VIDYA JYOTHI
INSTITUTE OF TECHNOLOGY
AN AUTONOMOUS INSTITUTION

Accredited by NAAC & NBA, Approved By A.I.C.T.E., New Delhi, Permanently Affiliated to JNTUH, Hyderabad
Aziz Nagar, C.B.Post, Hyderabad -500075

Board of Studies Meeting

of

Department of Electrical and Electronics Engineering

held on 28.03.2023

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Department of Electrical and Electronics Engineering

Minutes of the Board of studies of Department of Electrical and Electronics Engineering meeting held on 28-03-2023 at 11 AM.

The following members were present in the meeting.

S. No	Name of the Member	Designation	Signature
1	Dr. A. Srujana, Professor and HOD/EEE,VJIT	Chairperson	
2	Dr. M. Sushama, Professor/ EEE, JNTUH UCEH	JNTUH Nominee	
3	Mr. P. Chow Reddy, Managing Director, Interleaved Multidisciplinary Research Centre	External Member	
4	Dr. T. Anil Kumar, Professor &HOD/EEE, Anurag University	External Member	
5	Dr. G. Suresh Babu, Professor& HOD /EEE, CBIT	External Member	
6	Dr. P. Ram Kishore Kumar Reddy, Professor & HOD/EEE, MGIT	External Member	
7	Dr. C. N. Ravi, Professor/EEE, VJIT	Internal Member	
8	Mr. T. Parameshwar, Associate Professor/EEE, VJIT	Internal Member	
9	Mr. P. Nageshwara Rao, Associate Professor/EEE, VJIT	Internal Member	
10	Mr. Ch. Vikram, Assistant Professor/EEE, VJIT	Internal Member	
11	Mr. B. Rajesh, Assistant Professor/EEE,VJIT	Internal Member	

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Department of Electrical and Electronics Engineering

BOARD OF STUDIES MEETING NOTICE

The Board of Studies meeting of Electrical and Electronics Engineering department is scheduled to be held on 28.03.2023 at 11 A.M. You are requested to make it convenient to attend the same.

Items on Agenda:

1. To discuss and decide the course structure and syllabi of II, III Year and IV Year B.Tech Electrical and Electronics Engineering for the students admitted from the AY 2022-23 (R22 Regulation). **Annexure - I**
2. To ratify the course structure and syllabi of Minor and Honor Degree Courses for students admitted from the AY 22-23 (R22 Regulation). **Annexure – II**
3. To discuss and decide the syllabi of the subjects offered by EEE Department for other departments admitted under R22 Regulation: **Annexure - III**
    1. Electrical Technology (for II B. Tech ECE II semester)
    2. Control Systems Engineering (for III B. Tech ECE I Semester)
    3. Basic Electrical Engineering (for II B. Tech Mechanical II Sem & II B.Tech Civil II Sem)
    4. Basic Electrical Engineering Laboratory (for II B.Tech Mechanical II Sem & II B.Tech Civil II Sem)
    5. Open Elective Courses
4. To discuss and decide substitute subjects for rejoined students of B.Tech R21, R20, R19 regulations (VJIT Autonomous). **Annexure - IV**
5. To Approve Panel of Examiners.
6. Any other matter with the permission of the Chair.

Chairperson
BOS of EEE

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

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Department of Electrical and Electronics Engineering

Resolutions

Item No.1: To discuss and decide the course structure and syllabi of II, III Year and IV Year B.Tech Electrical and Electronics Engineering for the students admitted from the AY 2022-23 (R22 Regulation). Annexure - I

The Chairperson presented the course structure and syllabi of II Year, III Year and IV Year B. Tech. EEE courses. Dr. M. Sushama, JNTUH Nominee opined to include few applications of FPGA in Digital Electronics Course. She further suggested to include a microcontroller in Microprocessors and Microcontrollers Course.

Mr. P. Chow Reddy BOS member advised to include a book titled "Microprocessor Architecture, Programming and Applications" by "Ramesh Gaonkar" in the list of Reference Books as it would cover the entire syllabus.

Mr. G. Suresh Babu opined that courses like Analog Electronics, Digital Electronics, Microprocessors and Microcontrollers may be approved by EEE BOS Board as those subjects are dealt by many of the members of BOS. All the members of BOS agreed for the same.

After deliberations and discussions, the committee passed the following resolution.

Resolution(1): The members after thorough discussion approved the course structure and syllabi of II Year III Year and IV Year B. Tech. in Electrical and Electronics Engineering for R22 Regulation as per Annexure-I

Noted and Approved.

Item No.2: To ratify the course structure and syllabi of Minor and Honor Degree Courses for students admitted from the AY 22-23 (R22 Regulation). Annexure –II

The Chairperson presented the course structure and syllabi of Minor and Honor Degree Courses approved in the earlier BOS meeting held on 28.06.2022. The members of the BOS opined that the same course structure and syllabi may be implemented for students admitted during the AY 22-23 (R22 Regulation) as per Annexure – II.

Resolution (2): The members approved the course structure and syllabi of Minor and Honor Degree Courses for students admitted during the AY 22-23 (R22 Regulations) as per Annexure – II. The BoS Chairperson is authorized to choose and approve equivalent MOOCS course in the place of any course in Minor and Honor Degree Courses for attainment of credits by the students.

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Department of Electrical and Electronics Engineering

Item No. 3: To discuss and decide the syllabi of the subjects offered by EEE Department to other departments admitted under R22 Regulation: Annexure - III

(i) The Chairperson presented the syllabi of subjects offered to B. Tech. ECE, Mechanical and Civil Engineering Branches viz:

1. Electrical Technology (for II B. Tech ECE II semester)
2. Control Systems Engineering (for III B. Tech ECE I Semester)
3. Basic Electrical Engineering (for II B. Tech Mechanical II Sem & II B.Tech Civil II Sem)
4. Basic Electrical Engineering Laboratory (for II B.Tech Mechanical II Sem & II B.Tech Civil II Sem)

(ii) Further, the Chairperson presented subjects along with syllabi offered as Open Electives for other Branches of Engineering under R22 regulation in the college viz:

1. Sustainable Energy (OE-1)
2. Power Applications of Electricity (OE-1)
3. Energy Conservation and Management (OE-2)
4. Industrial Electrical Systems (OE-2)
5. Electric Vehicles and Hybrid Vehicles (OE-3)
6. Energy Storage Systems (OE-3)

After discussion and deliberation the committee approved the subjects along with the syllabi and passed the following resolution.

Resolution (3): The members after thorough discussion approved the syllabi of subjects offered to B. Tech. ECE, Mechanical and Civil Engineering Branches and Open Elective subjects offered to other Branches mentioned in Item 3 as per Annexure -II.

Noted and Approved.

Item No. 4: To discuss and decide substitute subjects for rejoined students of R21, R20 and R19 regulations (VJIT Autonomous). Annexure - IV

The Chairperson presented the substitute subjects for rejoining students of R21, R20 and R19 (VJIT Autonomous) as per Annexure - IV

After discussing various aspects of the subjects the committee passed the following resolution

Resolution (4): The members after thorough discussion approved the substitute subjects for rejoined students of R21, R20 and R19 (VJIT Autonomous) as per Annexure -III. The BoS Chairperson is authorized to choose and approve the substitute subjects for rejoined students.

Noted and Approved.

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Department of Electrical and Electronics Engineering

Item No. 5: To approve the Panel of Examiners

The Chairperson explained on the requirement and emphasized on the panel of examiners, whose services will be utilized, as and when required for preparation of the question paper for End Semester examination and also for evaluation of the Answer scripts of the End Semester Examinations. The panel of the examiners will be prepared in consultation with the senior faculty of the department. They will be paid remuneration as per the recommendations of College Finance Committee.

Resolution (5): The committee of BoS, after discussion, authorized the Chairperson of BoS to prepare the Panel of examiners, as and when required in consultation with the senior faculty members for both B. Tech. (EEE) courses under R22 regulations. The same may be submitted to the Examination branch (Autonomous) for further processing.

Noted and Approved.

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5. 6. 7. C.V. Rao 8.
9. 10. 11.

Annexure – I

R22 B.Tech EEE SECOND YEAR COURSE STRUCTURE

II YEAR I SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	BS-5	Complex Analysis and Fourier Transforms	3	1	0	4
2	PC-1	Network Analysis	3	0	0	3
3	ES-6	Analog Electronic Circuits	3	0	0	3
4	PC-2	Electrical Machines-I	3	0	0	3
5	PC-3	Electro Magnetic Fields	3	0	0	3
6	PC Lab-1	Electrical Machines Laboratory-I	0	0	2	1
7	PC Lab-2	Networks Laboratory	0	0	2	1
8	PC Lab-3	Electrical Simulation tools Laboratory	0	0	2	1
9	HSMC-1	Professional Communication	2	0	0	1
		Total Credits	**17**	**1**	**06**	**20**

II YEAR II SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-4	Power System-I	3	0	0	3
2	PC-5	Measurements and Instrumentation	3	0	0	3
3	PC-6	Electrical Machines–II	3	0	0	3
4	ES-8	Digital Electronics	2	0	0	2
5	PC-7	Control Systems	3	0	0	3
6	ES Lab-4	Analog Electronic Circuits Laboratory	0	0	2	1
8	PC Lab-4	Measurements and Instrumentation Laboratory	0	0	2	1
9	PC Lab-5	Electrical Machines Laboratory-II	0	0	2	1
10	PW-1	Real-time Research Project/ Field Based Project	0	0	4	2
11	ES-9	Quantitative Methods and Logical Reasoning	2	0	0	1
		Total Credits	**16**	**0**	**10**	**20**

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9. 10. 11.

R22 B.Tech EEE THIRD YEAR COURSE STRUCTURE

III YEAR I SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-8	Power Electronics	3	1	0	4
2	PC-9	Power System-II	3	1	0	4
3	PC-10	Microprocessors & Microcontrollers	3	0	0	3
4	PE-1	Professional Elective-I	3	0	0	3
5	OE-1	Open Elective-I	3	0	0	3
6	PC Lab-6	Microprocessors & Microcontrollers Laboratory	0	0	2	1
7	PC Lab-7	Control Systems Laboratory	0	0	2	1
8	H&S Lab-2	Advanced English Communication Skills Laboratory	0	0	2	1
9	MC-1	Environmental Science	2	0	0	0
		Total Credits	**17**	**2**	**6**	**20**

III YEAR II SEMESTER

S. No	Course Category	Course Title	L	T	P	Credits
1	H&S-2	Business Economics and Financial Analysis	3	0	0	3
2	PE-2	Professional Elective-II	3	0	0	3
3	PC-11	Power Semiconductor Drives	3	0	0	3
4	PC-12	Power System Protection	3	0	0	3
5	OE-2	Open Elective-II	3	0	0	3
6	PC Lab-8	Power Electronics Laboratory	0	0	2	1
7	PC Lab-9	Simulation of Power Converters Lab	0	0	2	1
8	PC Lab-10	Power System Laboratory	0	0	2	1
9	PW-2	Industry Oriented Mini Project/ Internship	0	0	4	2
10	MC-2	Gender Sensitization	2	0	0	0
		Total Credits	**17**	**0**	**10**	**20**

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R22 B.Tech EEE FOURTH YEAR COURSE STRUCTURE

IV YEAR I SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-13	Electric and Hybrid Vehicles	3	1	0	4
2	PC-14	Power System Operation and Control	3	0	0	3
3	PE-3	Professional Elective-III	3	0	0	3
4	OE-3	Open Elective-III	3	0	0	3
5	H&S-3	Essentials of Computer Networks	2	0	0	2
6	PC Lab-11	Simulation of Renewable Energy Systems Laboratory	0	0	4	2
8	PW-3	Project Stage – I	0	0	6	3
		Total Credits	**14**	**1**	**10**	**20**

IV YEAR II SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-15	Utilization of Electrical Energy	3	0	0	3
2	PC-16	Power Electronic Applications to Renewable Energy Systems	3	0	0	3
3	PE-4	Professional Elective-IV	3	0	0	3
4	PW-4	Project Stage – II including Seminar	0	0	22	9+2
		Total Credits	**9**	**0**	**22**	**20**

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5. 6. 7. 8.
9. 10. 11.

Professional Elective - I

1	IoT Applications in Electrical Engineering
2	Electrical Energy Conservation and Auditing
3	Cyber Physical Systems

Professional Elective - II

1	AI Techniques in Electrical Engineering
2	Modern Power Electronics
3	Wind and Solar Energy systems

Professional Elective-III

1	Power Quality & FACTS
2	Solar Power Batteries
3	Advanced Control of Electric Drives

Professional Elective-IV

1	Smart Grid Technologies
2	Machine Learning Applications to Electrical Engineering
3	Embedded Systems

Open Electives offered by EEE Department

Open Elective - I

1	Sustainable Energy
2	Power Applications of Electricity

Open Elective-II

1	Energy Conservation and Management
2	Industrial Electrical Systems

Open Elective-III

1	Electric Vehicles and Hybrid Vehicles
2	Energy Storage Systems

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

R22 B.Tech EEE SECOND YEAR COURSE STRUCTURE

II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	BS-5	Complex Analysis and Fourier Transforms	3	1	0	4
2	PC-1	Network Analysis	3	0	0	3
3	ES-6	Analog Electronic Circuits	3	0	0	3
4	PC-2	Electrical Machines-I	3	0	0	3
5	PC-3	Electro Magnetic Fields	3	0	0	3
6	A223284	Electrical Machines Laboratory-I	0	0	2	1
7	A223285	Networks Laboratory	0	0	2	1
8	A223286	Electrical Simulation tools Laboratory	0	0	2	1
9	HSMC-1	Professional Communication	2	0	0	1
		Total Credits	**17**	**1**	**06**	**20**

II YEAR II SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-4	Power System-I	3	0	0	3
2	PC-5	Measurements and Instrumentation	3	0	0	3
3	PC-6	Electrical Machines–II	3	0	0	3
4	ES-8	Digital Electronics	2	0	0	2
5	PC-7	Control Systems	3	0	0	3
6	A224288	Analog Electronic Circuits Laboratory	0	0	2	1
8	A224289	Measurements and Instrumentation Laboratory	0	0	2	1
9	A224290	Electrical Machines Laboratory-II	0	0	2	1
10	PW-1	Real-time Research Project/ Field Based Project	0	0	4	2
11	ES-9	Quantitative Methods and Logical Reasoning	2	0	0	1
		Total Credits	**16**	**0**	**10**	**20**

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5. 6. 7. 8.
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NETWORK ANALYSIS

B. Tech. II Year I Semester

L	T	P	C
3	1	0	4

Course Outcomes: After going through this course the student will be able to:

CO1. Obtain two port network parameters for applications.
CO2. Observe the transient response of various R, L and C circuits for different excitations.
CO3. Observe the transient response of various R, L and C circuits for different excitations using Laplace Transforms
CO4. Examine the behavior of polyphase circuits.
CO5. Design of various filters

UNIT-I:

Two port network parameters: Open circuit impedance, short-circuit admittance, Transmission, Hybrid parameters & inter-relationships, Series, parallel and cascade connection of two port networks,System function, and Impedance and admittance functions.

UNIT-II:

Transient analysis: Transient response of R, L & C circuits, Formulation of integral differential equations, Initial conditions, Transient Response of RL, RC and RLC (series and parallel) networks subjected to internal energy, Response to impulse, step, and ramp, exponential and sinusoidal excitations.

UNIT-III:

Electrical circuit Analysis using Laplace Transforms: Application of Laplace Transforms to RL, RC and RLC (series and parallel) Networks for impulse, step, and ramp, exponential and sinusoidal excitations.

UNIT-IV:

Poly-phase Circuits: Analysis of balanced and unbalanced 3-phase circuits, Star and delta connections, measurement of three-phase power for balanced and unbalanced loads.

UNIT-V:

Filters: Classification of filters – Low pass, High pass, Band pass and Band Elimination, Constant-k and M-derived filters-Low pass and High pass Filters and Band pass and Band elimination filters (Elementary treatment only)

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

TEXTBOOKS:

1. Van Valkenburg M.E, "Network Analysis", Prentice Hall of India, 3rd Edition, 2000.
2. Ravish R Singh, "Network Analysis and Synthesis", McGrawHill, 2nd Edition, 2019.

REFERENCE BOOKS:

1. B. Subramanyam, "Electric Circuit Analysis", Dreamtech Press & Wiley, 2021.
2. James W. Nilsson, Susan A.Riedel, "Electric Circuits", Pearson, 11th Edition, 2020.
3. A Sudhakar, Shyammohan S Palli, "Circuits and Networks: Analysis and Synthesis", McGrawHill, 5th Edition, 2017.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

ANALOG ELECTRONIC CIRCUITS

B. Tech. II Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: After going through this course the student will be able to:

CO1. Demonstrate the concepts of semiconductor theory.

CO2. Interpret the characteristics of different semiconductor devices with its applications.

CO3. Apply different biasing techniques of transistors for amplification.

CO4. Analyze transistor amplifiers using small signal model.

CO5. Describe the behaviour of special purpose diodes.

UNIT I

Diode: PN junction Diode – Characteristics, Current equation, Temperature dependence, Static and Dynamic resistances, Equivalent circuit, Diffusion and Transition Capacitances.

Diode Applications: Rectifier - Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Rectifiers with Capacitive Filter, Clippers and Clampers.

UNIT II

Bipolar Junction Transistor (BJT): Principle of Operation and characteristics - Common Emitter, Common Base, Common Collector Configurations, Operating point, DC & AC load lines, Transistor Hybrid parameter model, Determination of h-parameters from transistor characteristics, Conversion of h-parameters.

UNIT III

Transistor Biasing and Stabilization: Bias Stability, Fixed Bias, Collector to Base bias, Self Bias, Bias compensation using Diodes and Transistors.

Analysis and Design of Small Signal Low Frequency BJT Amplifiers: Analysis of CE, CC, CB Amplifiers and CE Amplifier with emitter resistance, low frequency response of BJT Amplifiers, effect of coupling and bypass capacitors on CE Amplifier.

UNIT IV

Junction Field Effect Transistor: Construction, Principle of Operation, Pinch-Off voltage, Volt-Ampere characteristics, comparison of BJT and FET, Biasing of FET, FET as voltage variable resistor, MOSFET construction and its characteristics in enhancement and depletion modes.

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5. 6. 7. 8.
9. 10. 11.

UNIT V

FET Amplifiers: Small Signal Model, Analysis of CS, CD, CG JFET Amplifiers. Basic Concepts of MOSFET Amplifiers.

Special Purpose Devices: Zener Diode - Characteristics, Voltage Regulator; Principle of Operation - SCR, Tunnel diode, UJT, Varactor Diode.

TEXT BOOKS:

1. Electronic devices and circuits, Millman & Halkias, McGraw Hill , 2007.
2. Electronic Devices and Circuits, S. Salivahanan, N. Suresh Kumar, A. Vallavaraj , Tata Mc Graw Hill , 2008.

REFERENCE BOOKS:

1. Electronic Devices and Circuits, Boylestad R L & Louis Nashelsky, Prentice Hall India, 2006.
2. Electronic Devices and Circuits, Gupta J B, S. K. Kataria, 2009.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

ELECTRICAL MACHINES-I

L	T	P	C
3	1	0	3

B. Tech. II Year I Semester

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

CO1. Understand different parts of DC Generators & understand its operation.
CO2. Explain the operation of DC motors.
CO3. Illustrate the different testing methods of DC machines.
CO4. Examine the constructional and operation of single phase transformers.
CO5. Analyze three phase transformers connections.

UNIT – I

D.C. Generators: Principle of operation – Action of commutator – constructional features – armature windings – lap and wave windings – simplex and multiplex windings – use of laminated armature – E.M.F Equation. Armature reaction – Cross magnetizing and de-magnetizing AT/pole – compensating winding – commutation – reactance voltage – methods of improving commutation. Methods of Excitation – separately excited and self-excited generators – build-up of E.M.F - critical field resistance and critical speed - causes for failure of self-excitation and remedial measures. Load characteristics of shunt, series and compound generators.

UNIT – II

D.C Motors: Principle of operation – Back E.M.F. - Torque equation – characteristics and applications of shunt, series and compound motors – Necessity of starter, principle of operation of 3-point and 4-point starters with protective devices ,Speed control of D.C. Motors - Armature voltage and field flux control methods.

UNIT – III

Testing of DC Machines: Losses – Constant & Variable losses – calculation of efficiency – condition for maximum efficiency. Methods of Testing – direct, indirect, and regenerative testing – Brake test – Swinburne's test – Hopkinson's test – Field's test - separation of stray losses in a d.c. motor.

UNIT – IV

Single Phase Transformers: Types - constructional details-minimization of hysteresis and eddy current losses- EMF equation - operation on no load and on load - phasor diagrams Equivalent circuit - losses and efficiency – regulation - All day efficiency - effect of variations of frequency & supply voltage on iron losses.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT – V

Testing of Transformers and Poly-Phase Transformers: OC and SC tests - Sumpner's test -predetermination of efficiency and regulation-separation of core losses-parallel operation with equal and unequal voltage ratios - auto transformers-equivalent circuit - comparison with two winding transformers. Poly-phase transformers – Poly-phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ

TEXT BOOKS:

1. Theory and Performance of Electrical Machines, J.B. Gupta , S.K.Kataria & Sons , 2013.
2. Electrical Machines, R.K.Rajput Laxmi Publications (P) Ltd, 2004.

REFERENCE BOOKS:

1. Electrical Machinery, P. S. Bimbhra, Khanna Publishers, 2011.
2. Electric Machines, I. J. Nagrath and D. P. Kothari McGraw Hill Education, 2010.
3. Electrical Machines III, M.V.Bakshi & U.A.Bakshi, Technical Publications.

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5. 6. 7. 8.
9. 10. 11.

ELECTRO MAGNETIC FIELDS

B. Tech. II Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand the basic laws of electromagnetism.
CO2. Compare the electric and magnetic fields concepts for simple configurations under static conditions.
CO3. Illustrate time varying magnetic fields.
CO4. Examine Maxwell's equations in different forms and different media.
CO5. Apply electromagnetic concepts to electrical machines.

UNIT – I :

ELECTROSTATICS: Vector Algebra - Coordinate Systems - Divergence theorem. Electrostatic Fields - Coulomb's Law - Electric Field Intensity (EFI) - EFI due to a line and a surface charge, work done in moving a point charge in an electrostatic field, Electric Potential, Properties of potential function, Potential gradient. Gauss's law - Application of Gauss's Law, Maxwell's first law, Laplace's equations and Poison's equations.

UNIT - II :

DIPOLE& CAPACITANCE: Electric Dipole, Dipole moment, Polarization, Potential due to an Electric Dipole and Torque. Capacitance - Capacitance of parallel plate, spherical and co-axial capacitors with composite dielectrics. Energy stored and energy density in static electric field. Current density, conduction and Convection current densities, Ohm's law in point form, Equation of continuity.

UNIT – III :

MAGNETO STATICS, AMPERE'S CIRCUITAL LAW: Biot-Savart's law - Magnetic field intensity (MFI) - MFI due to a straight current carrying filament- MFI due to circular and solenoid current Carrying wire, Relation between magnetic flux, magnetic flux density, Maxwell's second Equation.**Ampere's circuital Law & Applications:** Ampere's circuital law and its applications viz. - MFI due to an infinite sheet of current and a long current carrying filament, Point form of Ampere's circuital law - Curl-Stroke's Theorem, Maxwell's third equation.

UNIT – IV:

FORCE IN MAGNETIC FIELDS, MAGNETIC POTENTIAL: Magnetic force - Lorentz force equation – force on a current element in a magnetic field - Force on a straight and a long current carrying conductor in a magnetic field – Force between two straight long and parallel current carrying conductors – Magnetic dipole and dipole moment – Torque in a magnetic field. Scalar Magnetic potential and its limitations, vector magnetic potential and its properties.

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5. 6. 7. 8.
9. 10. 11.

UNIT - V :

INDUCTANCE, TIME VARYING FIELDS: Self and Mutual inductances, Determination of self-inductance of a solenoid, toroid and mutual inductance between a straight long wire, Energy stored and Density in a Magnetic field. Time varying fields - Faraday's laws of electromagnetic induction, Maxwell's fourth equation - Simple problems, Modification of Maxwell's equations for time varying fields, Displacement current.

TEXT BOOKS:

1. Engineering electromagnetics by William H. Hayt & John. A. Buck, McGraw Hill Companies-7th Edition, 2012.
2. Electromagnetic fields, Sadiku, Oxford Publications-7thEdition.

REFERENCE BOOKS:

1. Engineering electromagnetics, J P Tewari, Khanna Publishers-2nd Edition, 2005.
2. Elements of electromagnetic fields, S. P. Seth, Dhanpat Rai & Co. (Pvt.) Ltd-2ndEdition.
3. Electromagnetic field theory, K. A. Gangadhar, P. M. Ramanathan, Khanna Publishers- 16th Edition.

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9. 10. 11.

ELECTRICAL MACHINES LAB - I

B. Tech. II Year I Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Start and control the Different types of DC motors.
CO2. Assess the performance of different types of DC machines using different testing methods.
CO3. Identify different conditions required to be satisfied for self - excitation of DC Generators.
CO4. Separation losses of DC motor into different components.
CO5. Analyze the performance of coupled machines.

Any 10 out of the following 12 experiments should be conducted:

1. Magnetization characteristics of a DC shunt generator.
2. Load test on DC shunt generator.
3. Load test on DC compound generator.
4. Load test on DC series generator.
5. Brake test on DC compound motor.
6. Hopkinson's test on DC Shunt machines.
7. Field's test on DC Series machines.
8. Separation of losses in DC shunts motor.

In addition to the above eight experiments at least any two of the following experiments are required to be conducted from the following list.

1. Retardation test on DC shunt motor.
2. Speed control of DC shunt motor.
3. Swinburne's test on DC shunt machine.
4. Brake Test on DC shunt Motor.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

NETWORKS LABORATORY

B. Tech. II Year I Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Obtain two port network parameters and applications
CO2. Observe the time response of various R, L and C circuits for different excitations.
CO3. Obtain the self and mutual inductance of coupled circuits
CO4. Examine the behavior of single phase and polyphase circuits
CO5. Outline the locus diagrams of Rl, RC circuits

1. To draw the locus Diagrams of RL (R-Varying) and RC (R-Varying) Series Circuits.
2. Verification of Series and Parallel Resonance.
3. Determination of Time response of first order RL and RC circuit for periodic non – sinusoidal inputs
4. Determination of Two port network parameters – Z & Y parameters.
5. Determination of Two port network parameters – A, B, C, D parameters.
6. Determination of Co-efficient of Coupling and Separation of Self and Mutual inductance in Coupled Circuits.
7. Calculation of RMS, average values, form factor and peak factor of complex waveform.
8. Measurement of Active Power for Star and Delta connected balanced loads.
9. Measurement of Reactive Power for Star and Delta connected balanced loads.
10. Determination of Two port network parameters -Hybrid parameters.
11. To draw the locus Diagrams of RL (L-Varying) and RC (C-Varying) Series Circuits.
12. Determination of Time response of RLC circuit for periodic non – sinusoidal inputs

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9. 10. 11.

ELECTRICAL SIMULATION TOOLS LABORATORY

B. Tech. II Year I Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of laboratory course, the student will be able to

CO1. Correlate the data using plots.
CO2. Verify network theorems.
CO3. Observe transient response of series circuits.
CO4. Simulate rectifier circuits.
CO5. Analyze networks using network theorems.

Any Ten of the following experiments should be conducted

Introduction to basic block sets of simulation platforms.

1. Basic matrix operations, Generation of standard test signals

2. Find loop currents using Mesh Analysis

3. Find nodal voltages and branch voltages using nodal voltages

4. Basic 2D plots of simple equation

5. Measurement of Voltage, Current and Power in DC circuits.

6. Verification of Thevenin's Theorem using suitable simulation tools.

7. Verification of Superposition Theorem using suitable simulation tools.

8. Analysis of series and parallel resonance circuits using suitable simulation tools

9. Obtaining the response of electrical network for standard test signals using suitable simulation tools.

10. Solving the linear and nonlinear differential equations

11. Verification of performance characteristics of PN junction diode and Zener diode using suitable simulation tools.

12. Analysis of half wave rectifier with and without filter.

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POWER SYSTEMS – I

B. Tech. II Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

- **CO1.** Understand the operation of conventional and renewable electrical power generating stations.
- **CO2.** Evaluate the power tariff methods and Economics associated with power generation.
- **CO3.** Analyze the operations of AIS.
- **CO4.** Analyze various types of DC Distribution systems
- **CO5.** Assess the performance of various AC Distribution Systems

UNIT-I:

GENERATION OF ELECTRIC POWER:

Conventional Sources (Qualitative): Hydro station, Steam Power Plant, Nuclear Power Plant and GasTurbine Plant.

Non-Conventional Sources (Elementary Treatment):

Solar Energy, Wind Energy, Fuel Cells, Ocean Energy, Tidal Energy, Wave Energy, Cogeneration,Energy conservation and storage.

UNIT-II:

ECONOMICS OF POWER GENERATION: Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants.

Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer.

UNIT-III:

SUBSTATIONS:

AIR INSULATED SUBSTATIONS (AIS): Indoor & Outdoor substations: Substations layout showing the location of all the substation equipment. Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams.

UNIT-IV:

DC DISTRIBUTION: Classification of Distribution Systems. - Comparison of DC vs. AC and Under- Ground vs. Over- Head Distribution Systems. - Requirements and Design features of Distribution Systems. -Voltage Drop Calculations (Numerical Problems) in D.C Distributors for the following cases: Radial D.C Distributor fed one end and at the both the ends (equal/unequal Voltages) and Ring Main Distributor.

1. 2. 3. 4.
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UNIT-V:

A.C. DISTRIBUTION: Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, busbar arrangement, Selection of site for substation. Voltage Drop Calculations (Numerical Problems) in
A.C. Distributors for the following cases: Power Factors referred to receiving end voltage and with respect to respective load voltages.

TEXT BOOKS:

1. C.L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", 2nd Edition,New AgeInternational, 2009.
2. V.K Mehta andRohit Mehta, "Principles of Power Systems", S. Chand & Company Ltd, NewDelhi, 2004.

REFERENCE BOOKS:

1. A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, "A Text book on Power SystemEngineering", Dhanpat Rai Publishing Company (P) Ltd, 2008.
2. C.L. Wadhwa, "Electrical Power Systems", 5th Edition, New Age International, 2009.
3. M.V. Deshpande, "Elements of Electrical Power Station Design", 3rd Edition, Wheeler Pub.1998.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

MEASUREMENTS AND INSTRUMENTATION

B. Tech. II Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand all types of measuring instruments and error compensations.
CO2. Discuss the operation of DC Crompton potentiometer; compare the CT and PT with phasor diagram.
CO3. Describe the concepts of power and energy measurement by using wattmeter and energy meter.
CO4. Outline the concept of DC and AC bridges for the measurement of resistance, inductance & capacitance.
CO5. Analyze the concepts of transducers and cathode ray oscilloscopes.

UNIT - I

INTRODUCTION TO MEASURING INSTRUMENTS: Classification-deflection, control and damping torques- Ammeters and Voltmeters- PMMC and moving iron type instruments-expression for the deflecting torque and control torque- Errors and compensations, extension of range using shunts and series resistance. Electrostatic Voltmeters, electrometer type and attracted disc type voltmeters.

UNIT - II

POTENTIOMETERS& INSTRUMENT TRANSFORMERS: Principle and operation of D.C. Crompton's potentiometer - standardization, Measurement of unknown resistance, current and voltage. A.C. Potentiometers: polar and coordinate types, standardization and applications. CT and PT- Ratio and Phase angle errors (of CT only).

UNIT - III

MEASUREMENT OF POWER & ENERGY: Single phase dynamometer, LPF and UPF watt meters, Double element and three element dynamometer watt meter- expression for deflecting and control torques, extension of range of wattmeter using instrument transformers. Measurement of reactive power. Single phase Induction type energy meter- driving and braking torques-errors and compensations, testing by phantom loading using RSS meter. Three phase energy meter- Maximum demand meters.

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UNIT - IV

D.C BRIDGES & A.C BRIDGES: Methods of measuring low, medium and high resistances, sensitivity of wheat- stone Bridge, Carey foster's Bridge, Kelvin's double bridge for measuring low resistance, measurement of high resistance - loss of charge method. Measurement of Inductance and Q Factor - Maxwell's Bridge, Hay's bridge, Anderson's bridge and Owen's bridge. Measurement of capacitance and loss angle – Desauty's Bridge and Schering Bridge. Wien's Bridge.

UNIT - V

TRANSDUCERS & OSCILLOSCOPES: TRANSDUCERS: Definition of transducer, classification of transducers, advantages of electrical transducers, characteristics and choice of transducers. Principle of operation of LVDT and capacitor transducers, LVDT Applications, Strain guage and its principle of operation, guage factor, Thermistors, Thermo-couples, Piezo-electric transducers, photo-voltaic, photo-conductive cells and photo-diodes.

OSCILLOSCOPES - Cathode Ray Oscilloscope (CRO)- Cathode Ray tube, time base generator, horizontal and vertical amplifiers and Lissajous Patterns.

TEXT BOOKS:

1. A course in electrical and electronic measurements and instrumentation by A. K. Sawhney, Puneet Sawhney, Dhanpat Rai & Co.
2. Electrical & electronic measurements and instrumentation, R. K. Rajput, S. Chand & Company Ltd.

REFERENCE BOOKS:

1. Electrical measurements and measuring instruments, Golding E.W, Widdis F.C, Publisher: AH Wheeler &Company.
2. Electrical and electronic measurements, G.K. Banerjee, PHI Learning Pvt. Ltd.
3. Electrical Measurements and Measuring Instruments, N. V. Suryanarayana, Tata McGraw Hill.

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5. 6. 7. 8.
9. 10. 11.

ELECTRICAL MACHINES – II

B. Tech. II Year II Semester

L	T	P	C
3	0	0	3

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

CO1. Understand the concepts of poly phase induction machines.
CO2. Examine the operation of induction motors.
CO3. Analyze performance characteristics of synchronous machines.
CO4. Evaluate the performance characteristics of Synchronous Generators
CO5. Assess the construction and operation of synchronous motors and special machines

UNIT – I

Poly-Phase Induction Machines: Constructional details of cage and wound rotor machines-production of a rotating magnetic field - principle of operation - rotor EMF and rotor frequency - rotor reactance, rotor current and Power factor at standstill and during operation. Induction generator-principle of operation(elementary treatment only).

UNIT – II

Characteristics of Induction Motor: Rotor power input, rotor copper loss and mechanical power developed. Torque equation- expressions for maximum torque and starting torque - torque slip characteristic - equivalent circuit - phasor diagram-crawling and cogging - No-load Test and Blocked rotor test –Predetermination of performance-Methods of starting and starting current and Torque calculations.

Speed Control Methods: Change of voltage, change of frequency, voltage/frequency, and injection of an EMF into rotor circuit (qualitative treatment only)

UNIT – III

Synchronous Machines: Constructional Features of round rotor and salient pole machines – Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings –distribution, pitch and winding factors – E.M.F Equation. Harmonics in generated e.m.f. – suppression of harmonics – armature reaction - leakage reactance – synchronous reactance and impedance – experimental determination - phasor diagram – load characteristics.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT – IV

Regulation and Parallel operation of Synchronous Machine: Regulation: Regulation by synchronous impedance method, M.M.F. method, Z.P.F. method and A.S.A. methods – salient pole alternators – two reaction concept – experimental determination of X_d and X_q (Slip test).

Parallel Operation of Synchronous Machines: Synchronizing alternators with infinite bus bars –synchronizing power torque – parallel operation and load sharing - Effect of change of excitation and mechanical power input.

UNIT – V

Synchronous Motors and Special Machines: Synchronous Motors: Theory of operation – Methods of starting- phasor diagram – Variation of current and power factor with excitation – synchronous condenser – Mathematical analysis for power developed - hunting and its suppression –synchronous induction motor.

Special Machines: Principles of operation of Reluctance Motors, Permanent magnet Brushless DC Motors.

TEXT BOOKS:

1. Theory and Performance of Electrical Machines, J.B. Gupta, S.K.Kataria & Sons , 2013.
2. Electrical Machines, R.K.Rajput, Laxmi Publications (P) Ltd, 2004.

REFERENCE BOOKS:

1. Electrical Machinery, P. S. Bimbhra, Khanna Publishers, 2011.
2. Electric Machines, I. J. Nagrath and D. P. Kothari, McGraw Hill Education, 2010.
3. Alternating current machines, A. S. Langsdorf, McGraw Hill Education, 1984.

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5. 6. 7. 8.
9. 10. 11.

DIGITAL ELECTRONICS

B. Tech. II Year II Semester

L	T	P	C
2	0	0	2

Course Outcomes: At the end of the course, the student should be able to

CO1. Demonstrate the basic theorems of Boolean algebra, logic gates, combinational and sequential circuits and memories.
CO2. Analyze the combinational and sequential circuits and memories.
CO3. Design of logic circuits
CO4. Realization of gates using different logic families.
CO5. Explain the design and operation of different semiconductor memories

UNIT I
NUMBER SYSTEM AND MINIMIZATION TECHNIQUES:

Number System: Review of number system and base conversion, complements, signed binary numbers, floating point number representation, Error detection (parity detection only).

Minimization techniques: Boolean Algebra**,** postulates ,basic logic gates, Canonical and Standard Form, NAND and NOR implementation, Minimization of switching function using theorem, The Karnaugh Map Method-Up to Five Variable Maps, Tabular Method.

UNIT II
COMBINATIONAL CIRCUITS:

Adders & Subtractor, Binary Adder-Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparators, Multiplexers, De-multiplexers, Decoders, Encoders and Code converters, Hazards and Hazard Free Relations.

UNIT III
SEQUENTIAL CIRCUITS-I:

Basic Architectural Distinctions between Combinational and Sequential circuits, Latches, Flip Flops: SR, JK, Race Around Condition in JK, JK Master Slave, D and T Type Flip Flops, Excitation Table of all Flip Flops, Design of a Clocked Flip-Flop, Timing and Triggering Consideration, Clock Skew, Conversion from one type of Flip-Flop to another.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT IV

SEQUENTIAL CIRCUITS-II:

Synchronous – Asynchronous – Comparison, Design of Single mode Counter, Ripple Counter, Ring Counter, Shift Register, Shift Register Sequences, Ring Counter Using Shift Register, MOD Counters. Finite state machine - capabilities and limitations, Mealy and Moore models.

UNIT V

LOGIC FAMILIES AND SEMICONDUCTOR MEMORIES:

Logic Families: DCTL, RTL, DTL, TTL and CML Logic –gate realization - Comparison,

Semiconductor Memories: Introduction to ROM, PAL, PLA, CPLD, FPGA.

FPGA Applications: Server Applications, control of motors (elementary treatment only)

TEXT BOOKS:

1. Switching and finite automata theory, Zvi Kohavi & Niraj K. Jha, Cambridge-3rd Edition.
2. Modern digital electronics – R. P. Jain, Tata McGraw-Hill-3rd Edition.

REFERENCE BOOKS:

1. Digital design, Morris Mano, PHI-4thEdition.
2. Introduction to switching theory and logic design, Fredriac J. Hill, Gerald R. Peterson, John Wiley & Sons Inc-3rdEdition.
3. Fundamentals of logic design- Charles H. Roth, Cengage Learning-5thEdition.

1. 2. 3. 4.
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CONTROL SYSTEMS

B. Tech. II Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes

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

CO1. Understand the fundamentals of classical and modern control systems.
CO2. Apply modelling concepts for electrical and mechanical systems.
CO3. Analyse time and frequency responses of first and second-order systems.
CO4. Assess stability of control systems.
CO5. Analyze stability using state space

UNIT – I

Introduction: Concepts of Control Systems- Open Loop and closed loop control systems and their differences- Different examples of control systems- Classification of control systems, Feed-Back Characteristics, Effects of feedback.
Mathematical models – Differential equations, Impulse Response and transfer functions - Translation and Rotational mechanical systems

UNIT II

Transfer Function Representation: Transfer Function of DC Servo motor - AC Servo motor- Synchro Transmitter and Receiver, Block diagram representation of systems considering electrical systems as examples -Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

UNIT –III

Time Response and Stability Analysis: Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems.
The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability.

The root locus concept - construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci.

UNIT – IV

Frequency Response Analysis: Introduction, Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin Stability Analysis from Bode Plots, Nyquist Plots-Stability Analysis.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT – V

Classical Control Design Techniques:

Introduction to Compensation techniques, PID Controllers.

State Space Analysis of Continuous Systems:

Concepts of state, state variables and state model, derivation of state models - Solving the Time invariant state Equations - State Transition Matrix and its Properties, Concepts of Controllability and Observability.

TEXT BOOKS :

1. Control Systems Engineering – I.J.Nagrath and M.Gopal, New Age International (P) Limited, Publishers, 2nd edition, 2009.
2. Automatic Control Systems - B. C. Kuo, John wiley and sons. 8th edition, 2003.
3. Control Systems – N.C.Jagan, BS Publications

REFERENCE BOOKS:

1. Modern Control Engineering –Katsuhiko Ogata – Prentice Hall of India Pvt. Ltd., 3rd Edition, 1998.
2. Control Systems-N.K.Sinha, New Age International (P) Limited Publishers, 3rd Edition, 1998.
3. Control Systems Engg. -– John wiley, NISE, 4rd edition, 2007.
4. Control Systems – Nagoorkani, 1998.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

ANALOG ELECTRONIC CIRCUITS LABORATORY

B. Tech. II Year II Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Identify and use the basic components and instruments in electronics laboratory
CO2. Outline the characteristics of different semiconductor devices.
CO3. Interpret the ripple factor, regulations of rectifiers.
CO4. Sketch the frequency response of small signal amplifiers.
CO5. Understand the concepts of SCR & UJT and observe its characteristics.

PART-A: (Only for Viva-voce Examination) Electronic Workshop Practice (In 3 Lab Sessions):

1. Identification, Specifications, Testing of R, L, C Components (Color Codes), Potentiometers, Switches (SPDT, DPDT, and DIP), Coils, Gang Condensers, Relays, Bread Boards, PCB's.
2. Identification, Specifications and Testing of Active Devices, Diodes, BJT's, Low power JFET's, MOSFET's, Power Transistors, LED's, LCD's, SCR,UJT.
3. Study and operation of
   a. Multimeters (Analog and Digital).
   b. Function Generator.
   c. Regulated Power Supplies.
   d. CRO.

PART B: Minimum of 10 experiments of the following should be conducted

1. Forward & Reverse Bias Characteristics of PN Junction Diode.
2. Zener diode characteristics and Zener as voltage Regulator.
3. Half Wave Rectifier with & without filters.
4. Full Wave Rectifier with & without filters.
5. Input & Output Characteristics of Transistor in CB Configuration.
6. Input & Output Characteristics of Transistor in CE Configuration.
7. FET characteristics.
8. Lissajous patterns using CRO.
9. Frequency Response of CC Amplifier.
10. Frequency Response of CE Amplifier.
11. Frequency Response of Common Source FET amplifier.
12. SCR Characteristics.
13. UJT Characteristics.
14. Clippers
15. Clampers

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

MEASUREMENTS AND INSTRUMENTATION LABORATORY

B. Tech. II Year II Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Calibrate voltmeters, ammeters and single phase energy meter.
CO2. Design the scale of PMMC voltmeter, LPF wattmeter, LVDT and resistance strain gauge.
CO3. Calculate resistance, inductance and capacitance using bridges.
CO4. Compute 3-Φ reactive power.
CO5. Test single phase energy meter and dielectric strength of oil of transformers.

Any ten of the following experiments are required to be conducted

1. Calibration and Testing of single phase energy Meter.
2. Calibration of dynamometer type power factor meter.
3. Crompton D.C. Potentiometer - Calibration of PMMC ammeter and PMMC voltmeter.
4. Kelvin's double Bridge - Measurement of resistance - Determination of Tolerance.
5. Dielectric oil testing using H.T. testing Kit.
6. Schering Bridge & Anderson Bridge.
7. Measurement of 3 Phase reactive power with single-phase wattmeter.
8. Measurement of parameters of a choke coil using 3 voltmeter and 3 ammeter methods.
9. LVDT and capacitance pickup - characteristics and Calibration.
10. Resistance strain gauge - strain measurements and Calibration.
11. Transformer turns ratio measurement using A.C. Bridge.
12. Measurement of ratio error and phase angle of given C.T. by comparison.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

ELECTRICAL MACHINES LABORATORY - II

B. Tech. II Year II Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Understand the basic working principle of a transformer; obtain the equivalent circuit parameters, estimate efficiency & regulation at various loads of 1-Φ transformers.
CO2. Examine load sharing of transformers & conversion of 3- Φ to 2- Φ supply.
CO3. Determine the equivalent circuit parameters of a single phase induction motor; determine the performance characteristics and efficiency by direct and indirect methods of three phase induction motor.
CO4. Analyze the regulation of an alternator by various methods at different power factors.
CO5. Assess synchronous motor performance curves at various power factors and field currents.

Any Ten of the following experiments are required to be conducted.

1. Sumpner's test on a pair of single phase transformer.
2. Separation of core losses of a single phase transformer.
3. Scott connection of transformer and Parallel operation of single phase transformer.
4. No-load & Blocked rotor tests on three phase induction motor.
5. Regulation of a three – phase alternate by synchronous impedance M.M.F methods.
6. V and inverted V curves of a three – phase synchronous motor.
7. Equivalent circuit of a single phase induction motor.
8. Determination of Xd and Xq of a salient pole synchronous machine.

In addition to the above eight experiments at least any two of the following experiments are required to be conducted from the following list.

9. Regulation of three phase alternator by Z.P.F. and A.S.A methods.
10. Determination of sequence impedances of a three-phase alternator.
11. Determination of sequence impedances of a three-phase transformer.
12. Speed control of three phase slip ring Induction Motor.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

R22 B.Tech EEE THIRD YEAR COURSE STRUCTURE

III YEAR I SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-8	Power Electronics	3	1	0	4
2	PC-9	Power System-II	3	1	0	4
3	PC-10	Microprocessors & Microcontrollers	3	0	0	3
4	PE-1	Professional Elective-I	3	0	0	3
5	OE-1	Open Elective-I	3	0	0	3
6	PC Lab-6	Microprocessors & Microcontrollers Laboratory	0	0	2	1
7	PC Lab-7	Control Systems Laboratory	0	0	2	1
8	H&S Lab-2	Advanced English Communication Skills Laboratory	0	0	2	1
9	MC-1	Environmental Science	2	0	0	0
		Total Credits	**17**	**2**	**6**	**20**

III YEAR II SEMESTER

S. No	Course Category	Course Title	L	T	P	Credits
1	H&S-2	Business Economics and Financial Analysis	3	0	0	3
2	PE-2	Professional Elective-II	3	0	0	3
3	PC-11	Power Semiconductor Drives	3	0	0	3
4	PC-12	Power System Protection	3	0	0	3
5	OE-2	Open Elective-II	3	0	0	3
6	PC Lab-8	Power Electronics Laboratory	0	0	2	1
7	PC Lab-9	Simulation of Power Converters Lab	0	0	2	1
8	PC Lab-10	Power System Laboratory	0	0	2	1
9	PW-2	Industry Oriented Mini Project/ Internship	0	0	4	2
10	MC-2	Gender Sensitization	2	0	0	0
		Total Credits	**17**	**0**	**10**	**20**

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5. 6. 7. 8.
9. 10. 11.

POWER ELECTRONICS

B. Tech. III Year I Semester

L	T	P	C
3	1	0	4

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand about various power electronic devices and their commutation procedure.
CO2. Discuss the operation of various single phase-controlled converters.
CO3. Examine operation of various three phase-controlled converters and AC voltage controllers.
CO4. Identify the operation of DC-DC converters.
CO5. Analyze the operation of DC-AC converters.

UNIT - I

POWER SEMI CONDUCTOR DEVICES & COMMUNICATION CIRCUITS:

THYRISTORS: Silicon Controlled Rectifiers (SCR's), BJT, Power MOSFET, Power IGBT, their characteristics and other thyristors. Basic theory of operation of SCR, Static characteristics, Turn on and turn off methods. Dynamic characteristics of SCR - Turn on and Turn off times -Salient points. Two transistor analogy. UJT firing circuit, Series and parallel connections of SCR's, Snubber circuit details – Specifications .Ratings of SCR's, BJT and IGBT - Line Commutation and Forced Commutation circuits. Numerical problems

UNIT - II

AC-DC CONVERTERS (1-PHASE CONTROLLED RECTIFIERS): Phase control techniques, Single phase Line commutated converters, Midpoint and Bridge connections, half controlled converters with R, RL and RLE loads. Derivation of average load voltage and current-Active and Reactive power inputs to the converters without and with Freewheeling Diode Numerical problems. Fully controlled converters, Midpoint and Bridge connections with Resistive, RL loads and RLE load Derivation of average load voltage and current Line commutated inverters -Active and Reactive power inputs to the converters without and with Freewheeling Diode, Effect of source inductance- Derivation of load voltage and current. Numerical problems.

UNIT - III

AC-DC CONVERTERS (3-PHASE CONTROLLED RECTIFIERS):

THREE PHASE CONVERTERS: Three pulse and six pulse converters, Midpoint and bridge connections- average load voltage With R and RL loads, effect of Source inductance. Dual converters (both single phase and three phase) Waveforms. Numerical Problems.

AC-AC CONVERTERS (AC VOLTAGE CONTROLLERS) & FREQUENCYCHANGERS (CYCLO-CONVERTERS):

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

AC VOLTAGE CONTROLLERS: Single phase two SCR's in anti-parallel with R and RL loads. Modes of operation of Triac, Triac with R and RL loads - Derivation of RMS load voltage, current and power factor wave forms. Firing circuits -Numerical problems – **CYCLOCONVERTERS:** Single phase mid-point cyclo-converters with Resistive and inductive loads. (Principle of operation only) Bridge configuration of single phase cyclo-converter (Principle of operation only) Waveforms.

UNIT IV

DC-DC CONVERTERS (CHOPPERS): CHOPPERS: Time ratio control and Current limit control strategies. Step down choppers- Derivation of load voltage and currents with R, RL and RLE loads. Step up Chopper – load voltage expression. Jones chopper, AC Chopper, Problems. Switched Mode Regulator - SMPS (Basic Principle of Operation).

UNIT V

DC-AC CONVERTERS (INVERTERS): INVERTERS: Single phase inverter, basic series inverter, parallel inverter - operation and waveforms .Three phase inverters (180, 120 degrees conduction modes of operation). Voltage control techniques for inverters, Pulse width modulation techniques. Numerical problems.

TEXT BOOKS:

1. Power electronics, Dr. P. S. Bimbhra, Khanna Publishers, 3rd edition.
2. Power electronics, circuits, devices and applications, M. H. Rashid, Prentice Hall of India, 4th edition.

REFERENCE BOOKS:

1. Power electronics devices, circuits and industrial applications, V. R. Moorthi, Oxford University Press.
2. Power electronics, M. D. Singh &K. B. Kanchandhani, Tata McGraw - Hill Publishing Company, 1998,
3. Power electronics, Vedam Subramanyam, New Age International (P) Limited Publishers, 2nd edition.

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5. 6. 7. 8.
9. 10. 11.

POWER SYSTEMS – II

B. Tech. III Year I Semester

L	T	P	C
3	1	0	4

Course Outcomes: After learning the contents of this paper the student must be able to

CO1. Understand the concept of over head transmission systems.
CO2. Analyze performance of transmission lines
CO3. Assess the need of voltage control and compensation in power systems
CO4. Prioritize per unit representation of power systems
CO5. Analyze various faults

UNIT - I:

OVER HEAD TRANSMISSION LINES: Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductors- transposition, bundled conductors, and effect of earth on capacitance,skin and proximity effects.

OVERHEAD LINE INSULATORS: Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators, Sag and tension calculations.

UNIT- II:

PERFORMANCE OF TRANSMISSION LINES: Representation of lines, short transmission lines, medium length lines, nominal T and PI- representations, long transmission lines. The equivalent circuit representation of a long Line, A, B, C, D constants, Ferranti Effect.

Corona: Introduction, disruptive critical voltage, corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, interference between power and Communication lines.

UNIT-III:

VOLTAGE CONTROL & POWER FACTOR IMPROVEMENT: Introduction – methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase modifiers, power factor improvement methods.

COMPENSATION IN POWER SYSTEMS: Introduction - Concepts of Load compensation – Load ability characteristics of overhead lines – Uncompensated transmission line – Symmetrical line – Radial line with asynchronous load – Compensation of lines.

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UNIT-IV:

PER UNIT REPRESENTATION OF POWER SYSTEMS: The one-line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unitsystem.

TRAVELLING WAVES ON TRANSMISSION LINES: Production of travelling waves, open circuited line, short-circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves.

UNIT-V:

SYMMETRICAL COMPONENTS AND FAULT CALCULATIONS: Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, fault calculations, sequence network equations, singleline to ground fault, line to line fault, double line to ground fault, three phase fault, faults on power systems, faults with fault impedance, reactors and their location, short circuit capacity of a bus.

TEXT BOOKS:

1. C.L. Wadhwa, "Electrical Power Systems", New Age International Pub. Co, Third Edition, 2001.
2. D.P. Kothari and I.J. Nagrath, "Modern Power System Analysis", Tata Mc Graw Hill Pub. Co.,New Delhi, Fourth edition, 2011.

REFERENCE BOOKS:

1. A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, "A Text book on Power SystemEngineering", Dhanpat Rai Publishing Company (P) Ltd, 2008.
2. John J. Grainger & W.D. Stevenson, "Power System Analysis", Mc Graw Hill International,1994.
3. Hadi Scadat, "Power System Analysis", Tata Mc Graw Hill Pub. Co. 2002.
4. W.D. Stevenson, "Elements of Power system Analysis", McGraw Hill International StudentEdition.

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MICROPROCESSORS AND MICROCONTROLLERS

B. Tech. III Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes

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

CO1. Illustrate the internal architecture of 8086 and 8051
CO2. Understand and apply the fundamentals of assembly level programming of microprocessors and microcontroller.
CO3. Explain the use of interrupts with suitable examples.
CO4. Demonstrate the interfacing of various peripheral devices with the microprocessor 8086.
CO5. Design electrical circuitry to the Microcontroller I/O ports in order to interface the controller to external devices.

UNIT-I

8086 Microprocessor: Introduction to 8085 microprocessor- 8086 architecture- Functional Diagram- Register Organization- Memory segmentation- Memory addresses- physical memory organization- Signal descriptions of 8086- common function signals- Minimum and Maximum mode operation- Timing diagrams- Interrupt structure.

UNIT-II

Assembly Language Programming using 8086: Instruction formats- addressing modes- instruction set- assembler directives-procedures-macros- Simple programs.

UNIT-III

Interfacing with 8086 Microprocessor: 8255 Programmable Peripheral Interface-Various Modes of Operation-Interfacing Keyboard- Display-Stepper motor- ADC-DAC-8259 Programmable Interrupt Controller -8257DMA controller.

UNIT-IV

Communication Interface: Serial communication standards- serial data transfer schemes- 8251 USART architecture and Interfacing- RS-232-TTL to RS 232C and RS232C to TTL conversion. Simple programs on serial data transfer-IEEE-488

UNIT-V

Introduction to Microcontrollers: Overview of 8051 microcontroller- Architecture- I/O ports and Memory organization- addressing modes and instruction set of 8051- Simple programs

Introduction to ARM Processor: ARM Processor fundamentals, ARM Architecture.

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TEXT BOOKS

1. Advanced Microprocessors and Peripherals, A. K. Ray and K.M. Bhurchandani, TMH-2nd Edition 2006.
2. Microprocessor and Interfacing, DV Hall, , Mc Graw Hill, 2006

REFERENCES

1. The 8051Microcontrollers- Architecture and Programming and Applications, K.Uma Rao & Andhe Pallavi, Pearson- 2009.
2. The 8051 Micro controller, Kenneth. J. Ayala, Cengage Learning, 2004.
3. Microprocessor Architecture, Programming and Applications with the 8085 , Ramesh Gaonkar, Penram International Publishing; 6th edition (1 October 2013) 2013

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MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

B. Tech. III Year I Semester

L	T	P	C
0	0	2	1

CO1. Perform arithmetic operations on 8086 microprocessor
CO2. Illustrate array sorting, searching and string manipulations using 8086 microprocessor.
CO3. Examine various operations using simulation software.
CO4. Perform various operations on 8051 microcontroller
CO5. Design and implement electrical circuitry to the Microcontroller I/O ports in order to interface the controller to external devices.

8086 MICROPROCESSOR KITS AND/OR ASSEMBLER

1. Arithmetic Operations (addition, subtraction, multiplication and division)
2. Addition of two BCD numbers.
3. Ascending order/Descending order of an array of numbers.
4. Finding Largest/Smallest numbers in an array of numbers.
5. Generation of Fibonacci series.
6. Hexadecimal to Decimal conversions
7. ASCII to Decimal conversion
8. Program for sorting an array for 8086.
9. Program for searching for a number or character in a string for 8086.
10. Program for string manipulations for 8086.

8051 MICROCONTROLLER:

1. Arithmetic Operations (addition, subtraction, multiplication and division)
2. Addition of two BCD numbers.
3. Ascending order/Descending order of an array of numbers.
4. Finding Largest/Smallest numbers in an array of numbers.
5. Generation of Fibonacci series.
6. Masking of Bits.
7. Hexadecimal to Decimal conversion.

INTERFACING WITH 8086 MICROPROCESSOR:

1. Stepper motor interfacing to 8086.
2. Elevator simulator interfacing to 8086.
3. seven- segment display interfacing to 8086.
4. Interfacing ADC and DAC to 8086.
5. Digit Key – interfacing to 8086

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CONTROL SYSTEMS LABORATORY

B. Tech. III Year I Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Examine the time response of second order systems, Synchros, and truth tables verification by PLC.
CO2. Design of AC servomotor and DC servomotor to find out their transfer function practically.
CO3. Design of DC motor, DC generator, and finding out their transfer function practically.
CO4. Analyze magnetic amplifier characteristics.
CO5. Explain stability analysis through bode, Nyquist and root locus plots using Simulation Software.

Any Ten of the following experiments are to be conducted

1. Time response of Second order system.
2. Characteristics of Synchros.
3. Programmable logic controller – Study and verification of truth tables of logic gates, simple. Boolean expressions and application of speed control of motor.
4. Effect of feedback on DC servomotor.
5. Transfer function of DC motor.
6. Transfer function of DC Shunt generator.
7. Characteristics of magnetic amplifiers.
8. Characteristics of AC servomotor.
9. Simulation of Op-Amp based Integrator and Differential circuits.
10. Linear system analysis (Time domain analysis, Error analysis).
11. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant system using simulation software.
12. State space model for classical transfer function– Verification using simulation software.

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POWER SEMICONDUCTOR DRIVES

B. Tech. III Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand the concepts of the dynamics of electric drives and speed control of different types of DC drives.
CO2. Examine four quadrant operation to control speed of DC drives using dual converters.
CO3. Classify four quadrant operation to control speed of DC drives using choppers.
CO4. Compare speed control methods of induction motor drives.
CO5. Investigate speed control methods of synchronous motor drives.

UNIT - I

CONTROL OF DC MOTORS THROUGH PHASE CONTROLLED RECTIFIERS:

Introduction to Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to DC separately excited and DC series motors -continuous current operation output voltage and current waveforms- Speed and Torque expressions Speed Torque Characteristics- Problems on Converter fed DC motors. Three phase semi and fully controlled converters Connected to DC separately excited and DC series motors output voltage and current waveforms Speed and Torque expressions Speed Torque characteristics - Problems.

UNIT- II

FOUR QUADRANT OPERATIONS OF DC DRIVES THROUGH DUAL CONVERTERS:

Introduction to Four quadrant operation Motoring operations, Electric Braking Plugging, Dynamic and Regenerative Braking operations, Four quadrant operation of D C motors by dual converters Closed loop operation of DC motor (Block Diagram Only).

UNIT - III

CONTROL OF DC MOTORS BY CHOPPERS (1, 2, 4 QUADRANT OPERATIONS):

Single quadrant, Two quadrant and four quadrant chopper fed separately excited and series exacted motors Continuous current operation Output voltage and current wave forms Speed torque expressions speed torque characteristics Problems on Chopper fed DC Motors Closed Loop operation (Block Diagram Only).

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT - IV

CONTROL OF INDUCTION MOTORS: Variable voltage& Frequency Characteristics: Control of Induction Motor by AC Voltage Controllers Waveforms speed torque characteristics. Variable frequency control of induction motor by Voltage source and current source Inverter and cyclo-converters- PWM control - Comparison of VSI and CSI operations Speed torque Characteristics numerical problems on induction motor drives Closed loop operation of induction motor delves (Block Diagram Only).

Static rotor resistance control: Slip power recovery Static Scherbius drive Static Kramer Drive their performance and speed torque characteristics advantages applications - problems.

UNIT - V

CONTROL OF SYNCHRONOUS MOTORS: Separate control & self-control of synchronous motors Operation of self-controlled synchronous motors by VSI and CSI Cycloconverters. Load commutated CSI fed Synchronous Motor - Operation Waveforms speed torque characteristics Applications -Advantages and Numerical Problems Closed Loop control operation of synchronous motor drives (Block Diagram Only), variable frequency control, Cycloconverter, PWM, VFI, CSI. Principle of operation of BLDC motor drive.

TEXT BOOKS:

1. Fundamentals of electrical drives, G. K. Dubey, Alpha Science International Limited-2nd Edition.
2. Power Semiconductor Drives, J. Gnanavadivel, Anuradha Publications.

REFERENCE BOOKS:

1. Power semiconductor drives, PV Rao, BS Publications.
2. Thyristor control of electric drives, Vedam Subramanyam, Tata McGraw Hill Publications.
3. A first course on electrical drives, S K Pillai, New Age International (P) Ltd-2nd Edition

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POWER SYSTEM PROTECTION

B. Tech. III Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand basic working of circuit breaker and classification of circuit breakers.
CO2. Examine different types of circuit breakers in power systems.
CO3. Analyze Principle of operation of over current, directional, differential and distance relays.
CO4. Design protection schemes for alternators, transformers, bus-bars.
CO5. Assess over voltage protection and insulation level

UNIT - I

CIRCUIT BREAKERS: Circuit Breaker (CB): Elementary principles of arc interruption, Recovery and Recovery voltages - Restriking phenomenon, average, maximum RRRV and numerical Problems. Current chopping and Resistance switching. CB ratings and specifications: Types and Numerical problems. Auto reclosing. Description and operation of following types Circuit Breakers: Minimum Oil Circuit Breaker, Air Blast Circuit Breaker, Vacuum and SF6 circuit breaker.

UNIT - II

ELECTROMAGNETIC, STATIC RELAYS & NUMERICAL RELAYS: Principle of operation and construction of attracted armature, balanced beam, induction disc and induction cup relays-classification. Instantaneous DMT and IDMT types, Applications of relays: Over current/under voltage relays, Directional relays, percentage differential relays. Distance relays: Impedance, Reactance, Mho and offset Mho relays and Characteristics of distance relays. Comparison of numerical relays & static relays with electromagnetic relays.

UNIT - III

GENERATOR & TRANSFORMER PROTECTION: Protection of generators against stator faults, Rotor faults and abnormal conditions. Restricted earth fault and inter turn fault protection. Numerical examples on percentage of winding unprotected. Protection of transformers: Percentage and differential protection, Numerical problems on Design of CT's ratios and Buchholz relay protection.

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UNIT - IV

FEEDER AND BUS BAR PROTECTION& GROUNDING PROTECTION OF LINES:

Over current earth fault, Carrier current and three zone distance protection using impedance relays– Translay relay Protection of bus bars and Differential protection.

NEUTRAL GROUNDING

Grounded & ungrounded neutral systems. Effects of ungrounded neutral system performance. Methods of neutral grounding: Solid resistance, reactance, Arcing grounds& grounding practices.

UNIT - V

PROTECTION AGAINST OVER VOLTAGE AND GROUNDING: Generation of over voltages in power systems, Protection against lightning over voltages, Valve type and zinc–Oxide lighting arresters, Insulation coordination, BIL– impulse ratio. Earthing Practices in Substations.

TEXT BOOKS:

1. Power system protection and switch gear, Badriram, D. N. Viswakarma Tata McGraw Hill Education-2nd Edition.
2. Switchgear and protection, Sunil. S. Rao, Khanna publishers.

REFERENCE BOOKS:

1. Electrical power systems, C. L. Wadhwa, New age international (P) limited-4th Edition.
2. A Textbook on power system engineering, M. L. Soni, P. V. Gupta, U. S. Bhatnagar, A. Chakrabarthy, Dhanapat Rai & Co. pvt.ltd.
3. Principles of power system, V.K. Mehtha & Rohit Mehtha, S. Chand company Pvt. Ltd - 4th Edition.

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POWER ELECTRONICS LABORATORY

L	T	P	C
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B. Tech. III Year II Semester

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Examine the characteristics of SCR, MOSFET, & IGBT, and analyze triggering circuits.
CO2. Analyze input and output characteristics of AC-DC converters.
CO3. Synthesize input and output characteristics of Cycloconverters.
CO4. Examine input and output characteristics of DC-DC Converters.
CO5. Outline the operation of Power converter controlled motors.

Any ten of the following experiments are required to be conducted.

1. Study of the characteristics of SCR
2. Study of characteristics of MOSFET & IGBT.
3. Gate Firing Circuits for SCRs (R- Triggering, RC Triggering & UJT Triggering).
4. Single Phase AC voltage Controller with R & RL Loads.
5. Single Phase fully Controlled Bridge Converter with R& RL Loads.
6. DC Jones Chopper with R & RL Loads.
7. Single Phase Parallel Inverter with R& RL Loads.
8. Single Phase Cycloconverter with R& RL Loads.
9. Single Phase Series Inverter with R& RL Loads.
10. Single Phase Half controlled converter with R Load.
11. Thyristorised drive for 1Hp DC motor with closed loop control.
12. Speed Measurement and closed loop control using PMDC motor.

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SIMULATION OF POWER CONVERTERS LABORATORY

B. Tech. III Year II Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Examine the characteristics of SCR, MOSFET, & IGBT, and analyze triggering circuits.
CO2. Analyze input and output characteristics of AC-DC converters.
CO3. Synthesize input and output characteristics of Cycloconverters.
CO4. Examine input and output characteristics of DC-DC Converters.
CO5. Outline the output of various Power converters

Any ten of the following experiments are required to be conducted.

Any 10 experiments from the below may be conducted

1. Simulation models of SCR, IGBT and MOSFET
2. Simulation of Single Phase Semi controlled converter
3. Simulation of Single phase fully controlled converter using RL and E loads.
4. Simulation of Three phase fully controlled converter using RL and E loads.
5. Simulation of Single phase AC Voltage controller using RL load.
6. Simulation of single phase Inverter with PWM control.
7. Simulation of Three-phase inverter with PWM controller.
8. Simulation of DC-DC Converter with various classes operation.
9. Simulation of Dual Converter with various modes of operation
10. Simulation of resonant pulse commutation circuit.
11. Simulation of Buck and Boost Converters.
12. Simulation of Voltage commutated Chopper

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POWER SYSTEMS LABORATORY

B. Tech. III Year II Semester

L	T	P	C
0	0	2	1

Course Outcomes: Upon the completion of Laboratory course, the student will be able to

CO1. Predict the sequence impedances of electrical machines
CO2. Examine the characteristics of relays
CO3. Analyze the Merz -Price protection scheme
CO4. Assess the function of over current relay, over voltage relays and transmission lines
CO5. Compute the sub-transient reactance of electrical machine

Any 10 experiments from the below may be conducted

1 To find Positive, Negative and zero sequence impedances of a 3-phase, 3-Winding Transformer
2 Determination Sequence Impedances of Three Phase Transformer
3 To determine efficiency and regulation of 3-phase Transmission Line model
4 To determine characteristic of 2-overcurrent relay for 3-phase transformer protection
5 To determine the operating characteristic of Negative sequence Relay
6 Merz -Price protection scheme for 3-phase transformer
7 To determine characteristics of IDMT Over Current Relays
8 To find Positive, Negative and zero sequence impedances of a Cylindrical Rotor Synchronous Machine
9 To determine sub-transient reactance's of a Salient Pole Synchronous generator
10 To determine the characteristics of Over Voltage Relay
11 Merz -Price protection scheme for Single Phase Transformer
12 Feeder protection system for external faults

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R22 B.Tech EEE FOURTH YEAR COURSE STRUCTURE

IV YEAR I SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-13	Electric and Hybrid Vehicles	3	1	0	4
2	PC-14	Power System Operation and Control	3	0	0	3
3	PE-3	Professional Elective-III	3	0	0	3
4	OE-3	Open Elective-III	3	0	0	3
5	H&S-3	Essentials of Computer Networks	2	0	0	2
6	PC Lab-11	Simulation of Renewable Energy Systems Laboratory	0	0	4	2
8	PW-3	Project Stage – I	0	0	6	3
		Total Credits	**14**	**1**	**10**	**20**

IV YEAR II SEMESTER

S. No.	Course Category	Course Title	L	T	P	Credits
1	PC-15	Utilization of Electrical Energy	3	0	0	3
2	PC-16	Power Electronic Applications to Renewable Energy Systems	3	0	0	3
3	PE-4	Professional Elective-IV	3	0	0	3
4	PW-4	Project Stage – II including Seminar	0	0	22	9+2
		Total Credits	**9**	**0**	**22**	**20**

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ELECTRIC AND HYBRID VEHICLES

B. Tech. IV Year I Semester

L	T	P	C
3	1	0	4

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand the components of Electric Vehicles and Fundamentals of Electric Vehicles.
CO2. Explain the types of batteries and principles of operation of batteries.
CO3. Analyze the control techniques of Electric motors which are used in Electric vehicles.
CO4. Apprehend the transmission of the drive system and the components of transmission.
CO5. Assess various modes of Hybrid vehicles for different conditions.

UNIT- I

ELECTRIC VEHICLES: Introduction to Electric Vehicles - History of Electric and Hybrid Vehicles - Component's vehicle mechanics - Roadway fundamentals - vehicle kinetics - Dynamics of vehicle motion - Propulsion System Design.

UNIT -II

BATTERIES: Basics Types -Parameters - Capacity- Discharge rate - State of charge - State of Discharge -Depth of Discharge - Technical characteristics - Battery pack - Design Properties of Batteries -Fuel Cells - Types - Fuel Cell -Electric Vehicle.

UNIT - III

DC & AC ELECTRICAL MACHINES (Speed control Techniques): Motor and Engine rating - Requirements - Speed control techniques of DC machines in Electric Vehicles - Speed control techniques of three phase A/c machines, Induction machines, Permanent Magnet Machines, Switched Reluctance Machines.

UNIT - IV

ELECTRIC VEHICLE DRIVE TRAIN: Transmission configuration Components, gears, differential, clutch, brakes, regenerative braking- motor sizing, Gear Ratio, Torque- speed characteristics, EV Motor Sizing, Initial Acceleration, Rated Vehicle Velocity, Maximum Velocity – Maximum Gradability.

UNIT - V

HYBRID ELECTRIC VEHICLES: Types of Hybrid Vehicles- series and parallel Hybrid Electric Vehicles, series- parallel configuration, Internal Combustion Engines -Reciprocating Engines- Practical and Air-Standard Cycles Air- Standard Otto Cycle Air-Standard Diesel Cycle Example IC Engines in HEVs Design Drive train sizing of components.

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5. 6. 7. 8.
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TEXT BOOKS:

1. Electric & hybrid vehicles Design Fundamentals, Iqbal Hussain, CRC Press 2nd Edition.
2. Electric vehicle technology explained, James Larminie, John Lowry, Wiley& Sons- 2nd Edition.

REFERENCE BOOKS:

1. Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory and design, Mehrdad Ehsani, Yimin Gao, Ali Emadi, CRC Press - 2nd Edition.
2. Electric vehicle battery systems, Sandeep Dhameja – Kindle Edition.

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5. 6. 7. 8.
9. 10. 11.

POWER SYSTEM OPERATION AND CONTROL

B. Tech. IV Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand economic operation of power systems.
CO2. Analyze and compute optimal loading of generators for a particular load demand.
CO3. Develop mathematical models of turbines and governors.
CO4. Address load frequency control problem.
CO5. Explain how series and shunt compensation helps in reactive power control.

UNIT - I

ECONOMIC OPERATION OF POWER SYSTEMS: Optimal operation of Generators in Thermal Power Stations – 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 - II

HYDROTHERMAL SCHEDULING: Optimal scheduling of Hydrothermal System: Hydroelectric power plant models, scheduling problems- Short term hydrothermal scheduling problem.

UNIT - III

MODELING: 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.

Modeling of Excitation System: Fundamental Characteristics of an Excitation system, Transfer function, Block Diagram Representation of IEEE Type-1 Model

UNIT - IV

LOAD FREQUENCY CONTROL: Single Area Load Frequency Control: 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. Load frequency control of 2-area system – uncontrolled case and controlled case, tie-line bias control.

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5. 6. 7. 8.
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Load Frequency Controllers: Proportional plus Integral control of single area and its block diagram representation, steady state response – Load Frequency Control and Economic dispatch control.

UNIT - V

REACTIVE POWER CONTROL: Overview of Reactive Power control – Reactive Power compensation in transmission systems– advantages and disadvantages of different types of compensating equipment for transmission systems. Load compensation–Specifications of load compensator, Uncompensated and compensated transmission lines: Shunt and Series Compensation.

TEXT BOOKS:

1. Modern Power System Analysis, I.J. Nagarath & D.P. Kothari, Tata McGraw Hill Publishing Company Ltd -4th Edition.
2. Power systems analysis and stability, S.S Vadhera, Khanna Publications- 4thEdition.

REFERENCE BOOKS:

1. Power generation, operation and control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheble, Wiley -3rdEdition.
2. Power system stability and control, Prabha Kundur, McGraw Hill companies-Indean Edition.
3. Power system operation and control, Dr. K. Uma Rao, Wiley India Pvt. Ltd.

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ESSENTIALS OF COMPUTER NETWORKS

B. Tech. IV Year I Semester

L	T	P	C
2	0	0	2

Course Outcomes:

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

- **CO1.** Understand the scenario of reference models.
- **CO2.** Illustrate various sub protocols in multi access protocols.
- **CO3.** Outline various routing algorithms and their operations.
- **CO4.** Analyze transport protocols for the given scenario.
- **CO5.** Identify the protocols and functionalities in application layer

UNIT - I:

Introduction to Data Communication

Overview of the Internet: Definition of networks, Topology, Protocol, Layering Scenario, TCP/IP Protocol Suite: The OSI Model, Internet history, Comparison of the OSI and TCP/IP reference model.

UNIT - II:

Data Link Layer - Design issues, Elementary Data Link Layer Protocols.

Medium Access Protocols - ALOHA, CSMA, Ethernet- Physical Layer, Ethernet, Mac Sub layer – CSMA/CD, Fast, Gigabit, 10-Gigabit Ethernets, Data link layer repeaters, hubs, bridges, switches, routers and gateways.

UNIT - III:

Network Layer: Network Layer Design issues, Routing algorithms - shortest path, flooding and Distance Vector Routing.

Internetworking: IP addresses, IPv4, IPv6 Protocol, subnetting

UNIT - IV:

Transport Layer: Introduction to TCP and UDP, difference between TCP & UDP, The TCP Connection Management Modeling, and The TCP Congestion Control.

UNIT - V:

Application Layer- Introduction, providing services, Applications layer paradigms, Client server model, Standard client-server application-HTTP, DNS.

TEXT BOOKS:

1. Data Communications and Networking - Behrouz A. Forouzan, TMH, 2013, Fifth Edition
2. Computer Networks - Andrew S Tanenbaum, Pearson Education, 4th Edition

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5. 6. 7. 8.
9. 10. 11.

REFERENCE BOOKS:

1. An Engineering Approach To Computer Networks-S.Keshav, Pearson Education,2nd Edition
2. Understanding Communications And Networks, W.A.Shay, Cengage Learning, 3rd Edition.
3. Introduction To Computer Networks And Cyber Security, Chwan-Hwa (John)Wu, J.David Irwin, CRC Press.

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5. 6. 7. 8.
9. 10. 11.

SIMULATION OF RENEWABLE ENERGY SYSTEMS LABORATORY

B. Tech. IV Year I Semester

L	T	P	C
0	0	4	2

Course Outcomes: At the end of the laboratory course, the student will be able to

CO1. Understand PV energy conversion system
CO2. Interpret irradiation, temperature effect on PV array
CO3. Assessment of Solar power system
CO4. Understand wind energy conversion system and Fuel cell
CO5. Inspect the Hybrid renewable energy power system

Any 10 experiments from the following experiments may be conducted

1. Simulation study on Solar PV Energy System.
2. Formation of Admittance bus
3. Simulation study on GS method load flow analysis
4. Experiment on "VI-Characteristics and Efficiency of Solar PV System".
5. Effect of irradiation on PV array
6. Effect of temperature on PV array
7. Experiment on Performance assessment of Standalone Solar Power System.
8. Experiment on Performance assessment of Grid connected Solar Power System
9. Simulation study on Wind Energy Generator.
10. Experiment on Performance assessment of microWind Energy Generator.
11. Study on Hybrid (Solar-Wind) Power System.
12. Study on Performance Assessment of Fuel

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UTILIZATION OF ELECTRICAL ENERGY

L	T	P	C
3	0	0	3

B. Tech. IV Year II Semester

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand the importance of illumination and various illumination techniques.
CO2. Examine the performance of simple resistance furnaces, modern welding techniques.
CO3. Apply the concepts of Electrolytic process
CO4. Categorize different types of Electric Traction systems
CO5. Evaluate different types of traction mechanics

UNIT – I

ILLUMINATION: Definition – Laws of illumination – Polar curves – Calculation of MHCP and MSCP. Lamps: Incandescent lamp, Sodium Vapour lamp, Fluorescent lamp. Requirement of good lighting scheme – Types, Design and Calculation of illumination. Street lighting and Factory lighting – Numerical Problems.

UNIT – II

ELECTRICAL HEATING & ELECTRIC WELDING: Advantages, Methods of Electric heating – Resistance, arc, Induction and dielectric heating. Types of electric welding – Resistance, Electric arc, gas welding and Ultrasonic welding, Welding electrodes of various metals, Defects in welding.

UNIT – III

ELECTROLYTIC PROCESS: Basic principle of Electrolysis, Faradays laws of Electrolysis – Numerical problems, Applications of Electrolysis – Electro deposition-manufacturing of chemicals – anodizing – electro polishing – electro cleaning – electro parting – electro metallurgy, Power supply for Electrolysis.

UNIT – IV

ELECTRIC TRACTION: Introduction –Traction Systems, Systems of Electric Traction-Advantages of Electric Traction, Systems of Track Electrification, Desirable features of Traction Motors – Suitability of D.C. series motor, A.C. series motor, 3 phase induction motor and linear induction motor for traction. Electric Braking in traction - Plugging, Rheostatic and Regenerative types – Suitability of different motors for braking, Temperature Rise and Load Equalization.

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UNIT – V

TRACTION MECHANICS: Types of services – urban – sub-urban and main line services, Speed-time curves of different services – trapezoidal and quadrilateral speed-time curves – Numerical Problems, Tractive effort, Power, Specific Energy Consumption- factors affecting Specific Energy Consumption, Mechanics of train movement - Adhesive weight and coefficient of adhesion – Problems.

TEXT BOOKS:

1. Utilization of Electric Power, Er. R. K. Rajput, Laxmi Publications, 2nd Edition
2. Utilization of Electric Power and Electric Traction, J.B. Gupta, S.K. Kataria and sons, Delhi. Art & Science of Utilization of electrical Energy – by H. Partab, Dhanpat Rai & Sons.

REFERENCE BOOKS:

1. Generation, Distribution and Utilization of Electrical Energy" by C. L. Wadhwa, Eastern . Wiley Ltd.
2. Utilization of Electrical Power including Electric drives and Electric traction – by N.V.Suryanarayana, New Age International (P) Limited Publishers, 1996.
3. A text book on Power System Engineering" by A. Chakraborti, M. L. Soni, P. V. Gupta, U.S.Bhatnagar, Dhanpat Rai and Co.(P) Ltd – Delhi.

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POWER ELECTRONIC APPLICATIONS TO RENEWABLE ENERGY SYSTEMS

B. Tech. IV Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. acquire knowledge on Non-Conventional energy sources
CO2. analyze various DC-DC converter technologies used for renewable energy systems
CO3. Design inverters for renewable energy systems
CO4. Develop power extraction and supply schemes for wind energy systems
CO5. develop stand alone DG sets and micro grid systems from renewable energy sources

UNIT - I

Introduction to renewable sources: world energy scenario, Wind, solar, hydro, geothermal, availability and power extraction.
Introduction to solar energy: Photovoltaic effect, basics of power generation, P-V &I-V characteristics, effect of insolation, temperature, diurnal variation, shading, Modules, connections, ratings, Power extraction (MPP) tracking and MPPT schemes; standalone systems, grid interface, storage, AC-DC loads.

UNIT - II

DC-DC converters for solar PV: buck/boost/buck-boost /flyback /forward/cuk, bidirectional converters, Interleaved and multi-input converters.

UNIT - III

Grid connected Inverters: 1ph, 3ph inverters with & w/o x'mer, Heric, H6, Multilevel Neutral point clamp, Modular multilevel, CSI; Control schemes: unipolar, bipolar, PLL and synchronization, power balancing / bypass, Parallel power processing; Grid connection issues: leakage current, Islanding, harmonics, active/reactive power feeding, unbalance.

UNIT - IV

Introduction to wind energy: P-V, I-V characteristic, wind power system: turbine-generator-inverter, mechanical control, ratings; Power extraction (MPP) and MPPT schemes. Generators for wind: DC generator with DC to AC converters; Induction generator with & w/o converter.

UNIT - V

Synchronous generator with back to back controlled/ uncontrolled converter; Doubly fed induction generator with rotor side converter topologies; permanent magnet based generators. Battery: Types, charging discharging. Introduction to AC and DC microgrids.

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5. 6. 7. 8.
9. 10. 11.

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. 3. Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2011.

REFERENCE BOOKS:

1. N. Mohan, T.M. Undeland & W. P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989

2. Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2004

3. E. Guba, P. Sanchis, A. Ursa, J. Lpez, and L. Marroyo, Ground currents in single-phase transformerless photovoltaic systems, Progress in Photovoltaics: Research and Applications, vol. 15, no. 7, 2007.

4. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.

5. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley-IEEE Press, 2011.

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PROFESSIONAL ELECTIVES
IoT APPLICATIONS IN ELECTRICAL ENGINEERING
(Professional Elective – I)

B. Tech. III Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes:

The students should be able to

CO1. Understand the various fundamentals, architectures and technologies of Internet of Things.

CO2. Discuss about various communication technologies used in the Internet of Things.

CO3. Acquire knowledge on the various device connectivity methods using web and internet in the IoT environment.

CO4. Explore various data acquisition methods, data handling using cloud for IoT applications.

CO5. Apply IoT to design Smart Home, Smart city, agriculture practices etc.

UNIT - I

The Internet of Things An overview of internet of things (IoT) – IoT framework – Architecture technology behind IoT – Sources of the IoT – M2M communication – Examples of IoT.

UNIT – II

Design Principles for Connected Devices: Introduction –IoT/M2M systems, layers and designs, standardization – Communication technologies – Data enrichment, consolidation and device management at gateway – Ease of designing and affordability.

UNIT – III

Design Principles for the Web Connectivity: Introduction – Web communication protocols for connected devices - Message communication protocols for connected devices – Web connectivity for connected devices network.

Introduction to internet connectivity principles, internet connectivity, internet based communication – IP addressing in the IoT – Application layer protocols: HTTP, HTTPS, FTP, Telnet, WAP (Wireless Application Protocol).

UNIT – IV

Data Acquiring, Organizing, Processing and Analytics: Introduction – Data acquiring and storage – Organizing the data – Analytics.

Data Collection, Storage and Computing Using a Cloud Platform: Introduction – Cloud computing paradigm for data collection, storage and computing – IoTas a service and cloud service Models – IoT cloud based services using the Xively (Pachube/COSM), Nimbits and other platforms.

UNIT – V

Sensor technology: Actuator, sensor data communication protocols, radio frequency identification technology, wireless sensor network technology. IoT application case studies: Smart home, smart cities, environment monitoring and agriculture practices.

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5. 6. 7. 8.
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TEXT BOOKS:

1. Internet of Things: Architecture, Design Principles, Raj Kamal, McGraw Hill Education (India) Pvt. Limited, 2017.

REFERENCE BOOKS:

1. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley, First edition, 2013.
2. Getting Started with the Internet of Things, CunoPfister, O'reilly, 2011.
3. Internet of Things : A Hands-on Approach, Arshdeep Bahga, and Vijay Madisetti, 2014

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9. 10. 11.

ELECTRICAL ENERGY CONSERVATION AND AUDITING
(Professional Elective-1)

L	T	P	C
3	0	0	3

B. Tech. III Year I Semester

Course Outcomes: After completion of this course, students are able to:

CO1. Know the current energy scenario and importance of energy auditing.
CO2. Understand the concepts of energy auditing.
CO3. Evaluate the performance of existing engineering systems
CO4. Explore the methods of improving energy efficiency in different engineering systems
CO5. Design different energy efficient devices.

UNIT- I

Basics of Energy and its various forms: Overview of engineering, elements Solar energy, electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, elements of bio energy, bio mass energy conservation, elements of geothermal energy, sources of geothermal energy, sources of chemical energy, fuel cells, Energy Scenario in India

UNIT- II

Energy Auditing-1: Introduction: Need for energy audit, directions for the study of energy auditing, inclusions for energy auditing, types of energy audit: preliminary audit, general/mini audit, investment-grade/ comprehensive audit. Major energy consuming equipments and systems, energy audit team, energy auditing methodology: preliminary and detailed. Process flow diagram, energy audit report format

UNIT- III

Energy Auditing-2: For buildings: Energy auditing instruments, energy efficiency, energy auditing for buildings: stages in programs, surveying, measurements and model analysis. Energy audit form of commercial buildings, checklist for energy saving measures

UNIT - IV

Energy Efficient Technologies-I: Importance of energy efficiency for engineers, Energy efficient technology
in mechanical engineering: Heating, ventilation and air-conditioning, boiler and steam distribution systems
Energy efficient technology in civil engineering: future of roads, harnessing road and transport infrastructure;

UNIT - V

Energy Efficient Technologies-II : Energy efficient technology in electrical engineering: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors; Energy efficient technology in chemical engineering: green chemistry, low carbon cements, recycling paper

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TEXT BOOKS:

1. Energy Management, Umesh Rathore,, Kataria publications, 2nd ediiton, 2014.
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects

REFERENCES:

1. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland University of Technology.
2. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

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CYBER PHYSICAL SYSTEMS
(Professional Elective - I)

B.Tech III Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes:
At the end of the course students should be able to:

- **CO1.** Understand the concept of Cyber Physical System.
- **CO2.** Apply CPS platform components to develop Cyber Physical Systems.
- **CO3.** Develop solution using synchronous and asynchronous models.
- **CO4.** Apply concepts of security to enhance existing systems.
- **CO5.** Ability to develop concepts, logics towards solving problem in research and industry.

UNIT - I :
Introduction: Cyber-Physical System, Key Features of CPS, Application Domains of CPS, Basic principles of design and validation of CPS, Challenges in CPS.

UNIT – II :
CPS Platform components: CPS HW platforms, Processors, Sensors and Actuators, CPS Network - Wireless, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks, Synchronous Model and Asynchronous Model.

UNIT – III :
Synchronous and Asynchronous Model: Reactive Components, Components Properties, Components Composing, Synchronous Designs and Circuits, Asynchronous Processes and operations, Design Primitives in Asynchronous Process, Coordination Protocols in Asynchronous Process, Leader
Election, Reliable Transmission.

UNIT – IV:
Security of Cyber-Physical Systems: Introduction to CPS Securities, Basic Techniques in CPS Securities, Cyber Security Requirements, Attack Model and Countermeasures, Ddvanced Techniques in CPS Securities.

UNIT – V:
CPS Application: Health care and Medical Cyber-Physical Systems, Smart grid and Energy Cyber Physical Systems, WSN based Cyber-Physical Systems, Smart Cities.

TEXT BOOKS:
1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.
2. R. Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.

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9. 10. 11.

REFERENCE BOOKS:

1. Raj Rajkumar, Dionisio de Niz and Mark Klein, "Cyber-Physical Systems", Addison-Wesley,
2017
2. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press, 2015
3. Fei Hu, "Cyber-Physical Systems", CRC Press 2013

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5. 6. 7. 8.
9. 10. 11.

AI TECHNIQUES IN ELECTRICAL ENGINEERING
(Professional Elective-II)

L	T	P	C
3	0	0	3

B. Tech. III Year II Semester

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand artificial neural networks.

CO2. Generalize feed forward neural networks, feedback neural networks and learning techniques.

CO3. Identify fuzziness involved in various systems and fuzzy set theory.

CO4. Discover fuzzy logic control for applications in electrical engineering.

CO5. Interpret genetic algorithm for applications in electrical engineering.

UNIT - I

ARTIFICIAL NEURAL NETWORKS: Introduction, Models of Neuron Network-Architectures Knowledge representation, Artificial Intelligence and Neural networks–Learning process-Error correction learning, Hebbian learning Competitive learning-Boltzman learning, supervised learning-Unsupervised learning. Reinforcement learning - Learning tasks.

UNIT- II

ANN PARADIGMS: Multi-layer perceptron using Back propagation Algorithm (BPA), Self –Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

UNIT - III

FUZZY LOGIC: Introduction: Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets. Fuzzy Cartesian Product, Operations on Fuzzy relations Fuzzy logic, Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule based system, Defuzzification methods.

UNIT - IV

GENETIC ALGORITHMS: Introduction-Encoding Fitness Function-Reproduction operators, Genetic Modeling Genetic operators-Cross over-Single site cross over, Two point cross over Multi point cross over Uniform cross over, Matrix cross over-Crossover Rate-Inversion & Deletion, Mutation operator Mutation Mutation Rate-Bit-wise operators, Generational cycle-convergence of Genetic Algorithm.

UNIT V

APPLICATIONS OF AI TECHNIQUES: Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Reactive power control, Speed control of DC and AC Motors.

TEXT BOOKS:

1. Neural networks, fuzzy logic and genetic algorithms, S.Rajasekaran and G.A.V.Pai PHI, New Delhi.
2. Neural networks: A comprehensive foundation, Simon O Haykin, International Edition-2nd Edition.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

REFERENCE BOOKS:

1. Neural computing theory & practice, P.D.Wasserman & Van Nostrand Reinhold, New York.
2. Neural network & fuzzy system, Bart Kosko, PrenticeHall.
3. Genetic algorithms, D.E.Goldberg, Pearson Education.

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5. 6. 7. 8.
9. 10. 11.

MODERN POWER ELECTRONICS
(Professional Elective-II)

B. Tech. III Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Define the advances in power electronic devices.

CO2. Articulate power electronic resonant converters in power control applications.

CO3. Evaluate the design and control of multi-level inverters.

CO4. Articulate DC power supplies in Power electronic applications

CO5. Evaluate the design and control of AC power supplies and uninterruptable power supplies.

UNIT - I

Modern power semiconductor devices: Modern power semiconductor devices- MOS turn Off Thyristor (MTO) - Emitter Turn Off Thyristor (ETO) Integrated Gate- Commutated Thyristor (IGCTs)-MOS-controlled Thyristors (MCTs)-Static Induction circuit comparison of their features.

UNIT - II

Resonant Pulse Inverters: Resonant pulse inverters-series resonant inverters-series resonant inverters with unidirectional switches series resonant inverters with bidirectional Switches analysis of half bridge resonant inverter - evaluation of currents and Voltages of a simple resonant inverter-analysis of half bridge and full bridge resonant inverter with bidirectional switches.

UNIT - III

Multilevel Inverters: Multi level concept-Classification of multilevel inverters- Diode clamped multilevel inverter- principle of operation-main features improved diode - Clamped inverter-principle of operation-Flying capacitors multilevel inverter principle of operation-main features.

UNIT - IV

DC Power Supplies: DC power supplies-classification-switched mode dc power supplies-fly back Converter -forward converter- push pull converter-half bridge converter-Full bridge converter-Resonant dc power supplies-bidirectional dc power supplies-Applications.

UNIT - V

AC Power Supplies: AC power supplies classification-switched mode ac power supplies. Resonant AC power supplies-bi directional ac power supplies-multi stage conversions-control circuits - applications. Introduction-power line disturbances-power conditioners - uninterruptible Power supplies applications.

TEXT BOOKS

1. Power Electronics -Mohammed H. Rashid, Pearson Education - Third Edition
2. Power Electronics - Ned Mohan, Tore M. Undeland and William P. Robbins - John Wiley and Sons Second Edition.

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WIND AND SOLAR ENERGY SYSTEMS
(Professional Elective - II)

B.Tech. III Year II

Sem.

L	T	P	C
3	0	0	3

Course Outcomes: At the end of this course, students will demonstrate the ability to

CO1. Understand the basic physics of Wind Power.
CO2. Outline Wind turbine technologies and their operation. generation.
CO3. Understand the basics of Solar Power.
CO4. Apply the concepts of power electronic interfaces for wind and solar generation.
CO5. Analyze the technologies used for Solar Power generation.

UNIT - I
Physics of Wind Power

History of wind power, Indian and Global statistics, Wind physics, Betz limit ratio, stall and pitch control, Wind speed statistics-probability distributions, and Wind power-cumulative distribution functions.

UNIT - II
Wind Generator Topologies

Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator configurations, Converter Control.

UNIT - III
The Solar Resource

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar daylength, Estimation of solar energy availability.

Solar Photovoltaic

Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power point Tracking (MPPT) algorithms. Converter Control.

UNIT - IV
Network Integration Issues

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

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9. 10. 11.

UNIT - V

Solar Thermal Power Generation

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

TEXT BOOKS:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.

REFERENCE BOOKS:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
2. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" JohnWiley and Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
4. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

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5. 6. 7. 8.
9. 10. 11.

POWER QUALITY AND FACTS
(Professional Elective-III)

B. Tech. IV Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: After completion of this course, the student will be able to

CO1. Understand the severity of power quality problems in distribution system
CO2. Illustrate the concept of transmission line reactive power compensation
CO3. Choose proper shunt compensators for reactive power compensation
CO4. Apply the control circuits of static series compensators for various functions
CO5. Classify combined compensators.

UNIT - I

POWER QUALITY PROBLEMS IN DISTRIBUTION SYSTEMS: Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement.

UNIT- II

TRANSMISSION LINES AND SERIES/SHUNT REACTIVE POWER COMPENSATION:

Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.

UNIT- III

STATIC SHUNT COMPENSATORS: Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics

UNIT- IV

STATIC SERIES COMPENSATORS: Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

UNIT-V:

COMBINED COMPENSATORS: Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, independent control of real and reactive power.

TEXT BOOKS:

1. Electrical Power Systems Quality, Dugan Roger C, Santoso Surya, Mc Granaghan, Marks F.Beaty and H. Wayre, Mc Graw Hill
2. Power Systems Quality Assessment, J. Arillaga, N.R. Watson, S.Clon, John Wiley.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

REFERENCE BOOKS:

1. Power Quality, C.Sankaran, CRC Press 4. Understanding power quality problems, Math H.Bollen, IEEE press.
2. Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Narain G.Honorani, Laszlo Gyugyi

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5. 6. 7. 8.
9. 10. 11.

SOLAR POWER BATTERIES
(Professional Elective -III)

B. Tech. IV Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: After completion of this course, the student will be able to

CO1. Understand the PV Solar cell technologies
CO2. Illustrate the connections of solar PV module arrays.
CO3. Choose proper battery types and connections
CO4. Apply control techniques for inverter
CO5. Design Solar PV systems.

UNIT – I :
Photovoltaic Solar Cell and its function,:
Solar Technologies, Solar Cell Parameters, Efficiency of Solar Cell, Solar PV Module, Rating of Solar PV Module, PV Module Parameters Solar, Efficiency of PV Module, Measuring Module Parameters.

UNIT – II
Solar Photovoltaic Module Array
Connection of PV Module in Series and Parallel, Estimation and Measurement of PV Module Power, Selection of PV Module.

UNIT - III
Batteries
Battery function, Types of Batteries, Battery parameters, Selection of Battery, Series Parallel combination of Batteries, Batteries for Photo voltaic System, Application of Batteries in Solar PV system, Battery Maintenance and Measurements, Battery Fault Detection and Test, Battery Installation for PV system.

UNIT – IV:
Charge Controller, MPPT and Inverter
Power MOSFET and IGBT, Opto coupler, Buck and Boost Converter, Fly back Converter, Full Bridge Inverter, Voltage and Current Feedback, DC to DC power converter, DC to AC Converter, AC to DC Converter, Battery Charge controller, Maximum Power Point Tracking, Specification of Inverter and charger.

UNIT – V :
Solar PV System Design and Integration
Solar Radiation Energy Measurements, Estimating Energy requirement, Types of Solar PV System, Design methodology for SPV system, Design of Off Grid Solar Power Plant, Case studies of 3KWp Off grid Solar PV Power Plant.

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5. 6. 7. 8.
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TEXT BOOKS :

1. Solar Photovoltaic Technology and Systems A Manual for Technicians, Trainers and Engineers, Chetan Singh Solanki, PHI Learning Private Ltd.

REFERENCE BOOKS:

1. Design, Installation and Operation of Solar PV Plants, Dhirendra Kumar Tyagi, Mangolia Publication
2. A Practical Guide for Total Engineering of MW capacity Solar PV Power Project, A.S.Kapur, White Falcon Publishing, 2nd edition

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

ADVANCED CONTROL OF ELECTRIC DRIVES
(Professional Elective - III)

B.Tech. IV Year I Semester

Course Outcomes: At the end of the Course, the student will be able to:

L	T	P	C
3	0	0	3

CO1. Understand the operation of power electronic converters and their control strategies.
CO2. Apply the vector control strategies for ac motor drives
CO3. Examine the control of Synchronous Motor Drives
CO4. Analyze the speed control of Permanent Magnet motors and Switched Reluctance Motors.
CO5. Distinguish the implementation of the control strategies using digital signal processors.

UNIT - I

POWER CONVERTERS FOR AC DRIVES: PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H Bridge as a 4-Q drive.

UNIT - II

INDUCTION MOTOR DRIVES: Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).

UNIT - III

SYNCHRONOUS MOTOR DRIVES: Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

UNIT - IV

PERMANENT MAGNET MOTOR DRIVES: Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

Switched Reluctance Motor Drives: Evolution of switched reluctance motors- various topologies for SRM drives, comparison, closed loop speed and torque control of SRM.

UNIT - V

DSP BASED MOTION CONTROL: Use of DSPs in motion control, various DSPs available, and realization of some basic blocks in DSP for implementation of DSP based motion control.

TEXT BOOKS:

1. Modern Power Electronics and AC Drives, B. K. Bose, Pearson Education, Asia, 2003.
2. Analysis of Electric Machinery and Drive Systems, P. C. Krause, O. Wasynczuk and S. D. Sudhoff, John Wiley & Sons, 2013.

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5. 6. 7. 8.
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REFERENCE BOOKS:

1. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
2. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press,2009.

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9. 10. 11.

SMART GRID TECHNOLOGIES
(Professional Elective-IV)

B. Tech. IV Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand the features of Smart Grid.
CO2. Illustrate the smart grid architecture.
CO3. Explain tools and techniques for smart grid and Distribution systems.
CO4. Justify operation and importance of PMUs, WAMS.
CO5. Imagine control techniques for micro grid and smart grid.

UNIT – I

INTRODUCTION TO SMART GRID: Introduction to Smart Grid – Working – definitions of Smart Grid and Associated Concepts – Smart Grid Functions -Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid.

UNIT – II

SMART GRID ARCHITECTURE: Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid, fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation – Renewable energy Integration.

UNIT – III

COMPUTATIONAL TECHNIQUES FOR SMART GRIDS:

Tools and Techniques for Smart Grid: Computational Techniques Static and Dynamic Optimization Techniques, Computational Intelligence Techniques, Evolutionary Algorithms and Artificial Intelligence techniques.

Distribution Generation Technologies: Introduction to Renewable Energy Technologies- Micro grids – Storage Technologies -Electric Vehicles and plug in hybrids Environmental impact and Climate Change Economic Issues.

UNIT – IV

COMMUNICATION TECHNOLOGIES AND SMART GRID: Introduction to Communication Technology – Synchro-Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS) – Introduction to Internet of Things (IOT) – Applications of IOT in Smart Grid.

UNIT – V

CONTROL OF SMART POWER GRID SYSTEM: Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System -Reactive Power Control in Smart Grid, Case Studies and Test beds for the Smart Grids.

TEXT BOOKS:

1. Smart grids, infrastructure, technology and solutions, Stuart Borlase, CRC Press – 1st Edition.
2. Renewable and efficient electric power system, Gil Masters, Wiley IEEE Press 2nd Edition.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

REFERENCE BOOKS:

1. Synchronized Phasor measurements and their applications, A.G. Phadke and J.S Thorp, Springer 2nd Edition.
2. Wind power in power systems, T. Ackermann, Hoboken, NJ, USA, John Wiley 2nd Edition.

1. 2. 3. 4.
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9. 10. 11.

Machine Learning Applications to Electrical Engineering
(Professional Elective-IV)

B. Tech. IV Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand the concepts of computational intelligence like machine learning
CO2. Examine the operation of Neural Networks .
CO3. Assess maximum likelihood with the help of Bayesian learning.
CO4. Apply the concepts of Genetic Algorithm .
CO5. Apply machine learning techniques to address the real time problems in Electrical Engineering

Unit-I :

Introduction -

Well-posed learning problems, designing a learning system, Perspectives and issues in machine learning concept learning and the general to specific ordering – introduction, a concept learning task, concept learning as search, find-S: finding a maximally specific hypothesis, version spaces and the candidate elimination algorithm.

Linear Regression, Logistic Regression and Classification (elementary treatment only)

Decision Tree Learning –Introduction, decision tree representation, the basic decision tree learning algorithm

Unit-II :

Artificial Neural Networks

Introduction, neural network representation, appropriate problems for neural network learning, perceptions, multilayer networks and the back-propagation algorithm.

Evaluation Hypotheses

Motivation, estimation hypothesis accuracy, basics of sampling theory, a general approach for deriving confidence intervals, difference in error of two hypotheses, comparing learning algorithms.

Unit- III

Bayesian learning –

Introduction, Bayes theorem, Bayes theorem and concept learning, Maximum Likelihood and least squared error hypotheses, maximum likelihood hypotheses for predicting probabilities

Computational learning theory

Introduction, probably learning an approximately correct hypothesis

Instance-Based Learning

Introduction, k-nearest neighbour algorithm, locally weighted regression, radial basis functions

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Unit- IV

Genetic Algorithms –

Motivation, Genetic algorithms, an illustrative example, hypothesis space search, genetic programming, models of evolution and learning, parallelizing genetic algorithms.

Learning Sets of Rules –

Introduction, sequential covering algorithms, learning rule sets

Reinforcement Learning –

Introduction, the learning task, Q–learning, non-deterministic, rewards and actions, temporal difference learning,

Unit- V:

Applications in Electrical Engineering

Applications of Machine learning in Electric Vehicles, Prediction of power quality, Electrical Price prediction.

TEXT BOOKS:

1. Machine Learning – Tom M. Mitchell, - MGH
2. Machine Learning Algorithms and Applications in Engineering, Prasenjit Chatterjee, Morteza Yazdani, Francisco Fernández-Navarro, Javier Pérez-Rodríguez, CRC Press, 1st edition 2023

REFERENCES:

1. Machine Learning: An Algorithmic Perspective, Stephen Marshland, Taylor & Francis

1. 2. 3. 4.
5. 6. 7. 8.
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EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes: Upon completing this course, the student will be able to

CO1. Understand the selection procedure of Processors in the embedded domain.

CO2. Examine Embedded system components and operation

CO3. Design Procedure for Embedded Firmware.

CO4. Visualize the role of Real time Operating Systems in Embedded Systems.

CO5. Evaluate the Correlation between task synchronization and latency issues

Unit-I :

Introduction to Embedded Systems:

Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

Unit-II :

Typical Embedded System:

Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

Unit-III :

Embedded Firmware:

Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

Unit-IV :

RTOS Based Embedded System Design:

Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.

Unit-V :

Task Communication:

Shared Memory, Message Passing, Remote Procedure Call and Sockets,

Task Synchronization:

Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, Methods to Choose an RTOS.

TEXT BOOKS:

1. Introduction to Embedded Systems – Shibu K.V, Mc Graw Hill.

1. 2. 3. 4.

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REFERENCE BOOKS:

1. Embedded Systems – Raj Kamal, TMH.
2. Embedded System Design – Frank Vahid, Tony Givargis, John Wiley.
3. Embedded Systems – Lyla, Pearson, 2013
4. An Embedded Software Primer – David E. Simon, Pearson Education.

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Annexure – II

R22 Course Structure of Minor in Electric Vehicles

S. No.	Year/Semester	Course Title	L	T	P	Credits
1.	III-I Semester	Electric Vehicle and Energy Systems	4	0	0	4
2.	III-II Semester	Power Electronics and Control of Electric Machines	4	0	0	3
3.	III-II Semester	Simulation Lab	0	0	3	1.5
4.	IV-I Semester	Automotive Transmission and Communication	3	0	0	3
5.	IV-II Semester	**Electives** 1. Electric Vehicle Dynamics and Testing 2. Battery Charging Technology for EVs 3. Electric Vehicle: Safety and Regulations and Future of EVs	3	0	0	3
6.	IV-II Semester	Electric Mobility Lab	0	0	3	1.5
7.	IV-II semester	Internship/Mini Project	0	0	3	2
					Total	**18**

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R22 Course Structure of Minor in Sustainable Energy

S. No.	Year/Semester	Course Title	L	T	P	Credits
1.	III-I Semester	Energy and its Resources	4	0	0	4
2.	III-II Semester	Climate Change Understanding and Observations	4	0	0	3
3.	III-II Semester	Energy and its Resources Lab	0	0	3	1.5
4.	IV-I Semester	Energy Storage for Renewables	3	0	0	3
5.	IV-II Semester	**Electives** 1. Electronics for Renewables 2. Solar Energy Technologies and System Design 3. Solar Energy System Installations and Maintenance	3	0	0	3
6.	IV-II Semester	Energy Systems Lab	0	0	3	1.5
7.	IV-II semester	Internship/Mini Project	0	0	3	2
					Total	**18**

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B. Tech. (Electrical and Electronics Engineering) with Honors Program in Power Systems

S. No.	Year /Semester	Course to be chosen from/ studied	L	T	P	Credits
1	III-I	Professional Elective-1	4	0	0	3
2	III-II	Research Methodologies	4	0	0	3
3	III-II	Professional Elective-2	4	0	0	3
4	IV-I	Professional Elective -3	4	0	0	3
5	IV-I	Professional Elective -4	4	0	0	3
6	IV-II	Technical Paper Writing	0	0	4	2
7	IV-II	Professional Elective -5	4	0	0	3
						20

Professional Electives (PE)	Pre-Requisites
PE-1	
Waste to Energy Conversion	Power Systems I
Energy and its resources	Power Systems I
Electrical Safety and Quality Management	Power Systems I
PE-2	
Advances in Distribution Systems	Power Systems I, Power Systems II
IoT Applications in Electrical Engineering	Basic Electrical Engineering
Energy Storage systems for renewables	Power Systems I
PE-3	
Smart Cities – Management of Smart Urban	Power Systems I, Power Systems II
Grid Integration of Renewable Energy Systems	Power Systems I, Power Systems II
Grid Integration of Electric Vehicles	Power Systems I, Power Systems II
PE-4	
Cyber Security of Smart Grids	Smart Grids Planning and Operation
SCADA and Energy Management Systems	Power Systems I and Power Systems II
Distributed Generation and Micro Grids	Power Systems I and Power Systems II
PE-5	
Smart Grid Protection	Smart Grids Planning and Operation
Electrical Safety Management	Basic Electrical Engineering
HVDC Transmission	Power Electronics, Power Systems

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Annexure – III

ELECTRICAL TECHNOLOGY
(B. Tech. Electronics and Communication Engineering)

II Year B. Tech II semester

L	T	P	C
3	0	0	3

COURSE OUTCOMES: At the end of the course the student should be able to

CO1. Understand the concept of network topology
CO2. Apply the concepts of the filters, attenuators to real-world problems.
CO3. Synthesize the electrical networks using different techniques.
CO4. Analyze the basic concepts of DC machines & AC Machines.
CO5. Assess concepts of some special machines.

UNIT I:

Network topology:

Definitions, Graph, Tree, Basic cutest and Basic Tie set Matrices for Planar Networks, Loop and Nodal methods for analysis of Networks with Dependent & Independent Voltage and Current Sources, Duality & Dual Networks.

UNIT II:

Filters and attenuators:

Filters:
Classification of Filters, Filter Network, Classification of Pass band and Stop Band, Characteristic Impedance in the Pass and Stop bands, Constant-k Low Pass Filter, High Pass Filter, m-derived T-Section, Band Pass Filter and Band Elimination filter, Illustrative problems.

Attenuators:
T-Type Attenuator, p-Type Attenuator, Bridged T-Type Attenuator, Lattice Attenuator.

UNIT III:

Network synthesis:

Reliability Concept, Hurwitz Property, Positive Realness, Properties of positive real functions, Synthesis of R-L, R-C and L-C driving point functions, Foster and Cauer forms.

1. 2. 3. 4.
5. 6. 7. 8.
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UNIT IV:

Dc generators and dc motors:

DC Generators:

Principle of Operation, EMF equation, Introduction to armature reaction and commutation, Types of Generators, Magnetization (OCC) characteristics - critical field resistance and critical speed, Applications.

DC Motors:

Principle of operation - Back E.M.F. - Torque equation, Types of DC Motors, Losses and Efficiency, Brake Test, Speed control of DC Motor - Flux and Armature Voltage control methods, Applications.

UNIT V:

Special machines:

Principles of operation of Reluctance Motors, Stepper Motors, Universal Motors, Permanent magnet Brushless DC Motors

TEXT BOOKS:

1. Chakrabarti A , Circuit Theory: Analysis & Synthesis, Dhanpat Rai & Sons, 2008.
2. Gupta J B, Theory and performance of Electrical machines, S K Kataria, 2009.

REFERENCE BOOKS:

1. William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, Engineering Circuits Analysis, McGraw Hill Company, 2019.
2. Bimbra P S, Electric Machinery, Khanna Publishers, 2010

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CONTROL SYSTEMS ENGINEERING
(B.Tech. Electronics and Communication Engineering)

III B.Tech I semester

L	T	P	C
3	0	0	3

COURSE OUTCOMES: At the end of the Course, the student will be able to:

CO1. Understand and analyzing different linear-time-invariant systems using transfer function.
CO2. Analyze system response in time domain for first and second order systems and evaluate static error.
CO3. Understand the concept of stability and its assessment for linear-time invariant systems.
CO4. Analyze system response in frequency domain and understanding compensation networks.
CO5. Realize the concept of state variable, state space and analyze the stability of linear Time discrete systems.

UNIT I:

Introduction to control Systems:

Concepts of control systems, open & closed loop control systems-examples, Industrial Control systems examples, Mathematical models of physical systems.

Transfer Function Representation: Block diagram representation of systems considering electrical systems as examples- Block diagram algebra – Representation by signal flow graph-Reduction using Manson's gain formula

UNIT II:

Time Response Analysis: Standard test signals – Time response of first order systems-Characteristic Equation of feedback controls systems, Transient response of second order systems – Time domain specifications - Steady state response – Steady state errors & error constants – Effects of proportional derivative, proportional integral systems and PID controllers, Application of Proportional, Integral and Derivative Controllers.

UNIT III:

Stability analysis in S- Domain:

The concept of stability – Routh's stability criterion – qualitative stability & conditional stability – limitations of Routh's stability.

Root Locus technique: The root locus concept – construction of root loci-effects of adding poles and zeros to G(s)H(s) on the root loci.

UNIT IV:

Frequency-response analysis:

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.Introduction to compensation techniques

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5. 6. 7. 8.
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UNIT V:

State space analysis:

Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization-Solving the Time invariant state Equation- State Transition Matrix and it's Properties-Concepts of Controllability and Observability.

TEXT BOOKS:

1. Nagoorkani A, Control Systems Engineering, CBS PUB & DIST,2020
2. Nagrath I J & Gopal M, Control Systems Engineering, New Age International, 2009.

REFERENCE BOOKS:

1. A. Anand Kumar, Control Systems, PHI Publications, Second Edition,2014.
2. Jagan N. C, Control Systems, BS Publications, 2014.

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5. 6. 7. 8.
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BASIC ELECTRICAL ENGINEERING
(II B. Tech Mechanical Engineering and II B.Tech Civil Engineering)

II Year B. Tech II Sem

L	T	P	C
3	0	0	2

Course Outcomes: At the end of the course, students will be the able to
CO1. Understand basic principles of electrical elements.
CO2. Apply the concepts of AC circuits to various elements and combinations.
CO3. Examine principle and tests of transformer.
CO4. Contrast the working of DC machines and induction motors.
CO5. Assess working principle of AC generator and electrical installations.

UNIT- I
INTRODUCTION TO ELECTRICAL ENGINEERING AND DC CIRCUITS:
Basic definitions, Ohm's law, types of elements, types of sources, Kirchhoff's laws, resistive networks-series, parallel circuits, delta- star and star- delta transformation, Network theorems-Superposition, Thevenin's - simple problems.

UNIT- II
AC CIRCUITS: Representation of sinusoidal waveforms, peak, rms and average values. Phase representation of alternating quantities, analysis of AC circuits with single basic network element (R, L, C), single phase series circuits, concept of resonance, three-phase balanced circuits-voltage and current relations in star and delta connections(elementary treatment).

UNIT- III
TRANSFORMERS: Constructional details, principle of operation, ideal and practical single-phase transformer, losses in transformer, OC-SC tests, regulation and efficiency - simple problems.

UNTI- IV
DC MACHINES AND INDUCTION MOTORS
DC MACHINES: Construction, principle and operation of DC motor, voltage- torque equations - simple problems.
THREE PHASE INDUCTION MOTOR: Construction, principle and working of three phase induction motor, torque-slip characteristics-simple problems.
Single phase induction motor- Working principle.

UNIT- V
AC GENERATOR &ELECTRICAL INSTALLATION
AC GENERATOR: Construction, principle of operation of synchronous generator, EMF equation.
ELECTRICAL INSTALLATION: Fuse, circuit breakers, difference between fuse and circuit breaker, Types of batteries, battery backup.

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5. 6. 7. 8.
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TEXT BOOKS:

1. Basic Electrical Engineering - by T.K. Nagasarkar and M.S. Sukhija, Oxford University press.
2. Basic Electrical Engineering-by M.S. Naidu and S. Kamakshiah-TMH.

REFERENCE BOOKS:

1. Network Analysis by Sudhakar & Shyam Mohan.
2. Basic Electrical Engineering-by S.K. Bhattacharya, Pearson Publications.
3. Basic Electrical Engineering by K. Uma Rao and A. Jayalakshmi, IK Publications.

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BASIC ELECTRICAL ENGINEERING LABORATORY
(II B .Tech Mechanical Engineering and II B.Tech Civil Engineering)

L	T	P	C
0	0	2	1

B. Tech. II Year II Sem

Pre requisite: Basic Electrical Engineering

Course Outcomes: At the end of the course, students will be the able to

CO1. Understand basic electrical laws.
CO2. Examine the resistance, current and voltage using concepts of electric circuits
CO3. Analyse the response of different electrical circuits.
CO4. Apply electric laws and find out performance of various electrical machines
CO5. Asses the losses in electrical machines

List of experiments/demonstrations:

Any 5 experiments from Part-A and Part-B should be conducted (Total 10 Experiments)

Part-A

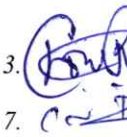
1. Verification of Ohms law
2. Verification of KVL and KCL
3. Verification of Thevenin's Theorem
4. Verification of Superposition Theorem
5. Determination of equivalent resistance, current and voltage across each element in a given circuit.
6. Determination and Verification of Impedance and Current of RL and RC series circuits

Part-B

1. Verification of Mesh Analysis.
2. Load Test on Single Phase Transformer (Calculate Efficiency and Regulation)
3. OC & SC Test on Single phase transformer
4. Brake test on DC shunt motor
5. Brake test on Three Phase Squirrel cage induction motor.
6. OCC of Three phase alternator.

REFERENCE BOOKS:

1. Sudhakar and Shyam Mohan, "Circuits and Networks" Tata Mc Graw Hill Companies.
2. P.S.Bimbra, "Electrical Machines", Khanna Publishers.

1.  2.  3.  4.

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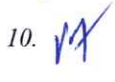
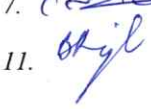
9.  10.  11. 

OPEN ELECTIVES (Offered by EEE Department for other branch students)

SUSTAINABLE ENERGY

(Open Elective-I)

B. Tech. III Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Realize the importance of renewable energy sources for energy planning.
CO2. Understand the value of solar energy potential and exploit the solar energy for real world applications.
CO3. Describe the potential of wind energy, types of wind mills, performance characteristics and Betz criteria.
CO4. Analyze the potential of both tidal and ocean thermal energies and learn the extraction methods.
CO5. Know the potential of geothermal, bio-mass energies and learn relevant extraction methods.

UNIT I
PRINCIPLE OF RENEWABLE ENERGY:

Comparison of renewable and conventional energy sources, ultimate energy sources, natural energy currents on earth, primary supply to end use, spaghetti & pie diagrams, energy planning-energy efficiency and management.

UNIT II
SOLAR RADIATION:

Extra-terrestrial and terrestrial solar radiation, solar thermal conversion, solar thermal central receiver, photovoltaic energy conversion, solar cell configurations.

UNIT III
WIND ENERGY:

Planetary and local winds, vertical and horizontal axis wind mills, principles of wind power-maximum power and actual power, wind turbine operation - Sources and potentials, horizontal and vertical axis windmills, performance characteristics and Betz criteria.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT IV
ENERGY FROM OCEANS:

Ocean thermal energy- principles of OTEC plant operations. Wave energy-devices for energy extraction. Tides: types of tidal stations.

UNIT V
GEOTHERMAL AND BIO FUEL ENERGY:

Origin and types Bio fuels. Direct combustion for heat and electricity generation- anaerobic digestion for biogas-biogas digester and power generation.

TEXT BOOKS:

1. Renewable energy sources, John Twidell &Timey &Weir. Rouledge Talylor &Francis group London & New York.
2. Non-conventional energy sources, G.D. Rai, Khanna publications.

REFERENCE BOOKS:

1. Power plant technology, EL-Wakil, McGraw-Hill.
2. Renewable energy resources: basic principles and applications, G.N.Tiwari, M K. Ghosal, Narosa publishers.
3. Energy conversion systems, Rakosh das Begamudre, New age International publishers.

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POWER APPLICATIONS OF ELECTRICITY
(Open Elective-I)

B. Tech. III Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Interpret the operation of thermal power station through its schematic diagram.
CO2. Observe the arrangement of hydroelectric power station through its components.
CO3. Examine various components of nuclear power station.
CO4. Describe the operation of gas and diesel power station through its schematic diagram.
CO5. Differentiate various power system protection components.

UNIT I
THERMAL POWER STATIONS:

Introduction to Generating stations - Steam Power Stations, advantages and disadvantages, Schematic arrangement of Steam power system, choice of site of steam power station, efficiency of steam power station and equipment of steam power station.

UNIT II
HYDRO ELECTRIC POWER STATION:

Introduction, advantages and disadvantages, Schematic arrangement of hydro electric power station, Choice of site for Hydro electric power station, constituents of hydro electric power station and pumped storage plants.

UNIT III
NUCLEAR POWER STATIONS:

Introduction, advantages and disadvantages, selection of site for nuclear power station, nuclear fission and chain reaction. Nuclear fuels, principle of operation of nuclear reactor, schematic arrangement of nuclear power stations, components of Nuclear Power plant, radiation hazards: Shielding and Safety precautions.

UNIT IV
GAS AND DIESEL POWER STATION:

Gas Turbine Power Station: Introduction, advantages, disadvantages, Schematic arrangement of gas turbine power station. Diesel Power station: Introduction, advantages, disadvantages, schematic arrangement of diesel power station.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT V

INTRODUCTION TO POWER SYSTEM PROTECTION COMPONENTS (ELEMENTARY TREATMENT ONLY):

Fuses-Definition, advantages, disadvantages of fuses, desirable characteristics of fuses, fuse element materials and important terms. Circuit Breakers: definition, important terms and Comparison of fuse and Circuit breaker Isolators: Protective relay, Requirement of Protective relay, electrical Hazards and need of earthing.

TEXT BOOKS:

1. Principles of power systems, V.K Mehta and Rohit Mehta, S. Chand Company Pvt. Ltd, New Delhi-4thEdition.
2. A course in power systems, J.B. Gupta, S.K. Kataria & Sons.

REFERENCE BOOKS:

1. A text book of power system engineering, R. K. Rajput, Laxmi Publications (P)Limited.
2. Electrical Power Generation: Transmission and distribution, S.N. Singh, PHI.
   Generation of electrical energy, B.R. Gupta, S. Chand.

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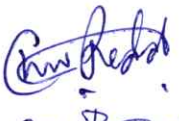
3. 
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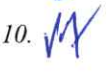
10. 
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ENERGY CONSERVATION AND MANAGEMENT
(Open Elective-II)

B. Tech. III Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Realize the need for energy auditing and conservation. Get awareness on types of energy audit; represent energy flows and energy consumption in tabular and graphical methods.
CO2. Understand and exploit energy saving opportunities in energy efficient motors and power factor improvement methods.
CO3. Learn energy auditing and conservation opportunities in energy efficient buildings.
CO4. Analyze economic viability with respect to real world problems using depreciation methods.
CO5. Examine the check lists for energy conservation in boilers, heat pumps, cooling systems, compressors and fans.

UNIT-I

Principles of Energy management –organizing and Energy management program-Initiating and managing an energy management program- Planning- leading – controlling- promoting- monitoring and reporting.

UNIT-II

Energy auditing- definitions and concepts-types of plant energy studies- energy index-cost index- pie charts – Sankey diagrams- load profiles- Energy conservation – energy conservation schemes – Energy Audit of industries – Energy saving potential

UNIT-III

Electrical energy management – energy efficient motors – power factor improvement – lighting and lighting system control – energy saving opportunities

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT-IV

Qualities and functions of energy managers – language of an energy manager – questionnaires – check list for top management.

UNIT-V

Economic Analysis – depreciation methods – time value of money – Evaluation methods projects- replacement analysis – special problems – inflation – risk analysis.

TEXT BOOKS:

1. Energy Management- W.R Murphy & G.Mckey Butterworths.

REFERENCE BOOKS:

1. Energy Management Hand Book- W.C. Turner, John Wiley and Sons.
2. Energy Conservation – Paul O' Callagun- Pergamon Press.
3. Energy Management Principles- Craig B Smith – Pergamon Press

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INDUSTRIAL ELECTRICAL SYSTEMS
(Open Elective - II)

B. Tech. III Year II Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student should be able to

- **CO1.** Review electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
- **CO2.** Distinguish residential and commercial electrical systems.
- **CO3.** Identify various illumination schemes.
- **CO4.** Select industrial load, motor, transformer and other components.
- **CO5.** Carry out selection of industrial power back scheme.

UNIT I
ELECTRICAL SYSTEM COMPONENTS:

LT system wiring components, selection of cables, wires, switches, distribution box, metering system. Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, Electric shock and Electrical safety practices.

UNIT II
RESIDENTIAL AND COMMERCIAL ELECTRICAL SYSTEMS:

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation.

UNIT III
ILLUMINATION AND INDUSTRIAL ELECTRICAL SYSTEM AUTOMATION:

Illumination Systems:

Understanding various terms regarding light, lumen intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, flood lighting.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

UNIT IV
INDUSTRIAL ELECTRICAL SYSTEMS I:

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction.

UNIT V
INDUSTRIAL ELECTRICAL SYSTEMS II:

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks.

TEXT BOOKS:

1. Electrical wiring, estimating & costing, S.L.Uppal and G.C.Garg, Khanna publishers-2008.
2. Electrical design, estimating & costing, K. B. Raina, New age International -2007.

REFERENCE BOOKS:

1. Web site for IS standards.
2. Residential commercial and industrial systems, H. Joshi, McGraw Hill Education-2008.
3. Electrical estimating and costing, S. Singh and R. D. Singh, Dhanpat Rai and Co-1997

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

ELECTRIC VEHICLES AND HYBRID VEHICLES
(Open Elective – III)

B. Tech. IV Year I Semester

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1. Understand the components of electric vehicles and fundamentals of electric vehicles.
CO2. Demonstrate the types of batteries, fuel cells and its characteristics.
CO3. Understand the basic principles of electric motors which can be used in electric vehicles.
CO4. Apprehend the transmission of the drive system and the components of transmission.
CO5. Design and analyze the performance of hybrid vehicles.

UNIT I
ELECTRIC VEHICLES:

Introduction to Electric Vehicles - History of Electric Vehicles -Components - vehicle mechanics - Roadway fundamentals - vehicle kinetics - Dynamics of vehicle motion - Propulsion System Design.

UNIT II BATTERIES:

Basics - Types - Parameters - Capacity - Discharge rate - State of charge - state of Discharge - Depth of Discharge - Technical characteristics - Battery pack Design - Properties of Batteries. Fuel Cells - Types - Fuel Cell Electric Vehicle.

UNIT III
DC & AC ELECTRICAL MACHINES (Basics Principle of Operation Only)**:**

Motor and Engine rating - Requirements - DC machines - Three phase A/c machines - Induction machines - Permanent Magnet Machines, Switched Reluctance Machines.

UNIT IV
ELECTRIC VEHICLE DRIVE TRAIN:

Transmission configuration - Components gears, differential, clutch, brakes regenerative braking- motor sizing- Gear Ratio Torque speed characteristics - EV Motor Sizing Initial Acceleration - Rated Vehicle Velocity - Maximum Velocity – Maximum Gradeability.

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UNIT V

HYBRID ELECTRIC VEHICLES:

Types of Hybrid Vehicles - series and parallel Hybrid Electric Vehicles, series- parallel configuration- Internal Combustion Engines - Reciprocating Engines - Practical and Air-Standard Cycles - Air- Standard Otto Cycle - Air-Standard Diesel Cycle - Example IC Engines in HEVs - Design - Drive train - sizing of components.

TEXT BOOKS:

1. Electric & hybrid vehicles - design fundamentals, Iqbal Hussain, CRC Press 2ndEdition.
2. Electric vehicle technology explained, James Larminie and John Lowry, Wiley&Sons-2nd Edition.

REFERENCE BOOKS:

1. Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory and design, Mehrdad Ehsani, Yimin Gao, Ali Emadi,", CRC Press - 2nd Edition.
2. Electric vehicle battery systems, Sandeep Dhameja – Kindle Edition.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

ENERGY STORAGE SYSTEMS

(Open Elective – III)

B. Tech. IV Year I Semester

Course Outcomes: At the end of the course, the student will be able to

L	T	P	C
3	0	0	3

CO1. Understand the concepts and roles of electrical energy storage technologies.
CO2. Analyze the needs for electric energy storage.
CO3. Identify the types of energy storage systems and various devices used for this purpose.
CO4. Evaluate the performance of electrical energy storage systems.
CO5. Apply the concepts of energy storage systems to real time problems.

UNIT I
ELECTRICAL ENERGY STORAGE TECHNOLOGIES:

Characteristics of electricity - The roles of Electric Energy Storage - High generation cost during peak demand periods - Need for continuous and flexible supply - long distance between generation and consumption- Congestion in power grids - Transmission by cables.

UNIT II
NEEDS FOR ELECTRICAL ENERGY STORAGE:

Emerging needs for Electric Energy Storage –Utilization of more renewable energy - less fossil fuel - Smart Grid uses - The roles of electrical energy storage technologies - The roles from the view point of a utility, from the view point of consumers, from the view point of generators of renewable energy.

UNIT III
FEATURES OF ENERGY STORAGE SYSTEMS:

Classification of Electric Energy Storage systems - Mechanical storage systems - Pumped Hydro Storage (PHS) - Compressed Air Energy Storage (CAES) - Flywheel Energy Storage (FES) - Electrochemical storage systems - Secondary batteries - Flow batteries - Chemical energy storage, - Hydrogen (H2) - Synthetic Natural Gas (SNG).

UNIT IV
TYPES OF ELECTRICAL ENERGY STORAGE SYSTEMS:

Electrical storage systems - Double-layer capacitors (DLC) - Superconducting magnetic energy storage (SMES) - Thermal storage systems - Standards for Electric Energy Storage - Technical comparison of EES technologies.

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UNIT V

APPLICATIONS:

Present status of applications - Utility use (conventional power generation, grid operation & service) - Consumer use (uninterruptable power supply for large consumers) - New trends in applications - Renewable energy generation - Smart Grid - Smart Micro grid, Smart House - Electric vehicles - Management and control hierarchy of storage systems - Internal configuration of battery storage systems - External connection of EES systems - Aggregating EES systems and distributed generation (Virtual Power Plant) - Battery SCADA - Aggregation of many dispersed batteries.

TEXT BOOKS:

1. Electrical energy storage, IEC Market Strategy Board.
2. Energy storage benefits and market analysis, James M. Eyer, Joseph J. Jannucci and Garth. P.Corey, Sandia National laboratories, 2004.

REFERENCE BOOKS:

1. Energy storage for the electricity grid-benefits and market potential assessment guide, Jim Eyer, Garth Corey, Sandia National laboratories, 2010.
2. Power system energy storage technologies, Paul Breeze, Academic Press.
3. Electric energy storage systems, Przemyslaw Komarnicki, PioLombardi, Zbigniew Styczynski, Springer.

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5. 6. 7. 8.
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Annexure – IV

The following are the details of substitute subjects for rejoined students of B.Tech.

For Students detained in R19 regulations and rejoined in R22 regulations (subjects in addition to the existing subjects of corresponding semesters) the following subjects are proposed as substitute subjects:

Courses Offered to those who are Re-admitted in I-I Sem.

No courses

Courses Offered to those who are Re-admitted in I-II Sem.

S.No.	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.	Engineering Chemistry	Applied Physics			4
2.	Chemistry Lab	Applied Physics Lab			1.5
3.	Engineering Graphics and Modelling	Engineering Workshop			2.5
4.			Elements of Electrical and Electronics Engineering		1

Courses Offered to those who are Re-admitted in II-I Sem.

S.No.	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.			Elements of Electrical and Electronics Engineering		1
2.			Python Programming Lab		3

Courses Offered to those who are Re-admitted in II-II Sem.

S.No.	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.			Elements of Electrical and Electronics Engineering		1
2.			Python Programming Lab		3
3.	Power Systems - I	Professional Communication			1
4.			Real-time Research Project/ Field Based Project		2

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Courses offered for those who are Re-admitted in III-I Sem.

S.No.	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.			Elements of Electrical and Electronics Engineering		4
2.			Python Programming Lab		3
3.	Power Systems - II	Measurements and Instrumentation			3
4.			Electrical Machines Lab - II		1
5.			Measurements and Instrumentation Lab		1
6.	Environmental Science	Quantitative Methods and Logical Reasoning			1
7.			Real-time Research Project/ Field Based Project		2

Courses Offered to those who are Re-admitted in III-II Sem.

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.			Elements of Electrical and Electronics Engineering		1
2.			Python Programming Lab		3
3.	Business Economics and Financial Analysis	Measurements and Instrumentation			3
4.			Control Systems Lab		1
5.			Microprocessors and Microcontrollers Lab		1
6.			Real-time Research		2

1. 2. 3. 4.
5. 6. 7. 8.
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			Project/ Field Based Project		
7.			PE-I		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

Courses Offered to those who are Re-admitted in IV-I Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.			Elements of Electrical and Electronics Engineering		1
2.			Python Programming Lab		3
3.			Microprocessors and Microcontrollers		3
4.			Power Systems Lab		1
5.			Simulation of Power Converters Lab		1
6.			Microprocessors and Microcontrollers Lab		1
7.			Measurements & Instrumentation		3
8.			Measurements & Instrumentation Lab		1
9.			Real-time Research Project/ Field Based Project		2
10			PE-I		3
11			PE-II		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

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5. 6. 7. 8.
9. 10. 11.

Courses Offered to those who are Re-admitted in IV-II Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.			Elements of Electrical and Electronics Engineering		1
2.			Python Programming Lab		3
3.			Power Systems Lab		1
4.			Simulation of Power Converters Lab		1
5.			Simulation of Renewable Energy Systems Laboratory		1
6.			Real-time Research Project/ Field Based Project		2
7.			PE - I		3
8.			PE - II		3
9.			PE - III		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

For Students detained in R-20 regulations and rejoined in R22 Regulation (subjects in addition to the existing subjects of corresponding semesters)

Courses offered to those who are Re-admitted in I-I Sem.

No courses

Courses offered to those who are Re-admitted in I-II Sem.

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.	Engineering Graphics and Modelling	Engineering Workshop		-	2.5
2.			Elements of Electrical and Electronics Engineering		1

Courses offered to those who are Re-admitted in II-I Sem.

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering	-	1
2			Python Programming Lab	-	3

Courses offered to those who are Re-admitted in II-II Sem.

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering	-	1
2			Python Programming Lab	-	3

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

Courses offered to those who are Re-admitted in III-I Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering		1
2			Measurements and Instrumentation	-	3
3			Electrical Machines Lab - II	-	1
4			Measurements and Instrumentation Lab		1
5	Environmental Science	Quantitative Methods and Logical Reasoning			1
6			Real-time Research Project/ Field Based Project		2

Courses offered to those who are Re-admitted in III-II Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering		1
2	Business Economics and Financial Anlysis	Measurements and Instrumentation		-	3
3			Microprocessors and Microcontrollers	-	3
4			Microprocessors and Microcontrollers Lab		1
5			Measurements and Instrumentation Lab		1
6	Environmental Science	Quantitative Methods and	Real-time Research Project/		2

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

		Logical Reasoning	Field Based Project		
7			PE - I		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

Courses offered to those who are Re-admitted in IV-I Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering	-	1
2			Microprocessors and Microcontrollers		3
3			Power Systems Lab		1
4			Simulation of Power Converters Lab		1
5			Microprocessors and Microcontrollers Lab		1
6			Measurements & Instrumentation		3
7			Measurements & Instrumentation Lab		1
8			Real-time Research Project/ Field Based Project		2
9			PE – I		3
10			PE – II		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

Courses offered to those who are Re-admitted in IV-II Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1	-	-	Elements of Electrical and Electronics Engineering	-	1
2	-	-	Power Systems Lab	-	1
3			Simulation of Power Converters Lab		1
4			Simulation of Renewable Energy Systems Laboratory		1
5			Real-time Research Project/ Field Based Project		2
6			PE - I		3
7			PE - II		3
8			PE - III		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

For Students detained in R-20 regulations and rejoined in R22 Regulation (subjects in addition to the existing subjects of corresponding semesters)

Courses offered to those who are Re-admitted in I-I Sem

No courses

Courses offered to those who are Re-admitted in I-II Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.	Engineering Graphics and Modelling	Engineering Workshop		-	2.5
2.			Elements of Electrical and Electronics Engineering		1

Courses offered to those who are Re-admitted in II-I Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1.	Engineering Graphics and Modelling	Engineering Workshop		-	2.5
2.			Elements of Electrical and Electronics Engineering		1

Courses offered to those who are Re-admitted in II-II Sem.

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering	-	1
2			Python Programming Lab	-	3

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

Courses offered to those who are Re-admitted in III-I Sem.

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering		1
2			Measurements and Instrumentation	-	3
3			Electrical Machines Lab - II	-	1
4			Measurements and Instrumentation Lab		1
5	Environmental Science	Quantitative Methods and Logical Reasoning			1
6			Real-time Research Project/ Field Based Project		2

Courses offered to those who are Re-admitted in III-II Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering		1
2	Business Economics and Financial Anlysis	Measurements and Instrumentation		-	3
3			Microprocessors and Microcontrollers	-	3
4			Microprocessors and Microcontrollers Lab		1
5			Measurements and Instrumentation Lab		1
6	Environmental Science	Quantitative Methods and Logical Reasoning	Real-time Research Project/ Field Based Project		2

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5. 6. 7. 8.
9. 10. 11.

7			PE - I		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

Courses offered to those who are Re-admitted in IV-I Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1			Elements of Electrical and Electronics Engineering	-	1
2			Power Systems Lab		1
3			Simulation of Power Converters Lab		1
4			Microprocessors and Microcontrollers Lab		1
5			Measurements & Instrumentation		3
6			Measurements & Instrumentation Lab		1
7			Real-time Research Project/ Field Based Project		2
8			PE – I		3
9			PE – II		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

Courses offered to those who are Re-admitted in IV-II Sem

S.No	Current Subject	Substitute Subjects	Additional Subjects	Subject Code	Credits
1	-	-	Elements of Electrical and Electronics Engineering	-	1
2	-	-	Power Systems Lab	-	1

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.

3	-	-	Simulation of Power Converters Lab	-	1
4			Simulation of Renewable Energy Systems Laboratory		1
5			Real-time Research Project/ Field Based Project		2
6			PE - I		3
7			PE – II		3
8			PE – III		3

Note: If the Professional Elective (PE) taken up by the student in the previous semester of earlier regulation does not match with the current courses in PE then he must take up one course from the current PE in the previous semester(s) of R22 Regulation. The list of PEs is attached.

List of Professional Electives (R22 Regulation)

Professional Elective – I (PE – I)

1	IoT Applications in Electrical Engineering
2	Electrical Energy Conservation and Auditing
3	Cyber Physical Systems

Professional Elective – II (PE – II)

1	AI Techniques in Electrical Engineering
2	Modern Power Electronics
3	Wind and Solar Energy systems

Professional Elective-III (PE – III)

1	Power Quality & FACTS
2	Solar Power Batteries
3	Advanced Control of Electric Drives

Professional Elective-IV (PE – IV)

1	Smart Grid Technologies
2	Machine Learning Applications to Electrical Engineering
3	Embedded Systems

1. 2. 3. 4.
5. 6. 7. 8.
9. 10. 11.