Guduri <ratnamgy2003@gmail.com>, tgmanohar1973@rediffmail.com, pradeep301327@gmail.com, jkswamy@powergrid.in
Cc: Bhaskar Reddy <mbreddyeee@ksrmce.ac.in>, Ramamohan Reddy K <ramamohanreddy@ksrmce.ac.in>, Mariprasath Thenkaraimuth <mariprasath@ksrmce.ac.in>, "Dr. M S PRIYADARSHINI" <priyadarshini@ksrmce.ac.in>, Kumar Reddy Cheepati <kumarreddy.c@ksrmce.ac.in>, Saleha Tabassum <tabassum@ksrmce.ac.in>, Kalyan Kumar <kalyankumar@ksrmce.ac.in>, P Durga Prasad <durgaprasad@ksrmce.ac.in>, Kishore Kumar T <tkk@ksrmce.ac.in>

Good Morning Sir/Madam,
The 9th Board of Studies (BoS) meeting is scheduled on 04.08.2022 from 11.30 am onwards. In this context, I request all the members to make it convenient and attend the meeting without fail. The Agenda along with the syllabus are shared for your reference. I request all the members to check out once and if any changes are required, will do it on the scheduled date.
The google meet link is shared below
Thursday, August 4 · 11:30am – 12:30pm
Video call link: https://meet.google.com/aja-qetr-dkc

Thanks & Regards

Dr. K. AMARESH, M. Tech., Ph.D.,
Professor & HOD,
Department of EEE,
K.S.R.M.College of Engineering,
KADAPA - 516003.
Cell No. 9849050464
Email: hod.eee@ksrmce.ac.in (O)

6 attachments

- **Honors Degree Course (R20).docx** 64K
- **Minor Degree Syllabus (R20).docx** 52K
- **Open Electives(EEE).docx** 101K
- **V & VI Sem Syllabus.docx** 112K
- **R22 PG Syllabus.doc** 582K
- **9th BoS Meeting (04.08.22).docx** 96K

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Department of Electrical & Electronics Engineering

R20 Course Structure

V Semester (Theory - 05, Lab - 02)

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2002501	Linear Digital IC Applications	PCC	3	0	0	40	60	3
2	2002502	Power System - II	PCC	3	0	0	40	60	3
3	2002503	Power Electronics	PCC	3	0	0	40	60	3
		Open Elective Course - I (OEC - I)							
4	20OE501	Data Structures	OEC	3	0	0	40	60	3
	20OE502	Data Base Management Systems	OEC	3	0	0	40	60	3
		Professional Elective Course - I (PEC-I)							
5	2002504	Internet of Things	PEC	3	0	0	40	60	3
	2002505	Modern Control Theory	PEC	3	0	0	40	60	3
	2002506	Energy Conversion Systems	PEC	3	0	0	40	60	3
6	2002507	Power Systems - I Lab	PCC	0	0	3	40	60	1.5
7	2002508	Internet of Things Lab	PCC	0	0	3	40	60	1.5
8	2025509	Soft Skill Oriented Course	SC	1	0	2	40	60	2.0
9	2002510	Community Service Project	ROJ	0	0	3	100	00	1.5
10	20MC512	Constitution of India	MC	2	0	0	40	00	00
		Total		18	00	1	460	480	21.5

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VI Semester (Theory - 05, Lab - 02)

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2002601	Microprocessor & Microcontrollers	PCC	3	0	0	40	60	3
2	2002602	Fundamentals of Electric Drives	PCC	3	0	0	40	60	3
3	2002603	Switchgear & Protection	PCC	3	0	0	40	60	3
		Open Elective Course –II (OEC- II)							
4	20OE2603	Employability Skills	OEC	3	0	0	40	60	3
	20OE2604	Effective Technical Communications	OEC	3	0	0	40	60	3
		Professional Elective Course - II (PEC-II)							
5	2002604	Power System Operation & Control	PEC	3	0	0	40	60	3
	2002605	HVDC Transmission	PEC	3	0	0	40	60	3
	2002606	Signals & Systems	PEC	3	0	0	40	60	3
6	2002607	Power Electronics Lab	PCC	0	0	3	40	60	1.5
7	2002608	Power System- II Lab	PCC	0	0	3	40	60	1.5
8	2004609	LABVIEW Programming	ESC	0	0	3	40	60	1.5
9	2002610	Skill Advanced Course	SC	1	0	2	40	60	2.0
10	20MC612	Management Organizational Behavior	MC	2	0	0	40	00	00
		Total		18	00	11	440	540	21.5

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V - SEMESTER

Course Title	Linear and Digital IC Applications					B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2002501	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the Op-Amps, Timers and PLLs, applications of Op-Amps, Introduce **Verilog** and its language elements to design digital systems, Design of different combinational and sequential digital circuits.

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

CO 1	Understand the operation and characteristics of OP-AMPs
CO 2	Analyze multi vibrator circuits and 555 timers using OP-AMPs
CO 3	Apply PLL in various Communication applications
CO 4	Compare various digital logic families
CO 5	Simulate digital logic circuits using **Verilog** HDL

UNIT-I

Op-Amp & its Characteristics : Integrated circuits -types, classification, package types and temperature ranges, power supplies, OP-Amp Block diagram, ideal and practical OP-Amp specifications, DC and AC characteristics, 741 OP-Amp and its features, Inverting and non-inverting amplifier.

UNIT-II

Op-Amp Applications: Integrator and differentiator, difference and instrumentation amplifier, AC amplifier, V-I, I-V converters, comparators, Multivibrators, Triangular and square wave generators, Log and antilog amplifiers, precision rectifiers.

UNIT-III

Timers & Phase Locked Loops: Introduction to 555 Timer, functional diagram, Monostable and Astable operations, Schmitt Trigger, PLL-Introduction, Block schematic, principles and description of individual blocks, 565 PLL, applications.

UNIT–IV

Unipolar & Bipolar Logic Families: Introduction to logic families, CMOS logic, CMOS steady state electrical behavior, CMOS dynamic state electrical behavior, CMOS logic families, Bipolar logic, transistor logic, TTL families, CMOS/TTL interfacing, ECL, Comparison of logic families.

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UNIT–V

Verilog HDL & Design Examples: HDL basedDesign flow, Program Structure, Logic system, Nets, Variables and Constants, Vectors and Operators, Arrays, Logical Operators and Expressions. Structural design elements, data flow design elements, behavioral design elements (procedural code). Designusing basic gates,Decoders, Encoders, Multiplexers and Demultiplexers. Adders, Subtractors, SSI Latches and Flip-Flops, Counters, Design of Counters and Shift Registers .**Verilog** Modules for the above ICs.

Text Books

1. Ramakanth A. Gayakwad, "Op-Amps & Linear ICs", 4th edition, PHI, 1987.
2. John F. Wakerly, "Digital Design Principles & Practices" PHI/Pearson Education Asia, 4th Edition, 2008.
3. J. Bhasker, "A Verilog HDL Primer", Star Galaxy Publishing; 3rd edition (January 31, 2005)

References

1. D. Roy Chowdhury, "Linear Integrated Circuits", New Age International (P) Ltd, 2nd Edition, 2003.
2. James M.Fiore, "Operational Amplifiers & Linear integrated circuits & applications", Cengage 2009.
3. Fundamentals of Digital Logic with Verilog Design – Stephen Brown, Zvonko Vranesic, TMH, 3rd Edition, 2014

Course Title	Power Systems - II				B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002502	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn transmission line performance, per unit system, fault analysis on transmission and iterative methods.

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

CO 1	Understand various transmission lines, the formulation of impedance and admittance bus matrices for a power system network, symmetrical and unsymmetrical faults, importance of power flow studies.
CO 2	Evaluate the performances of transmission lines and Y_{bus} for a given power system network
CO 3	Analyze per unit quantities and fault calculations for various types of faults
CO 4	Investigate the load flow studies using different iterative techniques

UNIT - I

Performance of Transmission Lines: Classification of transmission lines – short, medium and long line and their model representation – estimation of regulation and efficiency by nominal T, nominal π and rigorous methods - problems. equivalent T and π, surge impedance loading, Ferranti effect.

UNIT - II

System Modeling: Representation of power system components– per unit representations and advantages – single line diagram representation – impedance and reactance diagram – changing the base of per unit quantities.

UNIT - III

Symmetrical Fault Studies: Introduction to symmetrical fault analysis – short circuit capacity of a bus – the short circuit currents and the reactance of synchronous machines – internal voltages of loaded machines under transient conditions – expressions for fault MVA in terms of per unit and percentage quantities – need for current limiting reactors and their location.

UNIT - IV

Unsymmetrical Fault Studies: Symmetrical components – phase shift of symmetrical components in star-delta transformer banks – power in terms of symmetrical components – sequence impedances and sequence networks of synchronous machines, transmission lines, transformers – zero sequence networks of 3 Φ transformer banks – unsymmetrical fault analysis on unloaded generator and on power systems with and without fault impedance.

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UNIT - V

Load Flow Studies: Need for load flow studies in a power system – formation of bus admittance matrix – classification of types of buses in a power system – formulation of load flow equations – Gauss-Seidel iterative method for load flow studies – treatment of pv bus – acceleration factors – problems (sample one iteration only), Newton - Raphson method in rectangular and polar coordinates – formulation of load flow solution with or without pv buses – derivation of Jacobian elements, algorithm and flowchart.

Text Books:

1. Elements of power system analysis, William. D. Stevenson, 4th Edition Jr., MGH
2. Modern Power System Analysis by I. J. Nagarath & D. P. Kothari, TMH, 2nd Edition.
3. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar, Chakrabarti, Dhanpat Rai & Co Pvt. Ltd., 2003.

Reference Books:

1. Electrical power systems by C. L. Wadhwa, New Age International publications.
2. A course in Power Systems by J. B. Gupta, S. K. Kataria & Sons, 11th Edition, 2013.
3. Power System Analysis by T.K. Nagsarkar, MS. Sukhija, Oxford University Press, 2nd Edition, 2014.

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Course Title	Power Electronics				B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002503	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the basic concepts of power semiconductor devices, converters, choppers, inverters and their analysis.

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

CO 1	Understand the static and dynamic characteristics of SCR and their commutation circuits.
CO 2	Acquire knowledge about fundamental concepts and techniques used in power electronics converters
CO 3	Evaluate the solution to numerical problems on AC-DC converters.
CO 4	Analyze the operation of AC-AC regulators.
CO 5	Analyze the voltage control strategies of choppers and Inverters

UNIT - I

Silicon Controlled Rectifier: Static characteristics –turn on and off mechanism – gate characteristics – dynamic characteristics – series and parallel operation of SCRs – static and dynamic equalization circuits – design of snubber circuit – line commutation and forced commutation circuits.

UNIT - II

Phase controlled Rectifiers: single phase fully controlled converters – midpoint and bridge connections with R and RL loads-Derivation of average and RMS values of load voltage, single phase half controlled converters – with R and RL loads-Derivation of average load voltage and current– effect of source inductance- Single Phase Dual converter, Three phase half and fully controlled converters with R load-Derivation of average and RMS values of load voltage- numerical problems.

UNIT - III

AC Voltage Controllers: Single phase AC voltage controller for R and RL load Derivation of RMS output voltage, AC voltage controller using TRIAC.

Cyclo Converters: Single phase step-down Cyclo Converters with midpoint and Bridge type configurations for R and RL load- Single phase step-up Cyclo Converters with midpoint and Bridge type configurations for R and RL load (Only operation and Waveforms).

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UNIT - IV

Choppers: Introduction-principle of Step-down and Step-up Chopper-Derivation of load voltage and Current-Time ratio control and Current limit control strategies–first quadrant chopper-second quadrant chopper- Steady state time domain analysis of first quadrant choppers for RLE –Two quadrant Choppers-Four quadrant chopper (principle of operation only).

UNIT - V

Inverters: single phase bridge inverter – Half and Full bridge inverters – voltage control in single phase inverters –Three Phase Inverters- Three phase 180-degree Mode VSI-Three phase 120-degree Mode VSI, Pulse width modulation techniques: single PWM-multiple PWM-SPWM

Text Books

1. Power Electronics – By M.D Singh & K.B. Kanchandhani, Tata McGrawHill Publishing Company, 1998.
2. Power Electronics - Circuits, Devices and Applications – by M.H. Rashid, Prentice Hall of India, 2nd Edition 1998.
3. Power Electronics- by PS Bimbhra, Khanna Publications.
4. Thyristorised Power Controllers – By G.K. Dubey, S. R. Doradla, A. Joshi and R. M. K. Sinha, New Age Informational(p) Limited Publishing 1996.

Reference Books

1. Power Electronics – By Vedam Subramanyam, New Age Information Limited, 3rd Edition.
2. Power Electronics – By V.R. Murthy, Oxford University Press, 1st Edition – 2005
3. Power Electronics – By P.C Sen, Tata Mc Graw Hill Publishing.
4. Thyristorised Power Controllers – By G.K. Dubey, S. R. Doradla, A. Joshi and R. M. K. Sinha, New Age Informational(p) Limited Publishing 1996.

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Course Title	Internet of Things (PE- I)				B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
2002504	Professional Elective Course (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M					End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the basic concepts of Internet of Things and its applications.

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

CO 1	Understanding IoT technology
CO 2	Learning basic IoT Elements
CO 3	Understanding basics of python programming
CO 4	Working with Arduino and Raspberry pi board

UNIT-I

Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT-Things in IoT,IoT Protocols, Logic Design of IoT-Functional Blocks, Communication Models, IoT Enabled Technologies-Wireless Sensor Networks, Communication protocols, Embedded Systems, IoT Levels and Templates

UNIT-II

Elements of IoT: What is an IoT Device, Basic Building blocks of an IoT Device, Sensors, Actuators, Details of Arduino-About Board Peripherals, Details of Raspberry Pi-About Board Peripherals.

UNIT-III

Logic Design: Introduction to Python, Python Data Types-Numbers, Strings, Lists, Tuples, Dictionaries, Type Conversions, Control Flow, Functions, Modules

UNIT-IV

IoT Application Development: Programming Arduino- Controlling LED, Interfacing an LED and Switch, Interfacing a Light Sensor. Programming Raspberry Pi- Controlling LED, Interfacing an LED and Switch, Interfacing a Light Sensor.

UNIT-V

Case Studies of IoT: Smart Lighting, Smart Irrigation, Weather Monitoring System, Smart Parking

Text Books:

1. "Internet of Things a Hand on Approach" by Arshdeep Bahga,Vijay Madisetti, Universities Press.
2. "Getting Started with the Internet of Things" by Cuno Pfister,o' REYLLY.

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Course Title	Modern Control Theory (PE - I)				B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002505	Professional Elective Course (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: Students are able to learn the State Space, Describing function, phase plane and stability analysis including controllability and observability.

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

CO 1	Understand the concept of State techniques
CO 2	Analyze the stability of linear and nonlinear Systems describing functions for different nonlinearities
CO 3	Construct the state model of linear time invariant systems and liapunov functions for nonlinear systems
CO 4	Determine Eigen values state transition matrix examine the controllability and observability of linear time invariant systems
CO 5	Design compensators controllers state feedback controller and observer

UNIT – I

Linear System Design:Introduction of compensating networks – Lead, Lag, lead – lag cascade compensation in time domain –P, PI and PID controllers design using bode plot and root locus techniques.

UNIT – II

State variable descriptions: Concepts of state, state variables, state vector, state space model, representation in state variable form, phase variable representation – solution of state equations – state transition matrix.

UNIT – III

Controllability and Observability: Definition of controllability – controllability tests for continuous linear time invariant systems – Definition of observability – observability tests for continuous linear time invariant systems, diagonalization – canonical variable representation.

UNIT – IV

Design of Control Systems: Introduction, Pole placement by state feedback, Full order and reduced order observers.

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UNIT – V

Stability: Introduction, equilibrium points – stability concepts and definitions – stability in the sense of liapunov stability of linear system – methods of constructing liapunov functions for non – linear system – krasovskii's method – variable gradient method.

Text Books

1. Modern Control System Theory by M. Gopal, New Age International Publishers, 2nd edition, 1996.
2. Control System Engineering by I. J. Nagarath and M. Gopal, New Age International (P) Ltd.

Reference Books

1. Modern Control Engineering by K. Ogata, Prentice Hall of India, 3rd Edition, 1998.
2. Systems and Control by Stainslaw, H. Zak, Oxford Press, 2003.
3. Digital Control and State Variable Methods by M. Gopal, TMH, 1997.

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Course Title	Energy Conversion Systems (PE-I)				B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002506	Professional Elective Course (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn about energy conversion techniques, sources of electrical energy production and impact of energy conversion systems on the environment.

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

CO 1	Understand the principles and applications of various non-conventional energy systems and energy storage
CO 2	Analyze the properties and characteristics of wind, turbines and generators used in tidal power
CO 3	Analyze the solar cell operation and its test specifications
CO 4	Analyze the impact of energy conversion systems on the environment and remedial measures

UNIT- I

Photovoltaic Power Generation: Spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, test specifications for PV systems.

UNIT -II

Wind Energy Conversion: Power from wind, properties of air and wind, types of wind Turbines, operating characteristics.

UNIT- III

Tidal Power Station: Tides and tidal power stations, modes of operation, tidal project examples, turbines and generators for tidal power generation.

Ocean Energy Conversion: Types of ocean thermal energy conversion systems, Application of OTEC systems examples.

UNIT- IV

Miscellaneous Energy Conversion Systems: biomass conversion, geothermal energy, thermoelectric energy conversion, principles of EMF generation, description of fuel cells. Types of fuel cells, H_2-O_2 Fuel cells, Application of fuel cells – Batteries, Description of batteries, Battery application for large power.

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UNIT -V

Environmental Effects: Environmental Effects of energy conversion systems, pollution from coal and preventive measures, steam stations and pollution, acid rain, pollution free energy systems and nuclear power station pollution.

Text Books

1. "Energy conversion systems" by Rakosh das Begamudre, New age international Private Ltd., publishers, 1st Edition, 2000.
2. "Renewable Energy Resources" by John Twidell and Tony Weir, CRC Press (Taylor & Francis).

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Course Title	Power Systems - I Lab				B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002507	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3	1.5	40	60	100
						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to determine the sequence impedances of alternators and transformers, study the faults on an unloaded synchronous machine, characteristics of relays and simulate the power flows

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

CO 1	Evaluate sequence Impedances of 3 Phase Alternator and Transformers.
CO 2	Compare the fault Currents for different faults on unloaded Synchronous Generators.
CO 3	Analyze the Characteristics of Relays
CO 4	Estimate the line parameters of a transmission line

List of experiments (Any Eight)

1. Power Angle Curve of a synchronous Generator
2. Determination of sequence reactance of 3-Φ Alternator
3. Determination of sequence impedance of 3-Φ Transformer
4. Operating Characteristics of Over Current-Relay
5. Operating Characteristics of Over/Under Voltage-Relay
6. Operating Characteristics of Differential Relay
7. Ferranti effect, Surge impedance loading and ABCD parameters of 220kV transmission line
8. Symmetrical Fault Analysis (LLL) at the Terminals of an Unloaded 3-Φ Alternator
9. Single Line to Ground Fault and Line to Line Fault with and without impedance at the Terminals of an Unloaded 3-Φ Alternator
10. Double line to Ground Fault with and without impedance at the Terminals of an Unloaded 3-Φ Alternator

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Course Title	Internet of Things (IoT) Lab				B. Tech. V Semester (EEE)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002508	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3	1.5	40	60	100
						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the basics of Arduino/ Raspberry Pi, Sensors, Actuators and design applications relevant to the IoT Technologies

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

CO 1	Understand the Concepts of IoT
CO 2	Understand Software and Hardware skills of Arduino / Raspberry Pi
CO 3	Able to Develop the C/Python Programming on Arduino / Raspberry Pi
CO 4	Design Simple Applications of IoT

List of Experiments (Any Eight)

1. To interface LED,s with Arduino / Raspberry Pi and write a program to build a Binary Counter.
2. To interface Push button with Arduino / Raspberry Pi and write a program to turn ON/OFF LED when push button is pressed .
3. To interface Potentiometer with Arduino / Raspberry Pi and write a program to Create Dimmable LED.
4. To interface LDR with Arduino / Raspberry Pi and write a program to turn ON RGBLED to get Mixing Primary Colours.
5. To interface IR Sensor with Arduino / Raspberry Pi and write a program to turn ON LED when sensor detects an object.
6. To interface an Ultrasonic Sensor with Arduino / Raspberry Pi and write a program to Measure how much is the distance of the object from the Sensor on LCD Display.
7. To interface a Servo motor with Arduino / Raspberry Pi and write a program to rotate the Servo motor.
8. To interface OLED with Arduino / Raspberry Pi and write a program to print LED ON/OFF.
9. To interface BULB using relay with Arduino / Raspberry Pi and write a program to turn ON/OFF the Bulb.
10. To interface a DHT11 sensor with Arduino / Raspberry Pi and write a program to print temperature and humidity readings.
11. To interface Bluetooth with Arduino / Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from a smartphone using Bluetooth.

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12. Write a program on Arduino / Raspberry Pi to upload temperature and humidity data to ThingSpeak cloud.

Reference Books

1. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
2. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
3. Adrian McEwen, "Designing the Internet of Things", Wiley
4. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

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Course Title	Community Service Project				B. Tech. V Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002510	PROJ	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		--	--	3	1.5	100	--	100
Course Objective: The objective of the project is to enable the student to take up investigative study for social relevance.								
On successful completion of this course, the students will be able to								
CO 1	Understand core concepts and research findings relative to human development, socialization, group dynamics and life course processes.							
CO 2	Identify and transfer existing ideas into new contexts and applications							
CO 3	Apply and transfer academic knowledge into the real-world.							
CO 4	Design a component or a product applying all the relevant standards and with realistic constraints							

The following are the rules and regulation for **Community Service Projects:**

1. The student has to spend 50 to 60 Hrs in the semester on any project (Social Relevance) and submit a report for evaluation.
2. The project is evaluated for 100 marks in the semester by a committee consisting of head of the department, project mentor and one senior faculty member of the department.
3. A student shall acquire 1.5 credits assigned, when he/she secures 50% or more marks from the total of 100 marks.
4. In case, if a student fails, he/she shall resubmit the report.
5. There is no external evaluation for the socially relevant project.

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Course Title	Constitution of India				B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20MC512	Mandatory Course (MC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	0	40	00	30
Mid Exam Duration : 1Hr30M							

Course Objectives: The main objective of the course is to learn

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik.
4. Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

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

CO 1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO 2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO 3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO 4	Discuss the passage of the Hindu Code Bill of 1956.

UNIT - I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working), Philosophy of the Indian Constitution: Preamble Salient Features.

UNIT - II

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT - III

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

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UNIT - IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati raj: Introduction, PRI: Zila Panchayat., Elected officials and their roles, CEO Zila Panchayat: Position and role.

Block level: Organizational Hierarchy (Different departments),

Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT - V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners.

State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Reference Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

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VI SEMESTER

Course Title	Microprocessors & Microcontrollers				B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002601	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	--	--	3	40	60	100
Mid Exam Duration : 1Hr30M					End Exam Duration: 3Hrs			

Course Objectives: The objective of the course is to learn 8086 Microprocessor and 8051 Microcontroller Architecture, Instructions, Operating Modes and Programming, 8086 microprocessor and 8051 microcontroller for various applications and to study various peripherals for microprocessor based systems.

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

CO 1	Define various components and list out various features of microprocessor, microcontroller and peripherals.
CO 2	Describe the internal block diagram of microprocessor, microcontroller and peripherals, addressing modes, instruction set and data transfer schemes.
CO 3	Develop algorithm and assembly language programs to solve problems.
CO 4	Apply an appropriate algorithm, program and peripheral for the application.
CO 5	Design the microprocessor or microcontroller based system to solve real time problems. (Prepare a case study model to get a first prototype)

UNIT - I

Introduction to Microprocessors: 8085 Microprocessor - Architecture,Instruction set, Addressing modes, Basic Timing Diagrams, Interrupts and Simple Programs.

8086 Microprocessor - Architecture, Instruction set,Addressing modes, Interrupt system. Pin diagram, Minimum mode 8086 system and timings, Maximum mode 8086 system and timings.

UNIT - II

Assembly Language Programming: Assembler directives, Assembly language programs (8086) withAssembler directives for addition, subtraction, multiplication, division etc., sorting and searching, bit manipulation, look-up tables, string manipulations, Macros and Delay subroutines.

Data transfer schemes and Memory Interfacing: Synchronous, Asynchronous, Interrupt driven and DMA type schemes, Address decoding techniques, Interfacing Static RAM and ROM chips.

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UNIT - III

Peripheral Interfacing: 8255 PPI and its interfacing, Programmable Communication Interface (8251 USART) and its interfacing, Programmable Interval Timer (8254) and its interfacing, Programmable interrupt controller (8259) and its interfacing, Programmable DMA controller (8257) and its interfacing, ADC and DAC Interfacing.

UNIT - IV

The 8051 microcontroller: Architecture, pin diagram, memory organization, external memory interfacing, stack, addressing modes, instruction set, Assembler directives, Assembly Language programs and Time delay Calculations, 8051 interrupt structure, 8051 counters and Timers, programming 8051 timers.

UNIT - V

Introduction to ARM: ARM Design philosophy, Registers, Program Status Register, Instruction pipeline, Interrupts and vector table, Instruction Set- Data Processing Instructions, Branch, Load-Store, Software interrupt, PSR instructions, Conditional instructions, Thumb instruction Set: Register Usage, Single-Register and Multi Register Load-Store Instructions.

Text Books:

1. Ramesh S. Gaonkar, "Microprocessor architecture, programming and its applications with 8085", Penram International Publications, 4th Edition.
2. A. K. Ray and K.M. Bhurchandi, "Advanced Microprocessors and Peripherals", TMH.
3. The 8051Microcontroller and Embedded Systems, Mazidi Muhammad Ali, Mazidi Janice Gillespie & McKinlay Rolin D, 2nd Edition, Pearson Education, 2008.
4. The 8051 microcontroller: Architecture, Programming & Applications, Kenneth J Ayala, penram publications, 2nd edition.

Reference Books:

1. Douglas V. Hall, "Microprocessors and Interfacing: Programming and Hardware", 2nd Edition, Tata McGraw-Hill.
2. Barry B. Brey, "The Intel Microprocessors-Architecture, Programming and Interfacing", 8th Edition, PHI.
3. Y. Liu and Glenn A. Gibson, "Microcomputer Systems: 8086/8088 Family Architecture, Programming and Design", 2nd Edition, PHI.
4. Microcontrollers Architecture, Programming, Interfacing and System Design – Raj Kamal, Pearson Education, 2005.

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Course Title	Fundamentals of Electric Drives					B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2002602	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn various speed control methods of AC & DC drives fed from power converters, multi-quadrant operation of drives and conservation of energy in electrical drives.

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

CO 1	Understand block diagram and dynamics of electrical drives
CO 2	Acquire the knowledge of power electronic converters and their control to AC and DC machines.
CO 3	Analyze the working operation and solution to numerical problems of the drives and machines.
CO 4	Apply the acquired knowledge in implementation and choosing of power electronic converters to their relevant motors
CO 5	Understand energy conservation in electrical drives with the usage of efficient motors and converters

UNIT – I

Electrical Drives: Introduction – Electrical Drives, Advantages of Electrical Drives, Block Diagram of Electrical drives – status of dc and ac drives.

Dynamics of Electrical Drives: Fundamental Torque Equation, Speed-Torque Convention and multi quadrant operation, loads with rotational motion, loads with translational motion, measurement of moment of inertia, components of load torques, Nature and classification of load torques.

UNIT – II

Control of Electrical DC-Drives –Modes of operation, speed control and drive classifications, closed loop control of drives.

D.C. Motor Drives: Speed control, Armature voltage control, and Controlled rectifier fed DC drives 1-Φ and 3-Φ fully controlled and half controlled converter fed separately Excited D.C. Motor (discontinuous and continuous mode), chopper controlled DC drives (separately Excited motor)- Braking Methods.

UNIT – III

Control of Induction Motor from Stator Side: Variable voltage Characteristics-Control of Induction Motor by Ac Voltage Controllers – Waveforms – speed torque characteristics.

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Variable frequency and Variable voltage control of induction motor by Voltage source inverter.Closed loop operation of induction motor drive (Block Diagram Only)
Control of Induction Motor from Rotor Side: Static rotor resistance control – Slip power recovery – Static Scherbius drive – Static Kramer Drive – their performance and speed torque characteristics

UNIT – IV

Synchronous Motor Drives –Cylindrical rotor wound field motor-salient pole wound filed motor- Torque Expression – self-controlled synchronous motors employing load commutated Thyristor inverter, self-controlled synchronous motors employing Cycloconverter, Brushless DC motor Drives – BLDC for servo applications.

UNIT – V

Energy Conservation in Electrical Drives – Losses in Electrical Drive System, Measures of energy conservation in Electrical drives, use of efficient Converters, Energy Efficient operation of drives, improvement of P.F.- improvement of quality of supply- maintenance of motors.

Text Books

1. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publications
2. Power Electronic Circuits, Devices and Applications by M. H. Rashid, PHI

Reference Books

1. Power Electronics by M.D. Singh and K. B. Khanchandani, TMH, 1998.
2. Modern Power Electronics and AC Drives by B. K. Bose, PHI.
3. Thyristor Control of Electric Drives by VedamSubramanyam, TMH
4. Analysis of Thyristor Power Conditioned Motors by S. K. Pillai, Universities Press, 1st edition.

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Course Title	Switchgear & Protection				B. Tech. VI Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
2002603	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	30	70	100
Mid Exam Duration : 1Hr30M					End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to learn about the different types of electromagnetic relays and microprocessor based relays, protection of Generators, Transformers, feeders and lines, Generation of over voltages and protection from over voltages, The technical aspects involved in the operation of circuit breakers.

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

CO 1	Identify the Main Components And Features Of A Protection System
CO 2	Understand Fault Clearing Phenomena And Feasibility Protection Systems Needed For Power System
CO 3	Understand Construction And Working Of Various Types Of Circuit Breakers And Relays
CO 4	Applying Conventional And Numerical Relays The Protection Of Rotating Machines Bus bars Transformers Transmission Lines And Distribution Networks

UNIT-I

Over Voltages in Power Systems: Cause of over voltages, protection against lightning over voltages, ground wires, counterpoises, surge absorbers and surge diverters ,lightning arresters(valve type),ratings of Lightning arresters, insulation coordination, neutral earthing-types.

UNIT-II

Circuit Breakers: Elementary principles of arc interruption, restriking and recovery voltages, average and maximum RRRV, numerical problems. Current chopping and resistance switching-circuit breaker ratings, auto reclosure and problems. Description and operation of minimum oil circuit breakers, air break circuit breakers, vacuum circuit breakers and sulphur hexafluoride circuit breakers.

UNIT-III

Protective Relays: Basic requirements of relays, relay terminology, types of relays, electromagnetic relays (attraction type and induction type). Construction and operation of non-directional and directional over current relays, universal torque equation, operating characteristics of impedance, reactance and admittance relays. Principle and operation of differential and percentage differential relays.

Static Relays: Advantages and Dis-advantages, amplitude comparators and phase comparators.

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UNIT-IV

Protection of Generators: protection of generators against stator faults, rotor faults and abnormal running conditions, restricted earth fault protection and inter turn fault protection, numerical problems on percentage winding unprotected.

Protection of Transformers: Percentage differential protection of transformers, numerical problems on design of CT's ratio, Buchholz relay.

UNIT-V

Protection of Feeders and Lines: Protection of feeders (radial and ring main) using over current relays, protection of transmission lines by three zone protection using distance relays, carrier current protection and protection of bus-bars.

Text Books:

1. Power System Protection and Switchgear by Badriram & D. N. Vishwakarma, TMH Publishing Company Ltd., 1995.
2. Electrical Power Systems by C. L. Wadhwa, New Age International (P) Limited, 3rd Edition.

Reference Books:

1. Fundamentals of Power System Protection by Y. G. Paithanakar and S. R. Bhide, PHI, 2nd Edition.
2. Power System Protection and Switchgear by Bhuvanesh Oza, TMH, 2010.

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Course Title	Power System Operation & Control (PE – II)					B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2002604	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn steady state and transient stability analysis, economic operation of power systems, hydrothermal scheduling, modeling of governor, generator, single area and two area load frequency control.

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

CO 1	Analyze the stability of the power system under different operating conditions
CO 2	Understand optimal operation of thermal unit, hydrothermal scheduling and modeling of power system components for LFC studies.
CO 3	Analyze economic operation criteria of thermal unit, hydrothermal units, modeling of turbine and governor.
CO 4	Analyze load frequency control parameters in single and two area systems.
CO 5	Design suitable controllers to improve LFC dynamics in single and two area power systems.

UNIT I

Stability Studies: Classification of stability studies – the power flow equations of wound rotor and salient pole synchronous machine connected to an infinite bus through a transmission system – power angle diagrams – steady state stability and limits.

Transient Stability Analysis: General considerations and assumptions –inertia constant, derivation of swing equations, equal area criterion – application of equal area criterion to a) sudden increase in input b) sudden three phase fault on one of the lines of a transmission system – determination of critical clearing angle – clearing time- – limitations of equal area criterion, methods for improving power system stability.

UNIT II

Economic Operation: Optimal operation of thermal power units, - heat rate curve – cost curve–incremental fuel and production costs, input-output characteristics, optimum generation allocation with line losses neglected. Optimum generation allocation including the effect of transmission line losses – loss coefficients, general transmission line loss formula.

UNIT III

Hydrothermal Scheduling: optimal scheduling of hydrothermal system: hydroelectric power plant models, scheduling problems- short term hydrothermal scheduling problem.

Modeling of Turbine: First order turbine model, block diagram representation of steam turbines and approximate linear models.

Modeling of Governor: Mathematical modeling of speed governing system , derivation of small signal transfer function – block diagram.

UNIT IV

Load Frequency Control - I: Necessity of keeping frequency constant, definitions of control area, single area control, block diagram representation of an isolated power system, steady state analysis dynamic response, uncontrolled case.

UNIT V

Load Frequency Control-II: Load frequency control of two -area system – uncontrolled case and controlled case, tie-line bias control, proportional plus integral control of two area and its block diagram representation, steady state response, load frequency control and economic dispatch control.

Text Books

1. Electrical Power Systems by C.L. Wadhwa, New Age International Publishers, 6th Edition,
2. Power System Analysis Operation and Control by A. Chakravarthy and S. Halder, 3rd Edition, PHI, 2012.
3. Modern Power System Analysis by I. J. Nagrath & D. P. Kothari, Tata Mc Graw – Hill Publishing Company Ltd, 2nd Edition, 2003.
4. Power Systems Analysis and Stability by S.S.Vadhera, Khanna Publications.

Reference Books

1. Power System Analysis and Design by J. Duncan Glover and M.S. Sharma., THOMSON, 3rd Edition, 2008.
2. Electric Power Systems by S. A. Nasar, Schaum Outline Series, Revised 1st Edition, TMH, 2005.

Course Title	High Voltage DC Transmission (PE-II)					B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2002605	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the student is to student able to learn fundamental concepts of HVDC, mainly focus on converter configuration and analysis for the application of High voltage transmission systems

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

CO 1	Understand various converter and Inverter circuits
CO 2	Analyze the applications of high voltage transmission system along with types of DC links
CO 3	Apply various protection system for HVDC transmission
CO 4	Understand the use of filters for DC transmission

UNIT-I

HVDC Power Transmission Technology: Introduction- Comparison of AC & DC transmission, Converter station, Description of DC Transmission systems, Choice of voltage level, Modern trends in DC transmission.

UNIT-II

Analysis of HVDC Converters: Pulse number, Choice of converter configuration, valve rating, Transformer, Simplified analysis of graetz-circuit with and without overlap, Rectifier and Inverter waveforms, Converter bridge characteristics.

UNIT – III

Converter and HVDC System Control: Principle of DC link control, Converter control characteristics, System and control hierarchy, Firing angle control, Converter and excitation angle control, Starting and stopping of DC Link , Power Control, Higher level Controllers.

UNIT – IV

Converter Faults: Protection against over currents, over voltages in a converter station, Surge arresters, Protection against over voltages. Smoothing reactor, DC Line, Transient over voltages in DC line, Protection of DC Line, DC breakers.

UNIT – V

Reactive Power Requirements in Steady State: Sources of reactive power, Static var systems, generation of Harmonics, Design of AC filters, DC filters, Carrier frequency and RI Noise.

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Text Books

1. High Voltage Direct Current Transmission by J. Arilliga 2nd edition, IEE Power and Energy Series.
2. High Voltage Direct Current Transmission by K. R. Padiyar, Wiley Eastern Ltd.,1993.
3. Direct current transmission by E. W. Kimbark, Wiley InterScience New York 1971.

Reference Books

1. EHVAC, HVDC Transmission and Distribution Engineering by S. Rao, Khanna Publishers, 2001.
2. Power Transmission by Direct Current by E. Uhlamann, Springer – Verlag, Berlin, 1975.

Course Title	Signals & Systems (PE-II)					B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2002606	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to analyze the response of linear, time-invariant dynamic systems to standard input signals and that can be applied to the various systems for the estimation of their performance.

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

CO 1	**Identify** the various signals and operations on signals.
CO 2	**Describe** the spectral characteristics of signals.
CO 3	**Illustrate** signal sampling and its reconstruction.
CO 4	**Apply** convolution and correlation in signal processing.
CO 5	**Analyze** continuous and discrete time systems.

UNIT-I

Introduction: Definition and Classification of Signals, Elementary signals, Basic operations on signals.

Fourier series representation of periodic signals: Analogy between vectors and signals, Orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, Closed or complete set of orthogonal functions, Orthogonality in complex functions. Representation of function by a set of mutually orthogonal functions, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Spectrum and its significance, Amplitude and Phase spectra.

UNIT-II

Fourier transforms: Fourier transform(FT), Fourier transform of standard signals, properties of Fourier transforms, Fourier transforms involving impulse function, Fourier transform of periodic signals.

UNIT-III

Signal transmission through LTI systems: Systems, Classification of Systems,Linear time invariant (LTI) system, Transmission of signals through LTI systems, Transfer function of a LTI system. Distortion less transmission through LTI system, Causality & Stability.

UNIT-IV

Discrete Time Signals: Sampling of continuous time signals, Sampling theorem, Reconstruction of signal from its samples, effect of undersampling – Aliasing. Representation of discrete time signals, Unit impulse, step, ramp, and exponential sequences, Operations on Discrete-time signals.

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Discrete Time Systems: Definition, classification, Linear Shift Invariant(LSI) system, Stability , Causality , Linear constant coefficient difference equation , Impulse response , Discrete time Fourier transform , Transfer function , System analysis using DTFT.

UNIT-V

Laplace Transform: Definition , ROC , Properties , Inverse Laplace transform , The S-plane and BIBO stability , Transfer functions , System response to standard signals.

Z–Transforms: Z-transform- definition, ROC and its properties, analysis of LTI system using z-transform, The Inverse z-transform, z-transform properties.

Text Books:

1. Simon Haykin, "Communication Systems", 2nd Edition, Wiley-Eastern, 2003.
2. Oppenheim AV and Willisky, "Signals and Systems", 2nd Edition, Pearson Ed, 1997.
3. B.P. Lathi, "Principles of Linear systems and signals," Oxford Univ. Press, Second Edition International version, 2009.

Reference Books

1. Simon Haykin, Van Veen, and Wiley, "Signals & Systems", 2nd Edition, 2003.
2. Luis F. Chaparro, "Signals and Systems using MATLAB," Academic Press, 2011

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Course Title	Power Electronics Lab					B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2002607	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3	1.5	40	60	100
						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the characteristics of MOSFET and IGBT, force commutated circuits, output voltage of single phase half and fully controlled rectifiers, ac voltage controllers. Design and simulation of three phase half and fully controlled rectifiers, PWM inverter using MATLAB.

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

CO 1	Understand the characteristics of MOSFET and IGBT, forced commutation circuits.
CO 2	Analyze the output voltage performance of single phase half and fully controlled rectifiers with R and RL loads.
CO 3	Analyze the output voltage performance of AC voltage controller, cyclo converter with R and RL loads.
CO 4	Design and simulate the three phase rectifier and PWM inverter using MATLAB.

List of the experiments (Any Eight)

1. Study of characteristics of MOSFET & IGBT
2. Single Phase AC Voltage Controller with R and RL Loads
3. Single Phase fully controlled bridge converter with R and RL loads
4. Forced Commutation circuits (Class A, Class B, Class C, and Class D & Class E)
5. DC Jones chopper with R and RL Loads
6. Single Phase Parallel, inverter with R and RL loads
7. Single Phase Half controlled converter with R load
8. Single Phase Dual converter with RL loads
9. MATLAB simulation of single-phase full converter using RLE loads and single-phase AC voltage controller using RLE Loads
10. MATLAB simulation of single phase inverter with PWM control

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Course Title	Power Systems – II Lab				B. Tech. VI Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2002608	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3	1.5	40	60	100
						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to identify & formulate solutions to problems relevant to power systems using software tools.

On successful completion of this course, the students will be able to

CO 1	Understand the concept of MATLAB programming and ETAP in solving power systems problems.
CO 2	Acquire knowledge on formation of Bus Admittance matrix.
CO 3	Analyze the power flow using GS, NR method and DC load flow method.
CO 4	Analyze various fault studies on the power system.
CO 5	Understand power system planning and operational studies.

List of Experiments (Any Eight)

1. Modeling of a Transmission Line with Lumped Parameters
2. Formation of Y-bus for a given power system network
3. AC Load flow analysis of a simple 3-bus system using Gauss Seidel method
4. AC Load flow analysis of a simple 3-bus system using Newton Raphson method
5. Study on D C Load Flow
6. Study on Economic Load Dispatch
7. Short circuit analysis
8. Simulation of single area load frequency control system
9. Simulation of Automatic Voltage Regulator
10. Tripping characteristics of Fuse & MCB
11. Tripping sequence of protective devices
12. Characteristics of over current relay

Note: All the above experiments are simulated by using MATLAB/ETAP Software

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Course Title	Advanced Programming Lab				B. Tech. VI Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2004609	Engineering Science Course (ESC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3	1.5	40	60	100
						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn, write, test and debug simple LABVIEW Programs.

On successful completion of this course, the students will be able to

CO 1	Understand, test and debug simple Programs
CO 2	Demonstrate operations on arrays and strings
CO 3	Apply conditional statements
CO 4	Make use of Sub VI's for structuring Programs
CO 5	Make use of Read and write data from/to files

List of Programs (Any Eight)

1. Basic arithmetic operations (Add, mul, div, compound arithmetic, expression node, express formula and formula node)
2. Boolean operations (truth table verification of logic gates, Half Adder and Full Adder, convert binary to decimal value, convert BCD to Gray and Vice-Versa)
3. String operations (Length, concatenation, insert string, sub-string, replace string, reverse string, rotate string, etc)
4. Sum of 'N' numbers using feedback loop (use 'for ' loop and 'while' loop)
5. Factorial of a give number using shift register (use 'for' loop and 'while' loop)
6. Generate Fibonacci series for N iteration (use 'for' loop)
7. Create a VI to increase the tank level from 0 to 100 & decrease the value from 100 to 0 using while loop in a single process.
8. Create a VI to implement and, or & not gates(or arithmetic operations) using case structure
9. Build a VI that generates a 1D array of random numbers and sort the array in descending and ascending order and find the following:
   a) Maximum and min value of array elements
   b) Size of the array
   c) Sum and product of array elements
   d) Rotate array by 1 position
   e) Split the array after 2 elements

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10. Build an array of cluster controls in which each cluster consists of a numeric control and 1D numeric array. This forms the database of students. The numeric control indicates the roll no and array indicates the test marks of 4 subjects. Build the logic to modify the mark in a particular subject of a particular student. Input the roll number, subject in which mark is to be changed and new mark. Display the database on a separate array indicator.
11. Create a VI to implement Full Adder circuit using SubVI.
12. Any application using Flat and stacked sequence

Software Used: LABVIEW Software for Windows/Linux

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Course Title	Skill Advanced Course (MATLAB – SIMULINK)				B. Tech. VI Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2002610	Skill Course (SC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		1	--	2	2	40	60	100
						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the basic features and fundamental blocks of SIMULINK and to solve electrical engineering problems.

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

CO 1	Understand basic features of SIMULINK
CO 2	Know various signals, operations and user defined functions
CO 3	Analyze fundamental blocks of SIM power systems
CO 4	Solve Electrical Engineering problems using SIMULINK

Module-1

Elementary features: Introduction to Simulink –Creating new Simulink file – Commonly used blocks – Continues & Discrete signals – Logic & Bit operations – Math operations – Ports & Subsystems – Sinks – Sources – User defined functions.

Module-2

SIM Power Systems: Fundamental Blocks: Electrical sources – Elements – Interface elements – Machines – Power Electronics – Control & Measurement- FACTS – Renewable Sources

Module-3

Electrical Engineering Applications – Modeling& Simulation of simple Electrical Block diagrams: Power electronics, Electrical Machines, Power & Control Systems.

Text books

1. Beginning MATLAB and Simulink from Novice to Professional bySulaymon Eshkabilov, Apress.
2. Modeling & Simulation Using MATLAB – Simulink by Dr. Shailendra Jain, Wiley.
3. MATLAB – Simulink for Engineers by Agam Kumar Tyagi, OXFORD University press.

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Minor Degree in Electrical Engineering

B. Tech.– R20 Regulations

Department of Electrical and Electronics Engineering

Minor Degree Course Structure

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	20MD201	Circuits Theory	PCC	4	0	0	40	60	4
2	20MD202	Basics of Electrical Measurements & Instrumentation	PCC	4	0	0	40	60	4
3	20MD203	Electrical Machines	PCC	4	0	0	40	60	4
4	20MD204	Principles of Power Systems	PCC	4	0	0	40	60	4
5	20MD205	Linear Control Engineering	PCC	2	0	0	40	60	2
6	20MD206	Principles of Power Electronics	PCC	2	0	0	40	60	2
			Total	20	00	00	240	360	20

* Minor degree starts from V Semester and student have to opt two subjects in each semester and complete within VIII Semester.

From the above 6 theory subjects, four subjects with 4 credits and two subjects with 2 credits to be done through MOOC (SWAYAM/NPTEL) for 8Weeks. So, the student should acquire 20 credits to get Minor Degree.

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Minor Degree Course Syllabus

Course Title	Circuit Theory				B. Tech. EEE (Minor Degree)		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
20MD201	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		4	0	0	4	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: This course introduces the concepts of circuit analysis which includes D.C. and A.C excitations, various Network functions, synthesis and various types of filters.

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

CO 1	To impart knowledge on applying various laws, selecting appropriate and relevant techniques for solving DC and AC electrical circuits
CO 2	To describe network functions for various electrical circuits
CO 3	To analyze various networks using different methods
CO 4	To derive various filter characteristics

UNIT - I

DC Circuits: Introduction, Electrical circuit elements (R, L & C),Voltage and current sources(Independent & Dependent),Source transformation,Network reduction techniques for simple Series & Parallel networks,Kirchhoff's current laws,Kirchhoff's voltage laws,Mesh and Nodal analysis of simple circuits with DC,Simple Problems.

UNIT - II

AC Circuits: Representation of sinusoidal waveforms, average, peak and RMS values,Form factor Peak factor for sinusoidal waveform,Phasor - Phasor representation, Impedance, Admittance, Reactance, Susceptance,Real power, Reactive power, Apparent power, power factor, Simple Problems.

UNIT - III

Network Functions: Single port and multiport networks, Immittance functions of two port parameters, Necessary conditions for driving point and transfer functions. Poles and Zeros,Time domain response from pole zero plots, Restrictions from pole zero locations.

UNIT - IV

Network Synthesis: Introduction, Definition, Necessary and sufficient conditions for a function to be positive real, Elements of circuit synthesis, Foster and cauer forms of LC Networks, Synthesis of RC and RL networks.

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UNIT - V

Filters: High-pass, low-pass, band-pass and band-stop L-C filters. Derivation of expression for propagation constant, attenuation constant, phase shift constant, cut-off frequency, characteristics impedance etc. for constant k and m-derived filters.

Text Books

1. Network Analysis – Van Valkenburg - 3rd edition, PHI.
2. Network Analysis - G.K.Mittal, Khanna Publishers

References Books

1. Circuits & Networks – A. Sudhakar, Shayammohan. S. Pillai, 4th Edition – TMH.
2. Networks and Systems – D. Roy Chowdari – New Age International
3. Electrical Circuits - N. Sreenivasulu, Reem publications.

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Course Title	Basics of Electrical Measurement & Instrumentation				B. Tech. EEE (Minor Degree)		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
20MD202	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		4	0	0	4	40	60	100
Mid Exam Duration : 2Hrs					End Exam Duration : 3Hrs			

Course Objectives: To introduce the basic principles of all measuring instruments. To deal with the measurements of voltage, current, power factor, power, energy and magnetic measurements. To understand the basic concepts of smart and digital metering.

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

CO 1	Understand the different types of measuring instruments, their construction, operation and characteristics.
CO 2	Identify the instruments suitable for typical measurements.
CO 3	Apply the knowledge about transducers and instrument transformers to use them effectively.
CO 4	Apply the knowledge of smart and digital metering for industrial applications.

UNIT - I

Introduction to Measuring Instruments: Classification-deflecting, control and damping torques-ammeters and voltmeters-PMMC, moving iron type instruments- expression for the deflecting torque and control torque-errors and compensations, extension of range using shunts and series resistance.

UNIT - II

Potentiometers: Principle operation of DC Crompton's potentiometer-standardization-measurement of unknown resistance, current, voltage. A.C. Potentiometers: polar and coordinate type's standardization-applications.

Instrument Transformers: CTs and PT s – ratio and phase angle errors.

UNIT - III

Measurement of Power: Single phase dynamometer wattmeter, LPF and UPF, Double element and three elements dynamometer wattmeter, expression for deflecting and controlling torques.

Measurement of Energy: Single phase induction type energy meter – driving and braking torques – errors and compensations.

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UNIT - IV

DC Bridges: Method of measuring low, medium and high resistance – sensitivity of wheat-stones bridge - Kelvin's double bridge for measuring low resistance, measurement of high resistance.

AC Bridges: Measurement of inductance-Maxwell's bridge, Anderson's bridge- Measurement of capacitance and loss angle-Desauty's bridge-Schering Bridge.

UNIT - V

Transducers: Definition of Transducers, classification of Transducers, advantages of electrical Transducers, characteristics and choice of Transducers, principle and operation of LVDT, LVDT applications, Strain Gauge and its principle of operation, gauge factor. Introduction to smart metering.

Text books

1. G.K.Banerjee, Electrical and Electronic Measurements, PHI Learning Pvt.Ltd., 2nd Edition, 2016
2. S.C.Bhargava, Electrical Measuring Instruments and measurements, BS Publications, 2012.

References Books

1. A.K.Sawhney, Electrical and Electronic Measurement and Instruments, Dhanpat Rai and Co. Publications, 2005
2. R.K.Rajput, Electrical and Electronic Measurement and Instrumentation, S.Chand and Company Ltd., 2007.
3. Reissland, M.U.Electrical Measurements: Fundamentals, Concepts, Applications, New Age international (P) Limited publishers, 1st Edition 2010.
4. E.W.Goloding and F.C.Widdis, Electrical Measurements and Measuring Instruments , fifth edition, wheeler publishing, 2011.

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Course Title	Electrical Machines					B. Tech. EEE (Minor Degree)		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
20MD203	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		4	0	0	4	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn principle of operation, construction, Starting methods,characteristics and performance of various electrical machines.

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

CO 1	Understand the construction Principle of operation of various electrical machines.
CO 2	Illustrate starting methods of various electrical machines.
CO 3	Analyze the characteristics, phasor diagrams of various electrical machines.
CO 4	Determine the losses and efficiency by conducting suitable tests.

UNIT - I

DC Generators: Working principle – Construction – Classification – EMF equation – Characteristics of DC Shunt Generators – Numeric problems.

DC Motors: Principle of operation – Torque expression – Characteristics – Speed control of DC Shunt motor – 3 point and 4 pointstarters - Numerical problems.

UNIT - II

Single Phase Transformers: Construction – Principle of operation – Types- EMF equation – transformer operation on no-load and load - Phasor diagrams – Equivalent circuit – losses – efficiency and regulation – OC and SC tests – Auto transformers – Numerical problems. Three phase transformer connections.

UNIT- III

Three Phase Induction Motors: Construction – types – production of rotating magnetic field – principle of operation – slip, rotor parameters at stand still and running condition – torque equation – Slip-Torque characteristics– Numerical problems.

UNIT - IV

Single Phase Induction Motors: Construction – Double revolving field theory – principle of operation – equivalent circuit – determination of equivalent circuit parameters using No-load and Blocked rotor tests – Starting Methods.

UNIT - V

Synchronous Machines: Construction – types – winding factor – EMF equation –phasor diagrams – equivalent circuit – OC and SC tests – Regulation by Synchronous impedance method – numeric problems.

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Synchronous motors: Principle of operation – Starting methods.

Text Books

1. Electrical Machines – I.J. Nagrath& D.P. Kothari – TMH Publications.
2. Electrical Machinery – Dr.P. S. Bimbra – Khanna Publishers.

Reference Books

1. Electrical Machines – J.B.Gupta – Kataria publications.
2. Electrical Machinery – A.E.Fitzgerlad, C. Kingsley & S. Umlauts – TMH Publications

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Course Title	Principles of Power Systems					B. Tech. EEE (Minor Degree)		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
20MD204	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		4	0	0	4	40	60	100
Mid Exam Duration: 2 Hrs						End Exam Duration : 3Hrs		

Course Objectives: Student is able to learn the types of Generating stations, Mechanical considerations and parameters, Performance of Transmission lines, Substations.

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

CO 1	Draw the layout of hydro power plant, thermal power station. explain its operation
CO 2	Determine various mechanical parameters of transmission lines
CO 3	Analyze various calculations regarding line constants.
CO 4	Evaluate the performance of Transmission line
CO 5	Understand the different types of sections in Substations and types of substations.

UNIT - I

Electric Power Generating Stations: Electric Power System – Sources of Electrical Energy – Generation, Transmission and Distribution of Electric Power-Schematic Arrangement of Different Power Plants like Hydro, Thermal, Solar and Wind.

UNIT - II

Mechanical Design of Transmission Lines: Overhead– Main Components of Overhead Lines – Conductor Materials – Line Supports – Insulators – String Efficiency – Corona Effect – Sag and Calculation of Sag in Overhead Transmission Line.

UNIT - III

Electrical Design of Transmission Lines: Resistance in Transmission Line – Skin Effect– Flux Linkage in Current Carrying Conductors – Inductance of a Single Phase and Three Phase Lines.Capacitance of a Single and Three Phase Transmission Line.

UNIT - IV

Electrical Distribution Systems:Classification of Distribution Systems - Comparison of DC Vs AC – comparison of Under Ground Vs Over - Head Distribution Systems.

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Design Considerations of Distribution Feeders: Radial and Loop Types of Primary Feeders, Voltage Levels, Feeder Loading, Basic Design Practice of the Secondary Distribution systems.

UNIT - V

Substations: Location of Substations, Substations Layout Showing the Location of all the Substation Equipment. Bus-bar arrangement in the substations with Relevant Diagrams.

Text Books

1. Generation &utilization of Electrical Energy, C. L. Wadhwa New age International (P) Limited, Publishers 1997.
2. Electrical Power Systems, C. L. Wadhwa New age International (P) Limited, Publishers 1997.

Reference Books

1. Electrical Power Generation, Transmission and Distribution, S.N. Singh, PHI, 2003.
2. Principles of Power Systems, V.K Mehta and Rohith Mehta S. Chand& Company Ltd, New Delhi, 2004.
3. A Text Book on Power System Engineering, L. Soni, P. V. Gupta, U. S. Bhatnagar and A. Chakrabarthi , Dhanpat Rai &Co. Pvt. Ltd, 1999.

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Course Title	Linear Control Engineering				B. Tech. EEE (Minor Degree)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20MD205	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	2	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn mathematical modeling of physical systems, electrical systems, time response of first order and second order Systems, stability analysis using time domain and frequency domain and design compensator in frequency domain to improve the performance.

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

CO 1	Understand modeling of physical systems, time and frequency domain specifications and stability of the system.
CO 2	Analyze the stability of the system in time and frequency domains.
CO 3	Block diagram construction and evaluate the transfer function using signal flow graph, steady state error and static error constants.
CO 4	Design lag, lead compensators in frequency domain.

UNIT - I

Control System Concepts: Introduction to control systems, classification, transfer function, mathematical modeling of physical systems, block diagram, signal flow graphs and mason's gain formula.

UNIT - II

Time Domain Analysis: Standard test signals, time response of first and second order systems-time response specifications, steady state error and error constants.

UNIT - III

Concept of Stability and Root Locus: The concept of stability, necessary conditions for stability – Routh Hurwitz's criterion – limitations of Routh's stability – Root locus concept – construction of Root loci - Effect of Poles & Zeros on stability.

UNIT - IV

Frequency Domain Analysis: Introduction, frequency domain specifications, bode plots, gain and phase margin.

UNIT - V

Compensation Techniques: System design and compensation – realization of basic lag and lead compensations in frequency domain.

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Text Books

1. Control Systems Engineering by I. J. Nagrath and M. Gopal, New Age International (P) Limited, Publishers, 5th edition, 2007.
2. Automatic Control Systems by B. C. Kuo and FaridGoinaraghi – John Wiley and Sons, 8th edition, 2003.

Reference Books

1. Modern Control Engineering by Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd., 5th edition, 2010.
2. Control Systems Engineering by NISE, 5th edition, John Wiley.
3. Control Systems by A. Anand Kumar, Prentice Hall of India Pvt. Ltd.

Course Title	Principles of Power Electronics				B. Tech. EEE(Minor Degree)		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20MD206	Professional Core Course (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	2	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The course is oriented to the study of power electronics devices, the analysis and describes the main industrial applications. The objectives include: 1) to know the principles of power electronics, 2) to classify the different kinds of power electronics circuits as a function of the input source and loads.

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

CO 1	To understand the characteristics of different power switches.
CO 2	To understand the single phase and three phase controlled rectifier with different loads
CO 3	To understand the operating principle of cyclo converters, choppers and inverters
CO 4	To understand harmonic content in output voltage and current waveforms of an inverter.

UNIT - I

Fundamentals of Power Semi-conductor devices:SCR – static characteristics –turn on and off mechanism – MOSFET, IGBT, GTO Characteristics.

UNIT -II

Phase controlled Rectifiers(AC to DC): Phase controlled rectifiers– single phase half and fully controlled converters – midpoint and bridge connections with R and RL loads – effect of source inductance- three phase half controlled converters with R load .

UNIT - III

AC Voltage Controllers (AC to AC):AC voltage controllers- single phase ac voltage controllers with SCR for R and RL load –cyclo converters – single phase cyclo converters (mid-point configuration) with R load.

UNIT - IV

Choppers(DC to DC): Choppers – principle of operation – control strategies- types of chopper circuits – type A, type B- buck -boost converter.

UNIT - V

Inverters(DC to AC): Inverters – single phase half bridge and full bridge inverters with R and RL load –output voltage control techniques- PWM techniques- harmonic reduction techniques.

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Text Books

1. Power Electronics –M.D Singh & K.B. Kanchandhani, TMH publications, 1998.
2. Power Electronics - Circuits, Devices and Applications –M.H. Rashid, Prentice Hall of India, 2nd Edition 1998.

Reference Books

1. Power Electronics- P.S.Bimbhra, Khanna Publications.
2. Power Electronics –Vedam Subramanyam, New Age Information Limited, 3rd Edition.
3. Power Electronics –V.R. Murthy, Oxford University Press, 1st Edition – 2005.
4. Power Electronics –P.C Sen, Tata Mc Graw Hill Publishing.

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Honours Degree for B. Tech.– R20 Regulations

Electrical and Electronics Engineering (E.E.E)

List of Subjects for Honours Degree Course:

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	20HD201	Energy Auditing & Demand Side Management	PEC	4	0	0	40	60	4
2	20HD202	Power System Deregulation	PEC	4	0	0	40	60	4
3	20HD203	PLC & its Applications	PEC	4	0	0	40	60	4
4	20HD204	Embedded System	PEC	4	0	0	40	60	4
		MOOC Courses (Any Two)							
5	20HD205	Electric Vehicles	PEC	2	0	0	40	60	2
6	20HD206	Smart Grid	PEC	2	0	0	40	60	2
7	20HD207	Industrial Automation & Control	PEC	2	0	0	40	60	2
8	20HD208	SCADA & its Applications	PEC	2	0	0	40	60	2
9	20HD209	DC Micro Grid	PEC	2	0	0	40	60	2
Total Credits									20

** **The Student will study any 6 subjects, four subjects each with 4 credits and two subjects through MOOC(SWAYAM/NPTEL) for 8weeks with 2 credits. So, the student should acquire 20 credits to get Honour's Degree.**

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Course Title	Energy Auditing & Demand Side Management				B. Tech. Honours Degree Course		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
20HD201	Professional Elective Core (PEC)	4	1	0	4	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn about energy auditing practices , conservation schemes, different methods to improve power factor, lighting and energy instruments, load and demand side management.

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

CO 1	Understand energy auditing practices, energy conservation schemes, energy economics and management
CO 2	Analyze energy conservation measures, energy auditing practices, energy economics and management
CO 3	Design an appropriate energy conservation scheme for commercial and industrial applications
CO 4	Choose appropriate technique for energy auditing and conservation.

UNIT – I

Energy Auditing: Energy audit- definitions, concept, types of audit, energy index, cost index, pie charts, sankey diagrams, load profiles, energy conservation schemes. measurements in energy audits, presentation of energy audit results.

UNIT - II

Energy Efficient Motors: Energy efficient motors, constructional details, loss distribution, factors affecting efficiency, characteristics - variable speed, variable duty cycle systems, RMSHP loading- voltage variation-voltage unbalance- over motoring- motor energy audit.

UNIT – III

Power Factor Improvement: Power Factor – methods of improvement, location of capacitors, pf with non linear loads, effect of harmonics on pf, pf motor controllers.

UNIT – IV

Lighting and Energy Instruments: Good lighting system design and practice, lighting control ,lighting energy audit - energy instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers ,application of PLC's.

UNIT – V

Demand Side Management: Introduction to DSM, concept of DSM, benefits of DSM, different techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning.

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Load Management: Load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. management and organization of energy conservation awareness programs.

Text Books

1. Electrical Power distribution by A. S. Pabla, TMH, 5th edition, 2004.
2. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
3. Energy management hand book by W. C. Turner, John Wiley and Sons.
4. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998.

References

1. Energy efficient electric motors by John. C. Andreas, Marcel Dekker Inc Ltd., 2nd Edition, 1995.
2. Energy management and good lighting practice: Fuel Efficiency- Booklet12 – EEO.
3. Recent Advances in Control and Management of Energy Systems by D. P. Sen, K. R. Padiyar, Indrane Sen, M. A. Pai, Interline Publisher, Bangalore, 1993.
4. Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern, 2005.

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Course Title	Power System Deregulation				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20HD202	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		4	0	0	4	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to learn the basic concept of restructuring of the electricity market, need behind requirement for deregulation of the electricity market and understand the money, power & information flow in a deregulated power system.

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

CO 1	Understand various types of regulations in power systems.
CO 2	Identify the need of regulation and deregulation.
CO 3	Analyze the technical and Non-technical issues in Deregulated Power Industry.
CO 4	Identify and give examples of existing electricity markets.
CO 5	Classify different market mechanisms and summarize the role of various entities in the market

UNIT - I

Deregulation of Electric Utilities: Introduction – Traditional central utility model, reform motivations, separation of ownership and operation, competition and direct access in the electricity market, independent system operator (ISO), retail electric providers, different experiences.

UNIT - II

Competitive Wholesale Electricity Markets & Transmission Open Access: Introduction, ISO, wholesale electricity market characteristics, market model, challenges, trading arrangements, the pool and bilateral trades, multi lateral trades.

UNIT - III

Transmission Cost Allocation Methods: Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

UNIT - IV

Market Power & Ancillary Services Management: Introduction - Different types of market Power – Mitigation of Market Power – Examples - Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

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UNIT - V

Available Transfer Capability (ATC) : Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow - Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

Text Books:

1. Power System Restructuring and Deregulation, Loi Lei Lai, John Wiley & Sons Ltd., England, 2001.
2. Operation of Restructured Power System, Kankar Bhattacharya, Math H.J. Boller and Jaap E. Daalder Kulwer Academic Publishers, 2001.
3. Restructured Electrical Power Systems, Mohammad Shahidehpour and Muwaffaq alomoush, Marcel Dekker, Inc., 2001.

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Course Title	Programmable Logic Controller (PLC) & its Applications				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20HD203	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		4	0	0	4	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to learn PLC basics, architecture, programming, about digital logic gates, PLC registers, functions and Analog PLC operations and various applications to PLC.

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

CO 1	Understand PLC and its basics, architecture, connecting devices and programming
CO 2	Apply Ladder logic for various Industrial Applications
CO 3	Analyze PLC logical and arithmetic operations
CO 4	Design Control Circuits for various Applications

UNIT-I

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming Equipment, programming formats, construction of PLC ladder diagrams, Devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.

UNIT-II

Digital Logic Gates: Programming in the Boolean algebra system, conversion examples. Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system.

UNIT-III

PLC Registers: Characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers.

PLC Functions: Timer functions & Industrial applications, counter function & industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

UNIT-IV

Data Handling Functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

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UNIT -V

Analog PLC Operation: Types of PLC Analog Modules and Systems, PLC Analog Signal Processing, BCD or Multibit Data Processing, Analog output application examples, PID Modules, PID Tuning, Typical PID Functions, PLC Installation, Troubleshooting and Maintenance.

Text Books:

1. Programmable Logic Controllers by W. Bolton, 5th Edition, Newnes, Elsevier, 2010.
2. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI.

Reference Books:

1. Programmable Logic Controllers- Programming Method and Applications –JR. Hackworth &F.D Hackworth Jr. –Pearson, 2004.
2. Programmable Logic Controllers: An Emphasis on Design & Application, Kelvin T. Erickson, Dogwood Valley Press, 2011.

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Course Title	Embedded Systems				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
20HD204	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		4	0	0	4	40	60	100
Mid Exam Duration: 2 Hrs					End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the basic working of a microcontroller system and its programming in assembly language and also to integrate hardware and software for microcontroller applications systems.

On successful completion of this course, the students will be able to

CO 1	Describe the differences between the general computing system and the embedded system, the classification of embedded systems.
CO 2	Illustrate the basic programming models
CO 3	Design real time embedded systems using the concepts of RTOS
CO 4	Apply program modeling and programming with RTOS - 2

UNIT - I

Introduction: History of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems, Core of the Embedded System, Sensors and Actuators, Communication Interface, Embedded Firmware.

Hardware Software Co-Design and Programme Modelling: Characteristics of an Embedded System, Quality Attributes of Embedded Systems, Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language (UML),Hardware Software Trade-offs.

UNIT - II

Real-Time Operating Systems (RTOS) Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling :Putting them Altogether, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS.

UNIT - III

Devices and Communication Buses for Devices Network: IO Types and Examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing Features in Device Ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Serial Bus Communication Protocols, Parallel Bus Device Protocols- Parallel Communication Network Using ISA, PCI, PCI-X and Advanced Buses, Internet Enabled Systems- Network Protocols, Wireless and Mobile System Protocols.

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UNIT - IV

Real Time Operating Systems: Process Management, Memory Management, Device, File and IO Subsystems Management, Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real-time Operating Systems, Basic-Design an RTOS, RTOS Task Scheduling Models, Interrupt Latency and Response of the Tasks as Performance Matrices, OS Security Issues.

UNIT - V

Design Examples and Case Studies of Program Modeling and Programming With RTOS-2: Case study of Communication between Orchestra Robots, Embedded Systems in Automobile, Case study of an Embedded System for Adaptive Cruise Control(ACC) System in a Car, Case study of an Embedded System for a Smart Card, Case study of a Mobile Phone Software for Key Inputs.

Text Books

1. Introduction to Embedded System- Shibu KV, Mc-Graw Hill Higher Edition.
2. Embedded Systems Architecture, Programming and Design- Raj Kamal, Second Edition, McGraw-Hill Companies.
3. Embedded System Design by Peter Marwedel, Springer.

Reference Books

1. Embedded System Design – A Unified Hardware/Software Introduction-Frank Vahid, Tony D. Givargis, John Wiley, 2002.
2. Embedded/ Real Time Systems-KVKK Prasad, Dreamtech Press, 2005.
3. An Embedded Software Primer- David E. Simon, Pearson Ed. 2005.

Course Title	Electric & Hybrid Vehicles				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
20HD205	Professional Elective (PEC)	2	0	0	2	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to learn upcoming technology of hybrid systems, different aspects of drives application & electric traction.

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

CO 1	Understand electric drive in vehicles / traction
CO 2	Acquire knowledge about fundamental concepts, principles of hybrid and electric vehicles
CO 3	Analyze and design of hybrid and electric vehicles

UNIT - I

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT - II

Hybrid Electric Drive-Trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-Trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT - III

Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switched Reluctance Motor drives, drive system efficiency.

UNIT - IV

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

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UNIT - V

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Text Books

1. Hybrid Electric Vehicles: Principles and applications with Practical Perspectives by C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011.
2. Hybrid Electric Vehicles: Energy Management Strategies by S. Onori, L. Serrao and G. Rizzoni, Springer, 2015.

Reference Books

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design by Ehsani, Gao, Gay, Emadi, 2005 by CRC Press.
2. Electric and Hybrid Vehicles by T. Denton, Routledge, 2016.

Course Title	Smart Grid				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
20HD206	Professional Elective (PEC)	2	0	0	2	40	60	100
Mid Exam Duration: 2 Hrs						End Exam Duration : 3Hrs		

Course Objectives: The student is able to learn fundamentals, Architecture and analysis of smart grid with communication, networking and measuring technologies involved in it.

On successful completion of this course, the students will be able to

CO 1	Understand the features, fundamental components and architecture of smart grid
CO 2	Explain information, communication and networking technologies involved with the smart grid
CO 3	Explain operation and importance of PMU, WAMPS and smart storage systems in smart grid
CO 4	Analyze Micro grid with various concepts and challenges in future

UNIT - 1

Introduction to Smart Grid: Working definitions of Smart Grid and Associated Concepts – Need of Smart Grid – Smart Grid Functions – Opportunities & Barriers of Smart Grid - Conventional Power Grid and Smart Grid -Concept of Resilient & Self-Healing Grid.

UNIT - II

Smart Grid Architecture: Components and Architecture of Smart Grid – Review of Proposed Architectures for Smart Grid – The Fundamental Component of Smart Grid Designs – Transmission Automation – Distribution Automation –Renewable Integration.

UNIT - III

Information and Communication Technology: Smart sensors, Wired and wireless communication Technology, Network Structures (**HAN, LAN, NAN, WAN**), Introduction to Smart Meters – Advanced Metering Infrastructure (AMI).

UNIT - IV

Smart Grid Technologies: Geographic Information System (GIS) - Intelligent Electronic Devices (IED) - Smart storage like Battery- SMES - Pumped Hydro - Compressed Air Energy Storage - Wide Area Measurement System (WAMS) – SCADA - Phasor Measurement Unit (PMU).

UNIT – V

Micro grids and Distributed Energy Resources: Concept of micro grid, need & application of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid, Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, and fuel cells.

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Text Books

1. Janaka Ekanayake, KithsiriLiyanage, Jian zhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
2. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 1e,2013.
3. James Momoh, "Smart Grid: Fundamentals of Design and Analysis"- Wiley, IEEE Press, 2012.

Reference Books

1. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press.
2. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability", Artech House Publishers July 2011.
3. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response"- CRC Press, 2009.

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Course Title	Industrial Automation & Control				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20HD207	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	2	40	60	100
Mid Exam Duration: 2 Hrs						End Exam Duration : 3Hrs		

Course Objectives: The student is able to learn Automation is playing a key role in Industries. Industries rely heavily on automation for economic viability and mass production. It is important for the students to learn the basics of automation, how systems work and the importance of PLC, SCADA and robots in automation. This course will provide an opportunity to learn industrial automation techniques.

On successful completion of this course, the students will be able to

CO 1	Understand various automation components and systems
CO 2	Draw block diagram of industrial automation and control system
CO 3	Explain architecture of industrial automation system
CO 4	Measure industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.

UNIT – I

Introduction: Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus&profibus

UNIT - II

Automation components: Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT – III

Computer aided measurement and control systems: Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software and Computer based data acquisition system, Internet of things (IoT) for plant automation

UNIT –IV

Programmable logic controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation,

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Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNIT – V

Distributed Control System: Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

Text Books

1. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies
2. Process Control Instrumentation Technology By. C.D. Johnson, PHI
3. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A.K. Deb, Jaico Publishing House, 2013
4. Programmable logic controller, Dunning, Delmar

Reference Books

1. Groover, Mikell. P: Automation, Production systems and Computer integrated Manufacturing –Prentice hall India-2004.
2. Mark W Spong& M Vidyasagar: Robot Dynamics and Control, John Wiley & Sons, 1989
3. Robert J Schilling: Fundamentals of Robotics, Analysis and Control. Printice Hall of India 1996
4. R.K.Mittal and I.J. Nagarath: Robotics and Control, TMH-2003.

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Course Title	SCADA & Its Applications				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
20HD208	Professional Elective (PEC)	2	0	0	2	40	60	100
Mid Exam Duration: 2 Hrs					End Exam Duration : 3Hrs			

Course Objectives: The student is able to understand SCADA and its applications.

On successful completion of this course, the students will be able to

CO 1	Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.
CO 2	Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
CO 3	Acquire knowledge about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server
CO 4	Acquire knowledge about SCADA communication, various industrial communication technologies, open standard communication protocols
CO5	Learn and understand about SCADA applications in transmission and distribution sector, industries etc
CO6	Gain knowledge and understanding for the design and implementation of a SCADA system

UNIT - I

Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries

UNIT - II

SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems

UNIT - III

SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850

UNIT - IV

SCADA Communication: various industrial communication technologies -wired and wireless methods and fiber optics. Open standard communication protocols

UNIT - V

SCADA Applications: Utility applications- Transmission and Distribution sector - operations, monitoring, analysis and improvement. Industries - oil, gas and water.

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Text Books

1. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications, USA,2004.
2. Gordon Clarke, Deon Reynders: Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004.

Reference Books

1. William T. Shaw, Cyber security for SCADA systems, PennWell Books, 2006.
2. David Bailey, Edwin Wright, Practical SCADA for industry, Newnes, 2003.
3. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric power, PennWell 1999.

Course Title	Distributed Generation & Micro Grid				B. Tech. Honours Degree Course		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
20HD209	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	2	40	60	100
Mid Exam Duration: 2 Hrs					End Exam Duration : 3Hrs		

Course Objectives: The student is able to learn about different distributed generations, energy storage devices and Micro grid systems and Understanding the concepts of system development and relevant issues.

On successful completion of this course, the students will be able to

CO 1	Understand the synchronization and other distributing resources such as energy storage and fuel cell
CO 2	Understanding of the microgrid types and configurations
CO 3	Applications of power electronics in Micro grid and acquire the knowledge of multifunction grid connected converters
CO 4	Analyze the various types of control in micro grid in islanded and grid connected operation

UNIT - I

Introduction to Distributed Generation: DG Units - Micro turbines, reciprocating engines, wind generators, photovoltaic generators, fuel cells, biomass, and tidal sources - Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, Planning of DGs – Sitting and sizing of DGs – optimal placement of DG sources in distribution systems.

UNIT - II

Grid integration of DGs: Synchronization - Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG units - Distributed resources to electric power systems: IEEE 1547. Energy storage elements: Batteries, ultra-capacitors, flywheels.

UNIT - III

Economics and Regulatory Aspects of DGs: Selection of sources, regulatory standards/ framework, Standards for interconnecting DG installation classes, security issues in DG implementations. Economic and control aspects of DGs –Market facts, issues and challenges - Limitations of DGs.

UNIT - IV

Introduction to Micro grid: Micro grid Configurations – CERTS Microgrid Test Bed – DC Micro grid- HFAC Micro grid –LFAC – Micro grid – Hybrid DC- and AC- Coupled Micro grid.

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Power Electronics in Micro grid: Power Electronics based Microgrid - Grid Connected Mode – Islanded mode – Battery Charging mode – design of parallel inverters – Microgrid application - Brick Busses Software Framework.

UNIT - V

Control in Micro grid: Impact of load characteristics – Local control – Centralized Control- Decentralized Control Microgrid control for island operation – PQ Control - Droop control methods – Frequency/Voltage Control – Control of Inverter Output Impedance.

Text Books

1. N. Jenkins, J.B. Ekanayake and G. Strbac, 'Distributed Generation', IET Press, 2010.
2. Nikos Hatziargyiou, "Micro grids: Architectures and Control", Wiley-IEEE Press, December 2013.

Reference Books

1. Suleiman M. Sharkh, Mohammad A. Abu-Sara, Georgios I. Orfanoudakis, Babar Hussai, "Power Electronic Converters for Microgrid" , Wiley-IEEE Press, 2014.
2. S. Chowdhury, S. P. Chowdury and Peter Crossley," Microgrids and Active Distribution Networks" ISBN978-1-84919-014-5, IET renewable Energy series, 2009.

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Approved by AICTE & New Delhi, Affiliated to JNTUA, Ananthapuramu.

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List of Open Electives Offering to Other Branches
(B. Tech., R20)

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
		Open Elective Course - I (OEC-I)							
1	20OE201	Modern Control Theory	OEC	3	0	0	40	60	3
2	20OE202	MATLAB Programming	OEC	3	0	0	40	60	3
		Open Elective Course – II (OEC-II)							
3	20OE203	Energy Conversion Systems	OEC	3	0	0	40	60	3
4	20OE204	Smart Grid	OEC	3	0	0	40	60	3
		Open Elective Course - III (OEC-III)							
5	20OE205	Intelligent Control Techniques	OEC	3	0	0	40	60	3
6	20OE206	Electrical System Estimation & Costing	OEC	3	0	0	40	60	3
		Open Elective Course - IV (OEC-IV)							
7	20OE207	Basics of Power Electronics	OEC	3	0	0	40	60	3
8	20OE208	System Reliability Concepts	OEC	3	0	0	40	60	3

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Course Title	Modern Control Theory				B. Tech. EEE Open Elective - 1		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20OE201	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: Students are able to learn the State Space, Describing function, phase plane and stability analysis including controllability and observability.

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

CO 1	Understand the concept of State Space Techniques
CO 2	Analyze the stability of linear and nonlinear Systems
CO 3	Construct the state model of Linear Time Invariant systems and Lyapunov functions for nonlinear systems
CO 4	Determine Eigen values state transition matrix and examine the controllability and observability of linear time invariant systems
CO 5	Design state feedback controller and observer

UNIT – I

State variable descriptions: Concepts of state, state variables, state vector, state space model, representation in state variable form, phase variable representation.

UNIT – II

Solution of State Equations: diagonalization –state transition matrix – properties - .solution of state equations of homogeneous and non-homogeneous systems.

UNIT – III

Controllability and Observability: Definition of controllability – controllability tests for continuous linear time invariant systems – Definition of observability – observability tests for continuous linear time invariant systems,

UNIT – IV

Design of Control Systems: Introduction, Pole placement by state feedback, Full order and reduced order observers.

UNIT – V

Stability: Introduction, equilibrium points – stability concepts and definitions – stability in the sense of Lyapunov - stability of linear system – methods of constructing Lyapunov functions for non-linear system : Krasovskii's method – Variable gradient method.

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Text Books

1. Modern Control System Theory by M. Gopal, New Age International Publishers, 2nd edition, 1996.
2. Control System Engineering by I. J. Nagarath and M. Gopal, New Age International (P) Ltd.

Reference Books

1. Modern Control Engineering by K. Ogata, Prentice Hall of India, 3rd Edition, 1998.
2. Systems and Control by Stainslaw, H. Zak, Oxford Press, 2003.
3. Digital Control and State Variable Methods by M. Gopal, TMH, 1997.

Course Title	Programming Fundamentals for Numerical Computations				B. Tech. EEE Open Elective - I		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20OE202	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to make the students familiar with scripts, functions, control flow and plotting and use them to solve various engineering problems.

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

CO 1	Understand basic features, arrays and symbolic algebra.
CO 2	Analyze various control flow structures, interpolation and curve fitting
CO 3	Solve linear equations, Polynomials
CO 4	Plot two-dimensional and three-dimensional graphics

UNIT-I

Basics Fundamental Features: Basic features, script M-files, code cells, arrays creation, addressing and array operations; multi dimensional arrays.

UNIT-II

Control Flow: Arithmetic & Logical operators, control flow - if, if-else, for, while, switch case constructions and functions.

UNIT-III

Mathematical Operations: Matrix algebra and solutions to systems of linear equations, polynomials, Numerical integration, numerical differentiation

UNIT-IV

Graphics & Numerical techniques: Two-dimensional graphics, basics of three-dimensional graphics, interpolation, curve fitting.

UNIT-V

Symbolic Mathematics: Symbolic algebra, equation solving, differentiation and integration.

Text Books

1. Hanselman and Littlefield, "Mastering MATLAB 7", Pearson Education Etter,
2. Kuncickly,Hull, "Introduction to MATLAB 6", Pearson Education.

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Course Title	Energy Conversion Systems				B. Tech. EEE Open Elective - II		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
20OE203	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M					End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn about energy conversion techniques, sources of electrical energy production and impact of energy conversion systems on environment.

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

CO 1	Understand various energy conversion systems, fuel cells & batteries
CO 2	Analyze solar and wind energy conversion process
CO 3	Illustrate Ocean Energy Conversion systems
CO 4	Explain the environmental effects of Energy Conversion Systems.

UNIT I

Photo Voltaic Power Generation: Spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, test specifications for PV systems.

UNIT II

Wind Energy Conversion: Power from wind, properties of air and wind, types of wind Turbines, operating characteristics.

UNIT III

Tidal Power Station: Tides and Tidal power stations - modes of operation of Tidal project - Turbines and Generators for Tidal Power generation.

Ocean Thermal Energy Conversion: Types of ocean thermal energy conversion systems, Application of OTEC systems examples.

UNIT IV

Miscellaneous Energy Conversion Systems: Biomass conversion, Geothermal energy, Thermo electric energy conversion: Seebeck effect, Peltier and Thomson effects and their coefficients – Thermo-Electric Generator – Peltier Cooling

UNIT V

Fuel Cells & Batteries: Introduction - principles of EMF generation - description of fuel cells - Batteries, Description of batteries, Battery applications for large power.

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Environmental Effects: Environmental Effects of Energy Conversion Systems, Pollution from coal and preventive measures - steam stations and pollution - pollution free energy systems.

Text Books

1. "Energy conversion systems" by Rakosh das Begamudre, New age international Private Ltd., publishers, 1st Edition, 2000.
2. "Renewable Energy Resources" by John Twidell and Tony Weir, CRC Press (Taylor & Francis).

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Course Title	Smart Grid				B. Tech. EEE Open Elective - II		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20OE204	Open Elective Course (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The student is able to learn fundamentals, Architecture and analysis of smart grid with communication, networking and measuring technologies involved in it.

On successful completion of this course, the students will be able to

CO 1	Understand the features, fundamental components and architecture of smart grid
CO 2	Explain information, communication and networking technologies involved with the smart grid
CO 3	Explain operation and importance of PMU, WAMPS and smart storage systems in smart grid
CO 4	Analyze Microgrid with various concepts and challenges in future

UNIT-1

Introduction to Smart Grid: Working definitions of Smart Grid and Associated Concepts – Need of Smart Grid – Smart Grid Functions – Opportunities & Barriers of Smart Grid - Conventional Power Grid and Smart Grid -Concept of Resilient & Self-Healing Grid.

UNIT-II

Smart Grid Architecture: Components and Architecture of Smart Grid – Review of Proposed Architectures for Smart Grid – The Fundamental Component of Smart Grid Designs – Transmission Automation – Distribution Automation –Renewable Integration.

UNIT-III

Information and Communication Technology: Smart sensors, Wired and wireless communication Technology, Network Structures (**HAN, LAN, NAN, WAN**), Introduction to Smart Meters – Advanced Metering Infrastructure (AMI).

UNIT-IV

Smart Grid Technologies: Geographic Information System (GIS) - Intelligent Electronic Devices (IED) - Smart storage like Battery- SMES - Pumped Hydro - Compressed Air Energy Storage - Wide Area Measurement System (WAMS) – SCADA - Phase Measurement Unit (PMU).

UNIT – V

Micro grids and Distributed Energy Resources: Concept of micro grid, need & application of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid, Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, and fuel cells.

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Text Books

1. Janaka Ekanayake, Kithsir iLiyanage, Jian zhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
2. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 1e,2013.
3. James Momoh, "Smart Grid: Fundamentals of Design and Analysis"- Wiley, IEEE Press, 2012.

Reference Books

1. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2e, 2017.
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press.
3. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability", Artech House Publishers July 2011.
4. 4. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response"- CRC Press, 2009.

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Course Title	Intelligent Control Techniques				B. Tech. EEE Open Elective - III		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20OE205	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	1	0	3	40	60	100
Mid Exam Duration: 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn neural network and fuzzy logic concepts and foster their abilities in designing and implementing soft computing based solutions for real-world and engineering problems.

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

CO 1	Understand architecture and approach to Artificial intelligence
CO 2	Understand the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms and their models
CO 3	Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic systems
CO 4	Understand the Bio-inspired and Swarm Intelligence Algorithms

UNIT - I

Introduction to Artificial Intelligence: Introduction and motivation – Approaches to AI – Architectures of AI – Symbolic Reasoning System –Rule based Systems – Knowledge Representation.

UNIT - II

Artificial Neural Networks: Basics of ANN - Comparison between Artificial and Biological Neural Networks – Basic Building Blocks of ANN – Artificial Neural Network Terminologies – McCulloch Pitts Neuron Model – Learning Rules.

UNIT - III

ADALINE and MADALINE Models – Perceptron Networks – Back Propagation Neural Networks – Associative Memories Neural Networks as Associative Memories

UNIT - IV

Fuzzy Logic: Classical Sets – Fuzzy Sets – Fuzzy Properties and Operations – Fuzzy Logic System – Fuzzification – Defuzzification – Membership Functions – Fuzzy Rule base – Fuzzy Logic Controller Design.

UNIT - V

Evolutionary Computation - Overview of other Bio-inspired Algorithms - Swarm Intelligence Algorithms

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Text Books

1. Introduction to Neural Networks using MATLAB by S. N. Sivanandam, S. Sumathi and S. N. Deepa, Tata McGraw Hill Edition, 2006.
2. Kumar S., "Neural Networks - A Classroom Approach", Tata McGraw Hill, 2004.
3. Fuzzy Logic with Engineering Applications by Timothy J. Ross, WILEY India Edition, 3rd Edition, 2012.

Reference Books

1. Intelligent System – Modeling, Optimization & Control by Yung C. Shin and Chengying Xu, CRC Press, 2009.
2. Eiben A. E. and Smith J. E., "Introduction to Evolutionary Computing", Second Edition, Springer, Natural Computing Series, 2007.
3. Engelbrecht A. P., "Fundamentals of Computational Swarm Intelligence", John Wiley & Sons, 2006.

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Course Title	Electrical System Estimation & Costing				B. Tech. EEE Open Elective - III		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
20OE206	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learnabout estimating and costing of wiring systems, earthing systems, various light schemes and its calculations.

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

CO 1	Understand principles of wiring systems and its estimation based on choice of wiring system
CO 2	Understand the concepts of earthing systems
CO 3	Understand various lightening schemes and its calculations used for domestic and industrial applications
CO 4	Analyze estimation of wiring to residential & commercial buildings

UNIT-I

General principles of estimating: Estimating – purpose of estimating and costing – catalogues – market survey and source selection - determination of required quantity of materials – determination of cost material and labor.

Wiring systems: Introduction – Systems of distribution of electrical energy – methods of wiring – systems of wiring – choice of wiring systems.

UNIT – II

Earthing Systems: Earthing – Points to be earthed – Factors influencing earth resistance – methods od reducing Earth resistance – Design data on earth electrodes – Methods of earthing – determination of size of earth wire and earth plate – Effects of electric current on Human body – Measurement of earth resistance.

UNIT - III

Lighting schemes and calculations: Types of lighting circuits – Various circuit diagrams – Two way switching – Aspects of good lighting service – Types of lighting schemes – Filament Lamps- Gas filled Lamps – Fluorescent Tubes - LED lamp – Compact Fluorescent lamp (CFL) – comparison between LED and CFL – terms used in illumination – laws of illumination.

UNIT - IV

Estimation of lighting schemes: Design of lighting schemes - Factory lighting – Public lighting installations: Classification – General principles – Design – Selection of equipment - Street lighting – Methods of lighting calculations.

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UNIT-V

Internal wiring estimation: General rules for wiring – determination of number of points – determination of total load – determination of sub circuits – determination of ratings of main switch and distribution board – determination of size of conductor – layout – simple problems.

Text books

1. Electrical installation estimating & Costing – J.B.Gupta, S.K.Kataria& sons.
2. Electrical design estimating and costing – K.B.Raina&S.K.Bhattacharya, NewAge International (P) Limited publishers.

Reference Books

1. Power System Analysis and Design – Dr.B.R.Gupta, S.Chand Publications
2. Electrical Estimating methods – Wayne J.Del Pico, Wiley Publishers

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Course Title	Basics of Power Electronics				B. Tech. EEE Open Elective - IV		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
20OE207	Open Elective (OEC)	3	0	0	3	40	60	100
Mid Exam Duration : 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn basic fundamentals of power electronics devices and to classify the different kinds of power electronics circuits as a function of the input source and loads.

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

CO 1	To understand the characteristics of different power switches.
CO 2	To understand the single phase and three phase controlled rectifier with different loads
CO 3	To understand the operating principle of cyclo converters, choppers and inverters
CO 4	To understand harmonic content in output voltage and current waveforms of an inverter.

UNIT - I

Fundamentals of Power Semi-conductor devices: SCR – static characteristics –turn on and off mechanism – MOSFET, IGBT, GTO Characteristics.

UNIT - II

Phase controlled Rectifiers(AC to DC): Phase controlled rectifiers – single phase half and fully controlled converters – midpoint and bridge connections with R and RL loads – effect of source inductance- three phase half controlled converters with R load .

UNIT - III

AC Voltage Controllers (AC to AC): AC voltage controllers- single phase ac voltage controllers with SCR for R and RL load – cyclo converters – single phase cyclo converters (mid-point configuration) with R load.

UNIT - IV

Choppers (DC to DC): Choppers – principle of operation – control strategies- types of chopper circuits – type A, type B- buck -boost converter.

UNIT - V

Inverters(DC to AC): Inverters – single phase half bridge and full bridge inverters with R and RL load –output voltage control techniques - PWM techniques- harmonic reduction techniques.

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Text Books

1. Power Electronics –M.D Singh & K.B. Kanchandhani, TMH publications, 1998.
2. Power Electronics - Circuits, Devices and Applications –M.H. Rashid, Prentice Hall of India, 2nd Edition 1998.

Reference Books

1. Power Electronics- P.S. Bimbhra, Khanna Publications.
2. Power Electronics –Vedam Subramanyam, New Age Information Limited, 3rd Edition.
3. Power Electronics –V.R. Murthy, Oxford University Press, 1st Edition – 2005.
4. Power Electronics –P.C Sen, Tata Mc Graw Hill Publishing.

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Course Title	System Reliability Concepts					B. Tech. EEE Open Elective - IV		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
20OE208	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	1	0	3	40	60	100
Mid Exam Duration: 1Hr30M						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn basic probability theory, network modeling, time dependent probability, markov modeling and system reliability evaluation.

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

CO 1	Understand the concept of basic probability theory, binomial distribution, network reliability, reliability functions, time dependent probability, markov chains & process and system reliability
CO 2	Apply probability rules to find probability distributions, network reliability for series, parallel, series-parallel, complex networks
CO 3	Analyze the failure rate distributions, bath-tub curve, STPM, continuous markov process and frequency duration techniques for single and two repairable components
CO 4	Evaluate transitional rates, cumulative probability and frequency n-component repairable models

UNIT-I

Basic Probability Theory: Basic concepts – Rules for combining Probabilities of events – Failure Density and Distribution functions – Bernoulli's trials – Binomial distribution – Expected value and standard deviation for binomial distribution – Examples.

UNIT-II

Network Modeling and Reliability Evaluation: Basic concepts – Evaluation of network Reliability / Unreliability – Series systems, Parallel systems, Series - Parallel systems, partially redundant systems – Types of redundancies - Evaluation of network Reliability / Unreliability using conditional probability method – Paths based and Cut set based approach – Examples.

UNIT-III

Time Dependent Probability: Basic concepts – Reliability functions f(t), F(t), R(t), h(t) – Relationship between these functions – Bath tub curve – Expected value and standard deviation of Exponential distribution – Measures of reliability – MTTF, MTTR, MTBF – Evaluation of network reliability / Unreliability of simple Series, Parallel – Examples.

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UNIT-IV

Discrete Markov Chains: Basic concepts – Stochastic transitional Probability matrix (STPM) – Limiting State Probability evaluation – Absorbing states.

Continuous Markov Processes: Modeling concepts – State space diagrams – time dependent reliability evaluation of single component repairable model – Evaluation of Limiting State Probabilities of one, two component repairable models – Frequency and duration concepts – Frequency balance approach.

UNIT-V

Multi Component & Approximate System Reliability Evaluation: Recursive relation for evaluation of equivalent transitional rates, cumulative probability and cumulative frequency and 'n' component repairable model - Series systems, Parallel systems, Basic reliability indices – Cut-set approach – Examples.

Text Books

1. Reliability Evaluation of Engineering Systems by Roy Billinton and Ronald N. Allan, Reprinted in India B. S. Publications, 2007.
2. System Reliability Concepts by V. Sankar, Himalaya Publishing House, 2015.

Reference Books

1. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2003.
2. Reliability and Maintainability Engineering by Charles E. Ebeling, Tata McGraw Hill, 2000.

M. Tech. Power Systems (PS)

Course Structure and Syllabus for the 2022-23 Batch

I-Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2252101	Advanced Power System Protection	PCC	3	0	0	40	60	3
2	2252102	Power System Dynamics - I	PCC	3	0	0	40	60	3
		Professional Elective Course – I (PEC - I)							
3	2252103	Energy Conversion Systems	PEC	3	0	0	40	60	3
	2252104	Smart grid Technologies	PEC	3	0	0	40	60	3
	2252105	Wind and Solar Energy Systems	PEC	3	0	0	40	60	3
		Professional Elective Course – II (PEC - II)							
4	2252106	Electrical Power Distribution System	PEC	3	0	0	40	60	3
	2252107	Mathematical Methods in Power Engineering	PEC	3	0	0	40	60	3
	2252108	Electric and Hybrid Vehicles	PEC	3	0	0	40	60	3
5	2252109	Research Methodology and IPR	--	2	0	0	40	60	2
6	2252110	Power System Lab - I	PCC	0	0	4	50	50	2
7	2252111	Power System Simulation Lab-I	PCC	0	0	4	50	50	2
8	---	Audit Course I	AC	2	0	0	40	00	00
Total				16	00	08	340	400	18

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II Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2252201	Power System Security and State Estimation	PCC	3	0	0	40	60	3
2	2252202	Power System Dynamics - II	PCC	3	0	0	40	60	3
3		Professional Elective Course – III (PEC- III)							
	2252203	Restructured Power Systems	PEC	3	0	0	40	60	3
	2252204	Energy Auditing and Management	PEC	3	0	0	40	60	3
	2252205	Electrical Machine Design	PEC	3	0	0	40	60	3
4		Professional Elective Course – IV (PEC- IV)							
	2252206	SCADA System and Applications	PEC	3	0	0	40	60	3
	2252207	Electrical Power Quality	PEC	3	0	0	40	60	3
	2252208	Power System Reliability	PEC	3	0	0	40	60	3
5	2252209	Technical Seminar	PCC	0	0	4	100	00	2
6	2252210	Power System Lab – II	PCC	0	0	4	50	50	2
7	2252211	Power System Simulation Lab-II	PCC	0	0	4	50	50	2
8	---	Audit Course II	AC	2	0	0	40	00	00
Total				14	00	12	340	340	18

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III - Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1		Professional Elective Course – V (PEC- V)							
	2252301	Power System Transients	PEC	3	0	0	40	60	3
	2252302	Industrial Load Modeling and Control	PEC	3	0	0	40	60	3
	2252303	Modern Control Theory	PEC	3	0	0	40	60	3
2		Open Elective (OEC)							
	2271304	Business Analytics	OEC	3	0	0	40	60	3
	2271305	Operations Research	OEC	3	0	0	40	60	3
	2271306	Waste to Energy	OEC	3	0	0	40	60	3
3	2252307	Dissertation Phase - I	PR	0	0	20	100	00	10
4	2252308	Co-curricular Activity	R	0	0	0	--	--	2
Total				6	0	20	180	120	18

IV Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2252401	Dissertation Phase - II	PR	0	0	32	50	50	16
		Total		0	0	32	50	50	16

Audit course I & II

S. No.	Course Code	Course Name
1	2270A01	English for Research Paper Writing
2	2270A02	Disaster Management
3	2270A03	Sanskrit for Technical Knowledge
4	2270A04	Value Education
5	2270A05	Constitution of India
6	2270A06	Pedagogy Studies
7	2270A07	Stress Management by Yoga
8	2270A08	Personality Development through Life Enlightenment Skills

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List of Open Elective Courses offered to other branch students:

Course Codes	Course Name
22OE521	Internet of Things
22OE522	Programmable Logic Controller (PLC) & its Applications
22OE523	Power Electronics for Renewable Energy Systems

I – Semester

Course Title	Advanced Power System Protection				M. Tech., I Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252101	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		
Course Objectives: The objective of the course is to learn about numerical relays, algorithms for numerical protection and developing mathematical approach towards protection.								
On successful completion of this course, the students will be able to								
CO 1	Learn the importance of Digital Relays							
CO 2	Apply Mathematical approach towards protection							
CO 3	Learn to develop various Protection algorithms							

UNIT - I

Introduction: Evolution of Digital Relays from Electromechanical Relays, Performance and Operational Characteristics of Digital Protection.

UNIT - II

Mathematical Background to Protection Algorithms: Finite Difference Techniques, Interpolation Formulas: Forward, Backward and Central Difference Interpolation, Numerical Differentiation, Curve Fitting and Smoothing, Least Squares Method, Fourier analysis, Fourier series and Fourier Transform, Walsh Function Analysis.

UNIT - III

Basic Elements Of Digital Protection: Signal Conditioning: transducers, Surge Protection, Analog Filtering, Analog Multiplexers, Conversion Subsystem Sampling Theorem, Signal Aliasing Error, Sample And Hold Circuits, Multiplexers, Analog To Digital

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Conversion, Digital Filtering Concepts, The Digital Relay as a Unit Consisting Of Hardware and Software.

UNIT - IV

Sinusoidal Wave Based Algorithms: Sample and First Derivative (Mann and Morrison) algorithm. Fourier and walsh based Algorithms.

Fourier Algorithm: Full Cycle Window algorithm, Fractional Cycle Window algorithm. Walsh Function Based Algorithm. Least Squares based algorithms. Differential Equation Based Algorithms.

UNIT - V

Travelling Wave based Techniques: Digital Differential Protection of Transformers. Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems.

Reference Books:

1. A.G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", Wiley/Research studies Press, 2009.
2. A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEE Press, 1999.
3. Gerhard Zeigler, "Numerical Distance Protection", Siemens Publicis Corporate Publishing, 2006.
4. S.R.Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014.

Course Title	Power Systems Dynamics - I				M. Tech., I Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252102	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn concepts of system dynamics and its physical interpretation, development of mathematical models for synchronous machine, modelling of induction motor.

On successful completion of this course, the students will be able to

CO 1	Understand the modeling of synchronous machine in detail.
CO 2	Carry out simulation studies of power system dynamics using MATLAB/ SIMULINK.
CO 3	Carry out stability analysis with and without power system stabilizer
CO 4	Understand the load modeling in power system

UNIT-I

Modelling of Synchronous Machine: Synchronous machine – Park's Transformation-analysis of steady state performance, per - unit quantities-Equivalent circuit of synchronous machine.

UNIT-II

Steady State Analysis: Voltage, Current and Flux Linkage relationships, Steady state equivalent circuit, Formulation of State Space Model.

UNIT-III

Sub-Transient and transient inductance and Time Constants, Synchronous Machines Simplified model.

UNIT-IV

Excitation System: Effects of Excitation system, PSS-Block Diagram, System State matrices (Type Systems).

UNIT-V

Modelling of Induction Motors: Basic Equations, d-q Transformations, Steady State Characteristics, Equivalent Circuits, Effect of rotor resistance, Modelling of Prime Movers.

Text Books:

1. P.M. Anderson & A.A. Fouad, "Power System Control and Stability", IEEE Press.
2. Power system Stability and Control, P. Kundur, TMH.
3. Power system Analysis and Design, William D Stevenson, John J Grainger, TMH.

Reference Books:

1. Power Systems Dynamics and Stability, M.A.Pai- PHI Publications.
2. Power system dynamics, K.R. PADIYAR - B.S. Publications.

<table>
<tr><td>Course Title</td><td colspan="5">Energy Conversion Systems (PE-I)</td><td colspan="3">M. Tech., I Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252103</td><td rowspan="2">Professional Elective (PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to learn various renewable energy sources, understanding of integrated operation of renewable energy sources and Power Electronics Interface with the Grid.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Knowledge about renewable energy.</td></tr>
<tr><td>CO 2</td><td colspan="7">Understand the working of distributed generation system in autonomous/grid connected modes.</td></tr>
</table>

CO 3	Know the Impact of Distributed Generation on Power System

UNIT - I

Introduction, Distributed Vs Central Station Generation, Various non - Conventional energy sources, availability, classification merits and demerits.

UNIT - II

Introduction to solar Energy, Theory of Solar Cells, Solar cell materials, Solar Cell array, solar radiation, Flat Plate Collectors, Focussing Plate Collectors, Solar Thermal Power Plants.

UNIT - III

Introduction to wind energy, wind power and its Sources, Site Selection, criterion, Classification of rotors, wind characteristics, Performance and limitations of energy conversion Systems.

UNIT - IV

Resources of geothermal energy, Thermo dynamics of geothermal energy conversion electrical conversion, non - electrical Conversion, environmental considerations.

UNIT - V

Tidal energy – Tides and tidal power stations- modes of operation – Turbines & Generators for Tidal Power Generation.

Fuel Cells-Working Principle, types of Fuel Cells, Performance and limitations.

Text Books:

1. RanjanRakesh, Kothari D.P, Singal K.C, "Renewable Energy Sources and Emerging Technologies, 2nd Ed. Prentice Hall of India, 2011.
2. Rakosh Das Begamudre, "Energy Conversion systems", New Age International Publishers.

Reference Books:

1. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators",October 2007, Wiley-IEEE Press.
2. Roger A.Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed, 2010.
3. James F.Manwell, Jon G.McGowan, Anthony L Rogers, "Wind energy explained: Theory Design and Application", John Wiley and Sons 2nd Ed, 2010.

Course Title	Smart Grid Technologies (PE-I)				M. Tech., I Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252104	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the concept of smart grid and its advantages over conventional grid, smart metering techniques, learn wide area

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measurement techniques and the problems associated with integration of distributed generation & its solution through smart grid.	
On successful completion of this course, the students will be able to	
CO 1	Understand the difference between smart grid & conventional grid.
CO 2	Apply smart metering concepts to industrial and commercial installations.
CO 3	Formulate solutions in the areas of smart sub-stations, distributed generation and wide area measurements.
CO 4	Come up with smart grid solutions using modern communication technologies.

UNIT - I

Introduction to Smart Grid, Evolution of Electric Grid-Concept of Smart Grid, Definitions-Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid.

UNIT - II

Introduction to Smart Meters, Real Time Pricing, Smart-Appliances, Automatic Meter Reading(AMR)-Outage Management System(OMS)-Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation-Smart Substations, Substation Automation, Feeder Automation.

UNIT - III

Geographic Information System (GIS)-Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Wide Area Measurement System(WAMS)-Phasor Measurement Unit(PMU).

UNIT - IV

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of inter-connection, protection & control of micro-grid.-Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines.

UNIT - V

Advanced Metering Infrastructure (AMI), Home Area Network(HAN),- Neighborhood Area Network (NAN), Wide Area Network (WAN)-Bluetooth, Zigbee, GPS, Wi-Fi, Wi-Max based communication,-Wireless Mesh Network, Basics of CLOUD Computing & Cyber-Security for Smart Grid-Broadband over Power line (BPL).

Text Books:

1. Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley IEEE, 2011.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press, 2009.

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications",Wiley 2012.
2. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions", CRC Press.
3. A.G.Phadke, "Synchronized Phasor Measurement and their Applications", Springer.

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Course Title	Wind & Solar Energy Systems (PE-I)					M. Tech., I Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252105	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn about wind and solar systems, the factors involved in installation and commissioning of a Solar or Wind plant and the dynamics involved when interconnected with power system grid.

On successful completion of this course, the students will be able to

CO 1	Understand the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems.
CO 2	Gain the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems.
CO 3	Gain the knowledge of physics of solar power generation and the associated issues.
CO 4	Identify, formulate and solve the problems of energy crises using wind and solar energy

UNIT-I

Historical development and current status: Introduction – historical background – current status of wind power worldwide – status of wind turbine technology.

Characteristics of wind power generation – basic integration issues: consumer requirements – requirements from wind farm operators – the integration issues.

UNIT – II

Generators and Power Electronics for wind turbines: generator concepts – power electronic concepts – power electronic solutions in wind farms.

Power quality standards of wind turbines: Power Quality characteristics of wind turbines – Impact on voltage quality.

Technical regulations for inter connections: overview of technical regulations – comparison of technical regulations.

UNIT- III

Isolated systems with wind power: isolated power systems – overview of wind – diesel power systems – wind power impact on power quality.

Reactive power capability and voltage control: Relevance and design paradigm – Reactive power capability of a wind turbine – model based design of voltage control systems for wind power plants.

Economic aspects: introduction – costs for network connection and network upgrading – System operation costs in a deregulated market.

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UNIT – IV

Impacts of wind power on power system stability: Power system stability and security – rotor angle stability – voltage stability – frequency stability – dynamic behavior of wind power plants.

Solar energy: merits, demerits – thermal applications.

UNIT- V

Concentrating collectors - devices for thermal collection & storages – Thermal energy storage: sensible heat storage, latent heat storage, Thermo chemical storage - solar pond: principle of working – description.

Text Books

Wind power in Power Systems by Thomas Ackerman, John Willy & Sons ltd.

Reference Books:

Solar Energy by K. Sukhatme & S.P. Sukhatme, TMH, 2nd Edition.

Course Title	Electrical Power Distribution Systems (PE-II)					M. Tech., I Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252106	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		
Course Objectives: The objective of the course is to learn about power distribution system, SCADA System and Distribution Automation.								
On successful completion of this course, the students will be able to								
CO 1	Gain knowledge in power distribution systems							
CO 2	Study of Distribution automation and its applications							
CO 3	Learn SCADA system							
CO 4	Apply AI Techniques to DA							

UNIT-I

Electricity Forecasting: Power loads – connected loads – short term load forecasting - long term load forecasting – distribution of power- Distributed energy supply system – technological forecasting.

UNIT-II

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Distribution Automation (DA): Need for distribution automation – characteristics of distribution system – distribution automation- feeder automation – communication requirements for DA- Remote Terminal Unit.

UNIT- III

SCADA System: Introduction- block diagram –components of SCADA – functions of SCADA – SCADA applied to DA – Advantages of DA through SCADA – Requirements and feasibility – DA Integration Mechanisms – Communication protocols in SCADA systems.

UNIT-IV

Remote Metering: Background for Automatic Meter Reading(AMR) for utility – Components of AMR systems – communication methods used for meter reading – AMR system – services and functions - Planning for AMR implementation -Optimal Switching Device placement in Radial distribution system – sectionalizing switches.

UNIT –V

AI Techniques Applied to DA: Introduction – general techniques description – genetic algorithm and its implementation – steps followed in simple Genetic algorithm – Application of GA to DA. Energy Management – Need Based Energy Management- Demand Side management -Urban and Rural Distribution Systems: Urban Distribution – Rural distribution systems.

Text Books:

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd, Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical Power Distribution Automation", University Science Press, New Delhi.
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press.

Course Title	Mathematical Methods for Power Engineering (PE-II)				M. Tech., I Semester		
Course Code	Category	Hours / Week		Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
2252107	Professional Elective (PEC)	3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration : 3Hrs			
Course Objectives: The objective of the course is to learn the relevance of mathematical methods to solve engineering problems and how to apply these methods for a given engineering problem.								
On successful completion of this course, the students will be able to								
CO 1	Knowledge about vector spaces, linear transformation, eigen values and eigenvectors of linear operators.							

CO 2	To learn about linear programming problems and understanding the simple method for solving linear programming problems in various fields of science and technology.
CO 3	Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems.
CO 4	Understanding the concept of random variables, functions of random variable and their probability distribution.
CO 5	Understand stochastic processes and their classification.

UNIT- I

Vector spaces, Linear transformations, Matrix representation of linear transformation, Eigen values and Eigen vectors of linear operator.

UNIT- II

Linear Programming Problems, Simplex Method and Duality. Non Linear Programming problems.

UNIT -III

Unconstrained Problems, Search methods, Constrained Problems.

UNIT- IV

Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions.

UNIT - V

Independent Random Variables, Marginal and Conditional distributions, Elements of stochastic processes.

Text Books

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992.
2. Hillier F S and Liebermann G J, "Introduction to Operations Research", 8th Edition, McGraw Hill, 2009.
3. A Papoulis, S. Unnikrishna pillai, "Probability, Random Variables and Stochastic Processes", 4rd Edition, McGraw Hill., 2002.

Reference Books:

1. S.S. Rao, Engineering Optimization Theory and Practice ' Third Enlarges Edition, New age international publishers, 2013.
2. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002.
3. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994

Course Title	Electric & Hybrid Vehicles (PE-II)				M. Tech., I Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
	Professional Elective	L	T	P	C	Continuous Internal Assessment	End Exam	Total

2252108	(PEC)	3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the upcoming technology of hybrid system, different aspects of drives application and learning the electric Traction.

On successful completion of this course, the students will be able to

CO 1	Acquire knowledge about fundamental concepts, principles of hybrid and electric vehicles.
CO 2	Analyze and design of hybrid and electric vehicles.
CO 3	To learn electric drive in vehicles / traction.

UNIT - I

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source, Characterization - Transmission characteristics, Mathematical models to describe vehicle performance.

UNIT - II

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

UNIT - III

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives and drive system efficiency.

UNIT - IV

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics devices, Selecting the energy storage technology, Communications, supporting subsystems.

UNIT - V

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies, Comparison of different energy management strategies, Implementation issues of energy strategies.

Reference Books

1. Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding Mode Control of Switching Power Converters".

Course Title	Research Methodology and IPR			M. Tech., I Semester
Course	Category	Hours /	Credits	Maximum Marks

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Code		Week						
2252109	--	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn a perspective on research to the scholars so as to broaden their conceptions of what research involves and to impart knowledge on techniques related to research such as problem formulation, literature survey, information retrieval, use of statistical techniques, writing of research reports and evaluation To expose the scholars ethics in research and Intellectual Property Rights.

On successful completion of this course, the students will be able to

CO 1	Understand research problem formulation and research ethics
CO 2	Analyze research related information
CO 3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO 4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO 5	Understand that IPR protection provides an incentive to inventors for further research work

UNIT - I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT - II

Effective literature studies approaches, Plagiarism and Research ethics

UNIT -III

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

UNIT - IV

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

UNIT - V

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

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

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
2. Wayne Goddard and Stuart Melville, "Research Methodology: an Introduction".
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners".

Reference Books:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Course Title	Power Systems Lab - I				M. Tech., I Semester		
Course Code	Category	Hours / Week		Credits	Maximum Marks		
2252110	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3	2	50	50	100
						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to analyze various faults with and without impedance, determine the sequence impedance of transformer and various parameters of a 220 KV transmission line.

On successful completion of this course, the students will be able to

CO 1	Analyze the fault currents for various faults on un-loaded synchronous machine
CO 2	Determine the sequence impedances of transformer and Synchronous Generators
CO 3	Determine the ABCD parameters of a Transmission Line

List of Experiments (Any Eight)

1. Sequence impedances of synchronous machine
2. Symmetrical faults

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3. Unsymmetrical Faults (LL & SLG)
4. Unsymmetrical Faults (LLG)
5. Sequence impedances of three phase transformer.
6. Power angle characteristics of salient pole synchronous machine.
7. Ferranti effect and ABCD parameters of 220kV transmission line.
8. Transient & sub-transient reactance's of synchronous machine.
9. Regulation & Efficiency of a 220KV transmission line

Course Title	Power System Simulation Lab - I				M. Tech., I Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252111	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	3	2	50	50	100
						End Exam Duration : 3Hrs		
Course Objectives: The objective of the course is to identify, analyze, illustrate and develop different models in power systems using MATLAB/ETAP Software.								
On successful completion of this course, the students will be able to								
CO 1	Develop admittance and impedance matrices of power systems using MATLAB/ETAP Software							
CO 2	Analyze the power flow problems for simple power system networks							
CO 3	Analyze the stability analysis of power systems using MATLAB/ETAP Software							
CO 4	Evaluate the short circuit analysis using MATLAB/ETAP Software							

List of Experiments (Any Eight)

1. Formation of Y-bus
2. Formation of Z-bus
3. Load flow analysis by Gauss-Seidel Method
4. Load flow analysis by Newton-Raphson Method
5. Load flow analysis by Fast-decoupled Method
6. Small signal stability of Single machine connected to Infinite bus system

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7. Transient stability of Multi Machine System
8. Simulation of Static VAR Compensator
9. Short circuit studies
10. Harmonic analysis & tuned filter design to mitigate harmonics

M. Tech. II Semester

Course Title	Power System Security and State Estimation					M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252201	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to

1. Understand the basic concepts of network matrices, power flow methods, state estimation, and applications of power system state estimation and structure of deregulated power system.
2. Analyze about admittance/impedance matrices, factors influencing power system security, network problems and power wheeling transactions.
3. Implement the methods for determining the bus matrices, optimal ordering, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC).
4. Develop the algorithm for orthogonal matrix, method to identify network problems and congestion management methods and electricity sector structure.

On successful completion of this course, the students will be able to

CO 1	Understand the concepts of network matrices, power flow methods, contingency analysis, state estimation, and need and conditions for deregulation.
CO 2	Analyze the bus admittance/impedance matrices methods, power system security, sensitivity factors, state estimation and electricity structure model
CO 3	Apply the methods for evaluating the bus matrices, sparsity, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC).
CO 4	Develop the methods for state estimation, method to identify network problems and methods for congestion management

UNIT-I

Power System Network Matrices: Formation of bus admittance matrices by direct inspection method and singular transformation method – Algorithm for formation of Bus impedance matrix: addition of a branch and addition of a link, removal element in

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Bus impedance matrix– Sparsity programming and Optimal Ordering – Numerical problems – ∏-representation of off-nominal tap transformers.

UNIT-II

Power System Security-I: Review of power flow methods (qualitative treatment only)– DC power flow method-simple problems – Introduction to power system security – Factors influencing power system security.

UNIT-III

Power System Security-II: Introduction to contingency analysis – Contingency analysis: Detection of Network problems, linear sensitivity factors –AC power flow methods– Contingency selection– Simple problems

UNIT-IV

State Estimation in Power System: Power system state estimation – SCADA –EMS center, Methods of state estimation – Method of least squares, Orthogonal matrix–Properties– Givens rotation–Orthogonal decomposition–Bad data detection, Pseudo measurements and applications of power system state estimation – Simple problems.

UNIT-V

Security in Deregulated Environment: Need and conditions for deregulation–Electricity sector structure model – Power wheeling transactions – Congestion management methods– Available Transfer Capability (ATC) – System security in deregulation.

Text Books:

Allen J. Wood and Wollenberg B.F., Power Generation Operation and control, John Wiley & Sons, 3rd edition, 2013.

Reference Books:

P. Venkatesh, B.V. Manikandan, S. Charles Raja and A.Srinivasan, Electrical power systems analysis, security, and deregulation, PHI learning private limited, Delhi, 1st edition 2014

Course Title	Power System Dynamics-II				M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252202	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		
Course Objectives: The objective of the course is to study of power system dynamics, Interpretation of power system dynamics phenomena and various forms of stability.								
On successful completion of this course, the students will be able to								
CO 1	Gain valuable insights into the phenomena of power system including obscure							

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	ones
CO 2	Understand the power system stability problem
CO 3	Analyze the stability problems and implement modern control strategies.
CO 4	Simulate small signal and large signal stability problems

UNIT-I

Basic Concepts and Definitions: Concept of State, Eigen values, Eigen Vectors, Representation of State space. Small signal stability of single machine connected to infinite bus system.

UNIT-II

Effect of Damper, Flux Linkage Variation and Effect of AVR on Synchronizing and Damping Torque Components, Block diagram.

UNIT-III

Large Signal Rotor Angle Stability, Mitigation Using Power System Stabilizer, Multi-Machine Stability.

UNIT-IV

Dynamic Analysis of Voltage Stability- Modeling requirements, Static and Dynamic analysis, Voltage Collapse.

UNIT-V

Frequency Stability: Automatic Generation Control Models-Primary Speed Control and Supplementary Control, Implementation of AGC, Functional Block Diagram.

Text Book

1. P.M. Anderson and A.A. Fouad, "Power System Control And Stability", IEEE Press.
2. Power System Stability and Control, P.Kundur, TMH.

Reference Books:

1. Power System Analysis and Design, William D Stevenson, John J Grainger, TMH.
2. Power Systems Dynamics and Stability, M.A.Pai- PHI Publications.

Course Title	Restructured Power Systems (PE – III)				M. Tech., II Semester		
Course Code	Category	Hours / Week		Credits	Maximum Marks		
2252203	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration : 3Hrs			

Course Objectives: The objective of the course is to understand what is meant by restructuring of the electricity market, the need behind requirement for deregulation of the electricity market, the money, power & information flow in a deregulated power systems.

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On successful completion of this course, the students will be able to	
CO 1	Understand various types of regulations in power systems.
CO 2	Identify the need of regulation and deregulation.
CO 3	Analyse technical and non-technical issues in Deregulated Power Industry.
CO 4	Identify and give examples of existing electricity markets.
CO 5	Classify different market mechanisms and summarize the role of various entities in the market

UNIT - I

Deregulation of Electric Utilities: Introduction – Traditional central utility model, reform motivations, separation of ownership and operation, competition and direct access in the electricity market, independent system operator (ISO), retail electric providers, different experiences.

UNIT -II

Competitive Wholesale Electricity Markets & Transmission Open Access: Introduction, ISO, wholesale electricity market characteristics, market model, challenges, trading arrangements, the pool and bilateral trades, multi lateral trades.

UNIT - III

Transmission Cost Allocation Methods: Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

UNIT - IV

Market Power & Ancillary Services Management: Introduction - Different types of market Power – Mitigation of Market Power – Examples - Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

UNIT - V

Available Transfer Capability (ATC) : Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow - Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

Text Books:

1. Power System Restructuring and Deregulation, Loi Lei Lai, John Wiley & Sons Ltd., England, 2001.
2. Operation of Restructured Power System, Kankar Bhattacharya, Math H.J. Boller and Jaap E. Daalder Kulwer Academic Publishers, 2001. \

Reference Books:

1. Restructured Electrical Power Systems, Mohammad Shahidehpour and Muwaffaq alomoush, Marcel Dekker, Inc., 2001.

Course Title	Energy Auditing and Management (PE – III)			M. Tech., II Semester
Course Code	Category	Hours / Week	Credits	Maximum Marks

2252204	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to understand the need for energy auditing, various loads involved based on power consumption for auditing to know about different audit instruments used in practice.

On successful completion of this course, the students will be able to

CO 1	Acquire the background required for engineers to meet the role of energy managers and to acquire the skills and techniques required to implement energy management.
CO 2	Identify and quantify the energy intensive business activities in an organization.
CO 3	Able to perform basic energy audit in an organization

UNIT - I

System approach and End use approach to efficient use of Electricity-Electricity tariff types-Energy auditing: Types and objectives - audit instruments-ECO assessment and Economic methods-Specific energy analysis-Minimum energy paths-consumption models-Case study.

UNIT - II

Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load-Load Matching and selection of motors-Variable speed drives; Pumps and Fans-Efficient Control strategies - Optimal selection and sizing-Transformer Loading/Efficiency analysis-Reactive Power management-Capacitor-Sizing-Degree of Compensation-Capacitor-losses-Location-Placement-Maintenance,-Case-study.

UNIT - III

Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study-Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes-Electronic ballast-Power quality issues-Luminaries, case study.

UNIT - IV

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study-Electric loads of Air conditioning &Refrigeration-Energy conservation measures- Cool storage-Types-Optimal operation case study.

UNIT - V

Electric water heating-Geysers-Solar Water Heaters-Power Consumption in Compressors-Energy conservation measures-Electrolytic Process-Computer Controls- software-EMS.

Text Books

1. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub; (1998).
2. Howard E. Jordan, .Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2ndedition (1994).

Reference Books:

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1. Giovanni Petrecca, Industrial Energy Management: Principles and Applications., The Kluwerinternational series -207,1999.
2. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006.
3. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009.

Course Title	Electrical Machine Design (PE – III)					M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252205	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		
Course Objectives: The objective of the course is to study the modelling analysis of rotating machine, learning electromagnetic energy conversion and rating of machines.								
On successful completion of this course, the students will be able to								
CO 1	To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used							
CO 2	Ability to model and design all types of rotation machines including special machines							

UNIT-I

The Design problem – Introduction, design specifications, limitations in design, Modern trends in design of electrical machines.

Thermal state in electrical Machines – Salient features of heating curves – cooling of rotating machines – Methods of cooling - cooling system - Induced & forced ventilation, Radial and Axial Ventilation - Cooling of turbo alternators: Hydrogen cooling, Direct cooling, Air cooled. - Types of Duties and Ratings.

UNIT - II

Design of transformers – Types of transformer – core construction, output equation, principle of design of core, windings, yoke main dimensions (H & W) for single phase: core type, shell type. 3-phase – core type transformers estimation of no load current of transformer - Design of tank with tubes.

UNIT- III

General concepts of rotating machines – Output equation of dc machines, ac machines, separation of D & L, choice of specific loadings.

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Design of D.C machines – Choice of no. of poles, selection of no. of armature slots, choice of winding, estimation of conductor cross section of armature, design of field systems: tentative design of field winding of dc machines.

UNIT- IV

Design of 3-phase induction motor – Separation of D & L, Choice of Ampere conductors and B_{av}.

Stator design – Selection of no of stator slots, turns per phase, design of conductor cross section.

Rotor design - Selection of no of rotor slots, principles of design of squirrel cage rotor, design of slip ring rotor.

Relation between D&L for best power factor – Methods of improving Starting Torque - Losses & Efficiency.

UNIT- V

Design of synchronous machines – Separation of D & L, choice of Ampere conductors & B_{av} - Short Circuit Ratio (SCR) and its significance.

Armature design – choice of no. of stator (Armature) slots, turns/phase, conductor cross section for both salient pole and cylindrical pole machines.

Introduction to computer aided design – different approaches.

Text Books

Sawhney. A. K., "A course in Electrical Machine Design", Dhanpat Rai & Co.

Reference Books:

Clayton. A. E. & NN Hancock, "The performance and design of Direct Current machines", CBS publishers & Distributors.

Course Title	SCADA Systems and Applications (PE – IV)				M. Tech., II Semester		
Course Code	Category	Hours / Week		Credits	Maximum Marks		
2252206	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration : 3Hrs		
Course Objectives: The objective of the course is to understand what is SCADA and its functions, various communication used in SCADA and its applications.							
On successful completion of this course, the students will be able to							
CO 1	Understand the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.						
CO 2	Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.						
CO 3	Gain knowledge about single unified standard architecture IEC 61850.						

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CO 4	Learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
CO 5	Learn and understand about SCADA applications in transmission and distribution sector, industries etc.

UNIT - I

Introduction to SCADA-Data acquisition systems-Evolution of SCADA-Communication technologies.

UNIT - II

Monitoring and supervisory functions-SCADA applications in Utility Automation-Industries SCADA.

UNIT - III

SCADA System Components-Schemes- Remote Terminal Unit (RTU)-Intelligent Electronic Devices (IED)-Programmable Logic Controller (PLC)-Communication Network, SCADA Server, SCADA/HMI Systems.

UNIT - IV

SCADA Architecture-Various SCADA architectures, advantages and disadvantages of each System-Single unified standard architecture -IEC 61850.

UNIT - V

SCADA Communication-various industrial communication technologies-wired and wireless methods and fiber optics-SCADA Applications: Utility applications.

Text Books

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.

Reference Books:

1. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.
2. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
3. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well 1999.

Course Title	Electrical Power Quality (PE – IV)					M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252207	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100

Mid Exam Duration: 2Hrs	End Exam Duration : 3Hrs

Course Objectives: The objective of the course is to understand the different power quality issues to be addressed, the recommended practices by various standard bodies like IEEE, IEC, etc on voltage & frequency, harmonics and STATIC VAR Compensators.

On successful completion of this course, the students will be able to

CO 1	Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads.
CO 2	Develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components.
CO 3	Understand active power factor correction based on static VAR compensators and its control techniques.
CO 4	Analyze series and shunt active power filtering techniques for harmonics.

UNIT - I

Introduction-power quality-voltage quality-overview of power quality Phenomena-classification of power quality issues-power quality measures and standards-flicker factor transient phenomena-occurrence of power quality problems.

UNIT - II

Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-Triplen harmonics-important of harmonic introducing devices-SMPS-Three phase power converters- arcing devices- saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

UNIT - III

Modeling of networks and components under non-sinusoidal Conditions- transmission and distribution systems-Shunt capacitors-transformers-electric machines-ground systems -loads that cause power quality problems-power quality problems created by drives and its impact on drive.

UNIT - IV

Power factor improvement- Passive Compensation-Passive Filtering, Harmonic Resonance-Active Power Factor Correction- Single Phase Front End,-Control Methods for Single Phase APFC & Three Phase APFC and Control Techniques, PFC-Based on Bilateral Single Phase and Three Phase Converter.

UNIT - V

Dynamic Voltage Restorers for sag , swell and flicker problems.

Grounding and wiring introduction-grounding requirements-reasons for grounding

Text Books:

1. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007.
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000.

Reference Books:

1. J. Arrillaga, "Power System Quality Assessment", John wiley, 2000.
2. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,"Power system Harmonic Analysis", Wiley, 1997.

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Course Title	Power System Reliability (PE – IV)				M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252208	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the basic reliability concepts, density and distribution functions, random variables and networks, reliability functions and time dependent reliability evaluation of different networks, markov modelling and component repairable models for frequency and duration and reliability applications to generation, transmission and distribution systems.

On successful completion of this course, the students will be able to

CO 1	Understand the basic reliability concepts, network modelling.
CO 2	Apply different reliability functions and time dependent reliability evaluation for different networks.
CO 3	Understand the concepts of markov modelling and component repairable models for frequency and duration techniques
CO 4	Apply various reliability fundamental techniques to Generation Systems
CO 5	Analyze bulk power system Reliability evaluation techniques and inter connected system reliability
CO 6	Apply basic reliability techniques to distribution system reliability for radial and parallel configurations.

UNIT -I

Basic Probability Theory and Distribution-Basic probability theory-rules for combining probabilities of events, Bernoulli's trials, Probability Density and Distribution Functions, Binomial and Poisson's Distribution- Expected Value and Standard Deviation.

Network Modeling and Reliability Analysis -Analysis of Series, Parallel, Series – Parallel Networks, Complex Networks – Decomposition Method, Cut set and Tie set methods. Reliability Functions – f(t), R(t), F(t), h(t) and their relationships – Exponential Distribution – Expected Value and Standard Deviation of Exponential Distribution - Reliability Analysis of Series –Parallel Networks using Exponential Distribution – Bath Tub Curve, Reliability Measures - MTTF, MTTR, MTBF

UNIT- II

Markov Modeling – Markov Chains – Concept of STPM, Evaluations of Limiting State Probabilities – Markov Processes on Components Repairable System – Time Dependent

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Probability Evaluation using Laplace Transform Approach – Evaluation of Limiting State Probabilities using STPM – Two Component Reliability Models.

Frequency and Duration Concept – Evaluation of Frequency of Encountering State, Mean Cycle Time for One and Two Component Repairable Models – Evaluation of Cumulative Probability and Cumulative Frequency of Encountering of Merged States.

UNIT - III

Generating System Reliability Analysis – I - Generation system model – Capacity Outage Probability Tables – Recursive Relation for Capacitive Model Building – Sequential Addition Method – Unit Removal – Evaluation of Loss of Load and Energy Indices – Examples.

Generating System Reliability Analysis – II – Frequency & Duration Methods – Evaluation of Equivalent Transitional Rates of Identical and Non-identical Units – Evaluation of Cumulative Probability and Frequency of Non--identical generating Units – Two Level Daily Load Representation – Merging Generation and Load Models - Examples

UNIT - IV

Bulk Power System Reliability Evaluation - Basic configuration – conditional probability approach – system and load point reliability indices –weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures.

Inter Connected System Reliability Analysis - Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads –Expression for cumulative probability and cumulative frequency.

UNIT - V

Distribution System Reliability Analysis- I (Radial Configuration) - Basic Techniques, Radial Networks, Evaluation of Basic Reliability Indices, Performance Indices, Load Point and System Reliability Indices, Customer Oriented, Load and Energy Oriented Indices – Examples.

Distribution System Reliability Analysis- II (Parallel Configuration) - Basic techniques – inclusion of bus bar failures, scheduled maintenance – temporary and transient failures – weather effects – common mode failures –Evaluation of various indices – Examples

Text Books

1. Reliability Evaluation of Engineering System – R. Billinton, R. N. Allan, Plenum Press, New York, Reprinted in India by B. S. Publications, 2006
2. Reliability Evaluation of Power Systems – R. Billinton, R. N. Allan, Plenum Press, New York, Reprinted in India by B. S. Publications, 2006.

Reference Books:

Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978. (First Edition).

Course Title	Technical Seminar				M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
	Project (PROJ)	L	T	P	C	Continuous Internal Assessment	End Exam	Total

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2252209		2	0	0	2	100	00	100

Course Objectives: The main objective of the seminar helps to develop in an emerging field at the intersection of multidisciplinary understandings of culture and education. The students also explore and develop in new perspectives.

On successful completion of this course, the students will be able to

CO 1	Understand the theme of the seminar.
CO 2	Identify and discuss current real-world issues.
CO 3	Distinguish and integrate differing forms of knowledge and academic disciplinary approaches with that of the student's own academic discipline and apply a multidisciplinary strategy to address current, real-world issues.
CO 4	Improve oral and written communication skills
CO 5	Explore an appreciation of the self in relation to its larger diverse social and academic contexts.
CO 6	Apply principles of ethics and respect in interaction with others.

Course Title	Power Systems Lab - II				M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252210	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	4	2	50	50	100
						End Exam Duration : 3Hrs		

Course Objectives: The main objective of power system lab is to understand the solar, wind and biomass generating systems and characteristics of various relays.

On successful completion of this course, the students will be able to

CO 1	Understand the solar, wind and biomass generating systems
CO 2	Analyze the characteristics of various relays
CO 3	Analyze the control techniques of a transmission lines

List of Experiments

(Any **Eight** of the following experiments has to be carried out)

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1. Characteristics of over current relay.
2. Characteristics of Directional Over Current Relay
3. Voltage control of 220kV transmission line.
4. Current control of 220kV transmission line.
5. Characteristics of differential current relay.
6. Over voltage/under voltage relay.
7. Negative sequence relay.
8. Study of rooftop solar system.
9. Field visit to wind generation system.
10. Study of Bio-mass generation plant.

Course Title	Power Systems Simulation Lab - II					M. Tech., II Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252211	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	4	2	50	50	100
						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to develop models of power system network, different types of compensators and controllers using MATLAB/ETAP Software.

On successful completion of this course, the students will be able to

CO 1	Model LFC and AVR for single and two area power systems using MATLAB/ ETAP Software
CO 2	Analyze the FACTS controllers using MATLAB/ETAP Software
CO 3	Analyze voltage stability issues using MATLAB/ETAP Software
CO 4	Analyze the rectifiers and converters for power system applications using MATLAB/ETAP Software

List of Experiments

(Any **Eight** of the following experiments has to be carried out)

1. Single Area Load Frequency Control with and without PI controller.
2. Two area load frequency control system.

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3. Simulation of swing equation.
4. Simulation of AVR system.
5. Simulation of Excitation system stabilizer.
6. Simulation of FACTS controllers.
7. Simulation of Power Quality problems.
8. Three -phase fully controlled rectifiers.
9. Three- phase inverter with PWM controller.
10. Buck & Boost converters for power system applications.

M. Tech., III Semester

Course Title	Power System Transients (PE – V)				M. Tech., III Semester		
Course Code	Category	Hours / Week		Credits	Maximum Marks		
2252301	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to understand the energy demand scenario, the modeling of load and its ease to study load demand industrially, analyze Electricity pricing models and reactive power management in Industries.

On successful completion of this course, the students will be able to

CO 1	Gain knowledge about load control techniques in industries and its application.
CO 2	Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO
CO 3	Apply load management to reduce demand of electricity during peak time
CO 4	Apply different energy saving opportunities in industries

UNIT - I

Electric Energy Scenario-Demand Side Management- Industrial Load Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers
Classification of Industrial Loads, Continuous and Batch processes -Load Modelling.

UNIT - II

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Electricity pricing – Dynamic and spot pricing -Models, Direct load control- Interruptible load control, Bottom - up approach- scheduling- Formulation of load Models, Optimization and control algorithms - Case studies.

UNIT - III

Reactive power management in industries-Controls-power quality impacts Application of filters Energy saving in industries.

UNIT - IV

Cooling and heating loads, load profiling, Modelling- Cool storage, Types-Control strategies, optimal operation, and Problem formulation- Case studies.

UNIT - V

Operating and control strategies, Power Pooling- Operation models, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries.

Text Books:

1. C.O. Bjork "Industrial Load Management - Theory, Practice and simulations", Elsevier, the Netherlands, 1989.
2. C.W. Gellings and S.N. Talukdar, Load management concepts. IEEE Press, New York, 1986, pp. 3-28.
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981.

Reference Books

1. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Inter science Publication, USA, 1989.
2. I.J. Nagarath and D.P. Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995.
3. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.

Course Title	Industrial Load Modelling & Control (PE – V)				M. Tech., III Semester		
Course Code	Category	Hours / Week		Credits	Maximum Marks		
2252302	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to understand the energy demand scenario, modeling of load and its ease to study load demand industrially, analyze electricity pricing models and study reactive power management in Industries.

On successful completion of this course, the students will be able to

CO 1	Gain knowledge about load control techniques in industries and its application.
CO 2	Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO

CO 3	Apply load management to reduce demand of electricity during peak time
CO 4	Apply different energy saving opportunities in industries

UNIT - I

Electric Energy Scenario-Demand Side Management- Industrial Load Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers

Classification of Industrial Loads, Continuous and Batch processes -Load Modelling.

UNIT - II

Electricity pricing – Dynamic and spot pricing -Models, Direct load control- Interruptible load control, Bottom - up approach- scheduling- Formulation of load Models, Optimization and control algorithms - Case studies.

UNIT - III

Reactive power management in industries-Controls-power quality impacts Application of filters Energy saving in industries.

UNIT - IV

Cooling and heating loads, load profiling, Modelling- Cool storage, Types-Control strategies, optimal operation, and Problem formulation- Case studies.

UNIT - V

Operating and control strategies, Power Pooling- Operation models, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries.

Text Books:

1. C.O. Bjork "Industrial Load Management - Theory, Practice and simulations", Elsevier, the Netherlands, 1989.
2. C.W. Gellings and S.N. Talukdar, Load management concepts. IEEE Press, New York, 1986, pp. 3-28.
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981.

Reference Books

1. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Inter science Publication, USA, 1989.
2. I.J. Nagarath and D.P. Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995.
3. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.

Course Title	Modern Control Theory (PE – V)					M. Tech., III Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252303	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to understand the linear system and its functions, the stability analysis of linear systems and implement the same in MATLAB.	
On successful completion of this course, the students will be able to	
CO 1	Learn linear system modelling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective.
CO 2	Gain knowledge on carrying out detailed stability analysis of both linear and nonlinear systems.
CO 3	Design observers and controllers for linear systems.
CO 4	Analyse and design pole placement method using MATLAB

UNIT- I

Introduction Concept of State, State Variables and State Model, State model for Linear Continuous Time Systems, transfer function and transfer function matrix, MATLAB programs.

UNIT- II

State Transition Matrix and its properties, solution for homogeneous and non-homogeneous state equations.

UNIT- III

Controllability, complete controllability of continuous time systems, observability, complete observability of continuous time systems, principle of duality.

UNIT- IV

Introduction, design of Pole placement by state feedback using MATLAB, Full order and reduced order observers

UNIT-V

Lyapunov stability analysis: Introduction, Lyapunov stability criterion, direct method of lyapunov and the linear systems.

Text Books:

1. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc., Englewood Cliffs, N.J., 1965.
3. K. Ogata, "Modern Control Engineering, (second edition)", Prentice Hall Inc., Englewood Cliffs, N.J., 1990.

Reference Books

1. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. C.T. Chen, "Linear System Theory and Design", New York: Holt Rinehart and Winston, 1984.
3. R.C. Dorf, and R. T. "Bishop, Modern Control Systems", Addison Wesley Longman Inc., 1999.

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Course Title	Dissertation Phase - I				M. Tech., III Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks	
2252307	Major Project (PR)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	20	10	100	00	100

Course Objectives: The objective of the course is to

- Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- Acquire and apply new knowledge as needed, using appropriate learning strategies.
- Apply knowledge of probability and statistics to applications in electrical engineering.

On successful completion of this course, the students will be able to

CO 1	Survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research
CO 2	Use different experimental techniques and software/ computational/analytical tools
CO 3	Design and develop an experimental set up/ equipment/testing.
CO 4	Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing the work

General Description

1. The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech.
3. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the examiners panel set by Head and PG coordinator.
6. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

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Course Title	Dissertation Phase - II					M. Tech., IV Semester		
Course Code	Category	Hours / Week			Credits	Maximum Marks		
2252401	Major Project (PR)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	32	16	50	50	100

Course Objectives: The objective of the course is to develop attitude of lifelong learning and will develop interpersonal skills to deal with people working in diversified field, write technical reports and research papers to publish at national and international level and develop strong communication skills to defend their work in front of technically qualified audience.

On successful completion of this course, the students will be able to

CO 1	Survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research
CO 2	Use different experimental techniques and software/ computational/analytical tools
CO 3	Design and develop an experimental set up/ equipment/testing.
CO 4	Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing the work

Open Elective courses offered to other branches for M. Tech., III Semester

Course Title	Internet of Things					M. Tech., III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
22OE523	Open Elective Course (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The objective of the course is to learn the basic concepts of Internet of Things and its applications.

Course Outcomes: On successful completion of this course, the students will be able to:	
CO 1	Understanding IoT technology
CO 2	Learning basic IoT Elements
CO 3	Understanding basics of python programming
CO 4	Working with Arduino and Raspberry pi board

UNIT-I

Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT-Things in IoT, IoT Protocols, Logic Design of IoT-Functional Blocks, Communication Models ,IoT Enabled Technologies-Wireless Sensor Networks, Communication protocols, Embedded Systems, IoT Levels and Templates

UNIT-II

Elements of IoT: What is an IOT Device, Basic Building blocks of an IT Device, Sensors, Actuators, Details of Arduino-About Board Peripherals, Details of Raspberry Pi-About Board Peripherals.

UNIT-III

Logic Design: Introduction to Python, Python Data Types-Numbers, Strings ,Lists, Tuples, Dictionaries, Type Conversions, Control Flow, Functions, Modules

UNIT-IV

IoT Application Development: Programming Arduino- Controlling LED, Interfacing an LED and Switch ,Interfacing a Light Sensor. Programming Raspberry Pi- Controlling LED, Interfacing an LED and Switch, Interfacing a Light Sensor.

UNIT-V

Case Studies of IoT: Smart Lighting, Smart Irrigation, Weather Monitoring System, Smart Parking

Text Books:

1. "INTERNET OF THINGS a Hand on Approach" by Arshdeep Bahga,Vijay Madisetti, Universities Press.
2. "Getting Started with the Internet of Things" by Cuno Pfister, O Reilly Media

Reference Books

1. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
2. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
3. Adrian McEwen, "Designing the Internet of Things", Wiley

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Course Title	Programmable Logic Controller (PLC) & its Applications				M. Tech., III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
22OE522	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	30	70	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to learn PLC basics, architecture, programming, about digital logic gates, PLC registers, functions and Analog PLC operations and various applications to PLC.

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

CO 1	Understand PLC and its basics, architecture, connecting devices and programming.
CO 2	Apply Ladder logic for various Industrial Applications.
CO 3	Analyze PLC logical and arithmetic operations.
CO 4	Design Control Circuits for various Applications.

UNIT I

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming Equipment, programming formats, construction of PLC ladder diagrams, Devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.

UNIT II

Digital Logic Gates: Programming in the Boolean algebra system, conversion examples. Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system.

UNIT III

PLC Registers: Characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers.

PLC Functions: Timer functions & Industrial applications, counter function & industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

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UNIT IV

Data Handling Functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

UNIT V

Analog PLC Operation: Types of PLC Analog Modules and Systems, PLC Analog Signal Processing, BCD or Multibit Data Processing, Analog output application examples, PID

Modules, PID Tuning, Typical PID Functions, PLC Installation, Troubleshooting and Maintenance.

Text Books:

1. Programmable Logic Controllers by W. Bolton, 5th Edition, Newnes, Elsevier, 2010.
2. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI.
3. Programmable Logic Controllers-Principles and Applications by Niit,PHI.
4. Programmable Logic Controllers-Programing methods and Applications by John R.Hackworth,Frederick D. Hackworth,1st Edidition, Pearson Publications.

Reference Books:

1. Programmable Logic Controllers- Programming Method and Applications–JR.Hackworth & F.D. Hackworth Jr. - Pearson, 2004.
2. Programmable Logic Controllers: An Emphasis on Design & Application, Kelvin T.Erickson, Dogwood Valley Press, 2011.
3. Programmable Logic Controllers-Principles and Applications by John W. Webb, Ronald AR eis, 5th Edition, PHI.
4. Programmable Logic Controllers- An Emphasis on Design and Application by KelvinT. Erickson,

Course Title	Power Electronics For Renewable Energy Systems				M. Tech., III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
22OE523	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs						End Exam Duration : 3 Hrs		

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Course Objectives:

- To create awareness on various non-conventional energy sources
- To understand role of power converters for solar PV systems
- To gain knowledge on wind energy conversion systems
- To know the grid connection and its issues
- To attain knowledge on importance of hybrid power systems

On successful completion of this course, the students will be able to

CO 1	Understand the various Non-Conventional sources of energy
CO 2	Acquire knowledge on various power converters for Solar energy system
CO 3	analyze the Power converter utilized by the wind energy conversion system
CO 4	Understand the concepts of grid connection and its issues.
CO 5	Recognize the hybrid operation of wind and PV systems and features of MPPT tracking

UNIT I

INTRODUCTION TO RENEWABLE ENERGY RESOURCES

World and Indian energy scenario - Wind, Solar, Hydro, and Geothermal: Availability and Power extraction - Environmental impacts of Renewable energy sources.

UNIT II

POWER CONVERTERS FOR SOLAR PV SYSTEM

Solar Photovoltaic System – P-V and I-V Characteristics –Different factors affecting PV output-Necessity of MPPT's- different types of MPPT- Buck, Boost, buck-boost converters - Isolated and Non isolated converters -Standalone PV system – Solar PV system calculation for specific applications- Battery Charging- Charge Controllers

UNIT III

POWER CONVERTERS FOR WIND ENERGY SYSTEM

Wind Energy Conversion System - Power Converters for Wind: AC voltage Controller - Matrix converter – Bi directional converter- flyback converter - Standalone operation of fixed

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and variable speed wind energy conversion systems - Static Kramer Drive for DFIG – Static Scherbius using cycloconverters for DFIG – Rating of Converter for WECS

UNIT IV

GRID CONNECTED SYSTEM

Grid interface - Grid connection issues: leakage current, Islanding, harmonics, Active / reactive Power feeding, unbalance Grid Interactive inverter: Line Commutated Inverter – Self Commutated Inverter – Selection of inverter – Rating of Inverters for Grid connected System.

UNIT V

HYBRID ENERGY SYSTEM

Need for hybrid systems- Range and type of Hybrid systems- Case studies of Wind and PV system – PV-Diesel System – Wind-Diesel Hybrid System – Energy Storage Devices for Hybrid Energy System - Maximum Power Point Tracking (MPPT) - MPPT schemes.

TEXT BOOKS

1. Sudipta Chakraborty, Marcelo G. Simes, and William E. Kramer, "Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration", Springer Science & Business, 2013.

2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, "Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems", CRC Press, 2013.

REFERENCES

1. Rashid .M. H "Power electronics Hand book", Academic press, 2001.

2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.

3. Rai. G.D, "Non conventional energy sources", Khanna publishes, 2009.

4. Gray, L. Johnson, "Wind energy system", Prentice Hall INC, 1995. 5. B.H.Khan, "Non-conventional Energy sources", Tata McGraw-Hill Publishing Company, New Delhi, 2017.

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