Scheme of Teaching and Examination and Syllabus

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

III-VIII SEMESTER

(Effective from Academic year 2018-19)
**B. E. ELECTRICAL AND ELECTRONICS ENGINEERING**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE) and Outcome Based Education (OBE)  
**SEMESTER - III**  
TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES  
(Common to all Programmes)

<table>
<thead>
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<th>Course Code</th>
<th>CIE Marks</th>
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**Course Learning Objectives:**
- To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z-transforms.
- To develop the proficiency in variational calculus and solving ODE’s arising in engineering applications, using numerical methods.

**Module-1**

**Laplace Transform:** Definition and Laplace transforms of elementary functions (statement only). Laplace transforms of Periodic functions (statement only) and unit-step function – problems.

**Inverse Laplace Transform:** Definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) and problems. Solution of linear differential equations using Laplace transforms.

**Module-2**

**Fourier Series:** Periodic functions, Dirichlet’s condition. Fourier series of periodic functions period $2\pi$ and arbitrary period. Half range Fourier series. Practical harmonic analysis.

**Module-3**

**Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Problems.

**Difference Equations and Z-Transforms:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse z-transform and applications to solve difference equations.

**Module-4**

**Numerical Solutions of Ordinary Differential Equations(ODE’s):**
Numerical solution of ODE’s of first order and first degree- Taylor’s series method, Modified Euler’s method. Runge-Kutta method of fourth order, Milne’s and Adam-Bash forth predictor and corrector method (No derivations of formulae)-Problems.

**Module-5**

**Numerical Solution of Second Order ODE’s:** Runge-Kutta method and Milne’s predictor and corrector method. (No derivations of formulae).

**Calculus of Variations:** Variation of function and functional, variational problems, Euler’s equation, Geodesics, hanging chain, problems.

**Course Outcomes:** At the end of the course the student will be able to:
- CO1: Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
- CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- CO3: Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.
- CO4: Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.
- CO5: Determine the externals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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**Textbooks**
|---|---------------------------------|------------|------------------|-------------------|

**Reference Books**

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<tr>
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<tbody>
<tr>
<td>5</td>
<td>Advanced Engineering Mathematics</td>
<td>Chandrika Prasad and Reena Garg</td>
<td>Khanna Publishing,</td>
<td>2018</td>
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</tbody>
</table>

Web links and Video Lectures:
2. http://www.class-central.com/subject/math(MOOCs)
4. VTU EDUSAT PROGRAMME - 20
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - III  

**ELECTRIC CIRCUIT ANALYSIS**

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<td>Credits</td>
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<tr>
<td>Exam Hours</td>
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</table>

**Course Learning Objectives:**
- To familiarize the basic laws, source transformations, theorems and the methods of analyzing electrical circuits.
- To explain the use of network theorems and the concept of resonance.
- To familiarize the analysis of three-phase circuits, two port networks and networks with non-sinusoidal inputs.
- To explain the importance of initial conditions, their evaluation and transient analysis of R-L and R-C circuits.
- To impart basic knowledge on network analysis using Laplace transforms.

**Module-1**

**Basic Concepts:** Active and passive elements, Concept of ideal and practical sources. Source transformation and Source shifting, Concept of Super-Mesh and Super node analysis. Analysis of networks by (i) Network reduction method including star – delta transformation, (ii) Mesh and Node voltage methods for ac and DC circuits with independent and dependent sources. Duality.

**Module-2**

**Network Theorems:** Super Position theorem, Reciprocity theorem, Thevenin’s theorem, Norton’s theorem, Maximum power transfer theorem and Millman’s theorem. Analysis of networks with and without dependent ac and DC sources.

**Module-3**

**Resonant Circuits:** Analysis of simple series RLC and parallel RLC circuits under resonances. Problems on Resonant frequency, Bandwidth and Quality factor at resonance.

**Transient Analysis:** Transient analysis of RL and RC circuits under DC excitations: Behavior of circuit elements under switching action ($t = 0$ and $t = oo$), Evaluation of initial conditions.

**Module-4**

**Laplace Transformation:** Laplace transformation (LT), LT of Impulse, Step, Ramp, Sinusoidal signals and shifted functions. Waveform synthesis. Initial and Final value theorems.

**Module-5**

**Unbalanced Three Phase Systems:** Analysis of three phase systems, calculation of real and reactive Powers by direct application of mesh and nodal analysis.

**Two Port networks:** Definition, Open circuit impedance, Short circuit admittance and Transmission parameters and their evaluation for simple circuits, relationships between parameter sets.

**Course Outcomes:** At the end of the course the student will be able to:
- Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and reduce the complexity of network using source shifting, source transformation and network reduction using transformations.
- Solve complex electric circuits using network theorems.
- Discuss resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.
- Synthesize typical waveforms using Laplace transformation.
- Solve unbalanced three phase systems and also evaluate the performance of two port networks.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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**Course Learning Objectives:**
- To understand the concepts of transformers and their analysis.
- To suggest a suitable three-phase transformer connection for a particular operation.
- To understand the concepts of generator and to evaluate their performance.
- To explain the requirement for the parallel operation of transformers and synchronous generators.

**Module-1**

**Single-phase Transformers:** Operation of practical transformer under no-load and on-load with phasor diagrams. Open circuit and Short circuit tests, calculation of equivalent circuit parameters and predetermination of efficiency-commercial and all-day efficiency. Voltage regulation and its significance.

**Three-phase Transformers:** Introduction, Constructional features of three-phase transformers. Choice between single unit three-phase transformer and a bank of three single-phase transformers. Transformer connection for three phase operation– star/star, delta/delta, star/delta, zigzag/star and V/V, comparative features. Phase conversion-Scott connection for three-phase to two-phase conversion. Labeling of three-phase transformers terminals, vector groups.

**Module-2**

**Tests, Parallel Operation of Transformer & Auto Transformer:** Polarity test, Sumpner’s test, separation of hysteresis and eddy current losses.

**Parallel Operation of Transformers:** Necessity of Parallel operation, conditions for parallel operation– Single phase and three phase. Load sharing in case of similar and dissimilar transformers. **Auto transformers and Tap changing transformers:** Introduction to autotransformer-copper economy, equivalent circuit, no load and on load tap changing transformers.

**Module-3**

**Three-Winding Transformers & Cooling of Transformers:** Three-winding transformers. Cooling of transformers.

**Direct current Generator:** Armature reaction, Commutation and associated problems.

**Synchronous Generators:** Armature windings, winding factors, e.m.f equation. Harmonics–causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit.

**Module-4**

**Synchronous Generators Analysis:** Alternator on load. Excitation control for constant terminal voltage. Voltage regulation. Open circuit and short circuit characteristics, Assessment of reactance-short circuit ratio, synchronous reactance, Voltage regulation by EMF, MMF and ZPF.

**Module-5**

**Synchronous Generators (Salient Pole):** Effects of saliency, two-reaction theory, Parallel operation of generators and load sharing. Methods of Synchronization, Synchronizing power, Determination of \( X_d \) & \( X_q \) – slip test.

**Performance of Synchronous Generators:** Power angle characteristic (salient and non salient pole), power angle diagram, reluctance power. Capability curve for large turbo generators. Hunting and damper windings.

**Course Outcomes:** At the end of the course the student will be able to:
- Understand the construction and operation of 1-phase, 3-Phase transformers and Autotransformer.
- Analyze the performance of transformers by polarity test, Sumpner’s Test, phase conversion, 3-phase connection, and parallel operation.
- Understand the construction and working of AC and DC Generators.
- Analyze the performance of the AC Generators on infinite bus and parallel operation.
- Determine the regulation of AC Generator by Slip test, EMF, MMF, and ZPF Methods.
**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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<tr>
<th><strong>Text Books</strong></th>
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<tr>
<td>2</td>
<td>Principals of Electrical Machines</td>
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### B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**

**SEMESTER - III**

### ANALOG ELECTRONIC CIRCUITS

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#### Course Learning Objectives:
- Provide the knowledge for the analysis of diode and transistor circuits.
- Develop skills to design the electronic circuits like amplifiers and oscillators.

#### Module-1

**Diode Circuits:** Diode clipping and clamping circuits.

**Transistor Biasing and Stabilization:** Operating point, analysis and design of fixed bias circuit, self-bias circuit, Emitter stabilized bias circuit, voltage divider bias circuit, stability factor of different biasing circuits. Problems. Transistor switching circuits.

#### Module-2

**Transistor at Low Frequencies:** BJT transistor modelling, CE fixed bias configuration, voltage divider bias, emitter follower, CB configuration, collector feedback configuration, analysis using h–parameter model, relation between h–parameters model of CE, CC and CB modes, Millers theorem and its dual.

#### Module-3

**Multistage Amplifiers:** Cascade and cascade connections, Darlington circuits, analysis and design.

**Feedback Amplifiers:** Feedback concept, different types, practical feedback circuits, analysis and design of feedback circuits.

#### Module-4

**Power Amplifiers:** Amplifier types, analysis and design of different power amplifiers, **Oscillators:** Principle of operation, analysis and derivation of frequency of oscillation of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator and frequency stability.

#### Module-5

**FETs:** Construction, working and characteristics of JFET and MOSFET. Biasing of JFET and MOSFET. Analysis and design of JFET (only common source configuration with fixed bias) and MOSFET amplifiers.

#### Course Outcomes: At the end of the course the student will be able to:
- Obtain the output characteristics of clipper and clamer circuits.
- Design and compare biasing circuits for transistor amplifiers & explain the transistor switching.
- Explain the concept of feedback, its types and design of feedback circuits
- Design and analyze the power amplifier circuits and oscillators for different frequencies.
- Design and analysis of FET and MOSFET amplifiers.

#### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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<tbody>
<tr>
<td>1</td>
<td>Electronic Devices and Circuit Theory</td>
<td>Robert L Boylestad</td>
<td>Pearson</td>
<td>11th</td>
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<td></td>
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<td>Louis Nashelsky</td>
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<td>Electronic Devices and Circuits</td>
<td>Millman and Halkias</td>
<td>Mc Graw Hill</td>
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<td>Electronic Devices and Circuits</td>
<td>David A Bell</td>
<td>Oxford University Press</td>
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<td>1</td>
<td>Microelectronics Circuits Analysis and Design</td>
<td>Muhammad Rashid</td>
<td>Cengage Learning</td>
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<td></td>
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Course Learning Objectives:
- Illustrate simplification of Algebraic equations using Karnaugh Maps and Quine- McClusky Techniques.
- Design combinational logic circuits.
- Design Decoders, Encoders, Digital Multiplexer, Adders, Subtractors and Binary Comparators
- Describe Latches and Flip-flops, Registers and Counters.
- Analyze Mealy and Moore Models.
- Develop state diagrams, Synchronous Sequential Circuits and to understand the basics of various Memories.

Module-1

Principles of Combinational Logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables, Incompletely specified functions (Don’t care terms) Simplifying Max term equations, Quine-McCluskey minimization technique, Quine-McCluskey using don’t care terms, Reduced prime implicants Tables.

Module-2

Analysis and Design of Combinational Logic: General approach to combinational logic design, Decoders, BCD decoders, Encoders, digital multiplexers, Using multiplexers as Boolean function generators, Adders and subtractors, Cascading full adders, Look ahead carry, Binary comparators.

Module-3


Module – 4

Flip-Flops Applications: Registers, binary ripple counters, synchronous binary counters, Counters based on shift registers, Design of a synchronous counter, Design of a synchronous mod-n counter using clocked T, JK, D and SR flip-flops.

Module – 5

Sequential Circuit Design: Mealy and Moore models, State machine notation, Synchronous Sequential circuit analysis, Construction of state diagrams, counter design.

Memories: Read only and Read/Write Memories, Programmable ROM, EPROM, Flash memory.

Course Outcomes: After studying this course, students will be able to:
- Develop simplified switching equation using Karnaugh Maps and QuineMcClusky techniques.
- Design Multiplexer, Encoder, Decoder, Adder, Subtractors and Comparator as digital combinational control circuits.
- Design flip flops, counters, shift registers as sequential control circuits.
- Develop Mealy/Moore Models and state diagrams for the given clocked sequential circuits.
- Explain the functioning of Read only and Read/Write Memories, Programmable ROM, EPROM and Flash memory.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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**Reference Books**

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<td>Digital Design</td>
<td>Morris Mano</td>
<td>Prentice Hall of India</td>
<td>ThirdEdition</td>
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<td>3</td>
<td>Fundamentals of Logic design</td>
<td>Charles H Roth, Jr.,</td>
<td>Cengage Learning,</td>
<td>Fifth Edition</td>
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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

ELECTRICAL AND ELECTRONIC MEASUREMENTS (Core Course)

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<td>18EE36</td>
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Course Learning Objectives:
- To measure resistance, inductance and capacitance using different bridges and determine earth resistance.
- To study the construction and working of various meters used for measurement.
- To study the adjustments, calibration & errors in energy meters and methods of extending the range of instruments.

Module-1

Measurement of Resistance: Wheatstone’s bridge, sensitivity, limitations. Kelvin’s double bridge. Earth resistance measurement by fall of potential method and by using Megger.

Measurement of Inductance and Capacitance: Sources and detectors, Maxwell’s inductance and capacitance bridge, Hay’s bridge, Anderson’s bridge, Desauty’s bridge, Schering bridge. Shielding of bridges. Problems.

Module-2


Module-3

Extension of Instrument Ranges: Desirable features of ammeters and voltmeters. Shunts and multipliers. Construction and theory of instrument transformers, Desirable characters of CT and PT. Turns compensation, Illustrative examples, Silsbee’s method of testing CT.

Magnetic measurements: Introduction, measurement of flux/ flux density, magnetising force and leakage factor.

Module-4


Module-5


Recording Devices: Introduction, Strip chart recorders, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and xy recorders. Digital tape recording, Ultraviolet recorders. Electro Cardio Graph (ECG)

Course Outcomes: At the end of the course the student will be able to:
- Measure resistance, inductance and capacitance using bridges and determine earth resistance.
- Explain the working of various meters used for measurement of Power, Energy & understand the adjustments, calibration & errors in energy meters.
- Understand methods of extending the range of instruments & instrument transformers.
- Explain the working of different electronic instruments.
- Explain the working of different display and recording devices.
**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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**Text Books**

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Course Learning Objectives:
- Conducting of different tests on transformers and synchronous machines and evaluation of their performance.
- Verify the parallel operation of two single phase transformers.
- Study the connection of single phase transformers for three phase operation and phase conversion.
- Study of synchronous generator connected to infinite bus.

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<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
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<tbody>
<tr>
<td>1</td>
<td>Open Circuit and Short circuit tests on single phase step up or step down transformer and pre-determination of (i) Efficiency and regulation (ii) Calculation of parameters of equivalent circuit.</td>
</tr>
<tr>
<td>2</td>
<td>Sumner’s test on similar transformers and determination of combined and individual transformer efficiency.</td>
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<tr>
<td>3</td>
<td>Parallel operation of two dissimilar single-phase transformers of different kVA and determination of load</td>
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<tr>
<td>4</td>
<td>Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency and regulation under balanced resistive load.</td>
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<tr>
<td>5</td>
<td>Comparison of performance of 3 single-phase transformers in delta – delta and V – V (open delta) connection under load.</td>
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<tr>
<td>6</td>
<td>Scott connection with balanced and unbalanced loads.</td>
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<tr>
<td>7</td>
<td>Separation of hysteresis and eddy current losses in single phase transformer.</td>
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<tr>
<td>8</td>
<td>Voltage regulation of an alternator by EMF and MMF methods.</td>
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<tr>
<td>9</td>
<td>Voltage regulation of an alternator by ZPF method.</td>
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<tr>
<td>10</td>
<td>Power angle curve of synchronous generator or Direct load test on three phase synchronous generator to determine efficiency and regulation</td>
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<tr>
<td>11</td>
<td>Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.</td>
</tr>
<tr>
<td>12</td>
<td>Performance of synchronous generator connected to infinite bus, under constant power and variable excitation &amp; vice - versa.</td>
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</tbody>
</table>

Course Outcomes: At the end of the course the student will be able to:
- Evaluate the performance of transformers from the test data obtained.
- Connect and operate two single phase transformers of different KVA rating in parallel.
- Connect single phase transformers for three phase operation and phase conversion.
- Compute the voltage regulation of synchronous generator using the test data obtained in the laboratory.
- Evaluate the performance of synchronous generators from the test data and assess the performance of synchronous generator connected to infinite bus.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
### Course Learning Objectives:
- To design and test half wave and full wave rectifier circuits.
- To design and test different amplifier and oscillator circuits using BJT.
- To study the simplification of Boolean expressions using logic gates.
- To realize different Adders and Subtractors circuits.
- To design and test counters and sequence generators.

### Experiments

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<tr>
<th>Sl. No</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design and Testing of Full wave – centre tapped transformer type and Bridge type rectifier circuits with and without Capacitor filter. Determination of ripple factor, regulation and efficiency.</td>
</tr>
<tr>
<td>2</td>
<td>Static Transistor characteristics for CE, CB and CC modes and determination of h parameters.</td>
</tr>
<tr>
<td>3</td>
<td>Frequency response of single stage BJT and FET RC coupled amplifier and determination of half power points, bandwidth, input and output impedances.</td>
</tr>
<tr>
<td>4</td>
<td>Design and testing of BJT -RC phase shift oscillator for given frequency of oscillation.</td>
</tr>
<tr>
<td>5</td>
<td>Determination of gain, input and output impedance of BJT Darlington emitter follower with and without bootstrapping.</td>
</tr>
<tr>
<td>6</td>
<td>Simplification, realization of Boolean expressions using logic gates/Universal gates.</td>
</tr>
<tr>
<td>7</td>
<td>Realization of Half/Full adder and Half/Full Subtractor using logic gates.</td>
</tr>
<tr>
<td>8</td>
<td>Realization of parallel adder/Subtractor using 7483 chip- BCD to Excess-3 code conversion and Vice - Versa.</td>
</tr>
<tr>
<td>9</td>
<td>Realization of Binary to Gray code conversion and vice versa.</td>
</tr>
<tr>
<td>10</td>
<td>Design and testing Ring counter/Johnson counter.</td>
</tr>
<tr>
<td>11</td>
<td>Design and testing of Sequence generator.</td>
</tr>
<tr>
<td>12</td>
<td>Realization of 3 bit counters as a sequential circuit and MOD – N counter design using 7476, 7490, 74192.</td>
</tr>
</tbody>
</table>

*Note: A minimum of three experiments to be simulated using (Freeware Software Package)*

### Course Outcomes:
At the end of the course the student will be able to:
- Design and test rectifier circuits with and without capacitor filters.
- Determine h-parameter models of transistor for all modes.
- Design and test BJT and FET amplifier and oscillator circuits.
- Realize Boolean expressions, adders and subtractors using gates.
- Design and test Ring counter/Johnson counter, Sequence generator and 3 bit counters.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II / III / IV
Aadalitha Kannada

Course Code 18KAK28/39/49
Teaching Hours/Week (L:T:P) (0:2:0)
Credits 01

CIE Marks 100

Course Details:

1. Understanding of the subject concepts and their applications.
2. Ability to analyze and solve problems related to the subject.
3. Preparation and execution of experiments related to the subject.
4. Preparation and execution of projects related to the subject.
5. Preparation and execution of assignments related to the subject.

Internal Evaluation:

1. Continuous Internal Evaluation (CIE) 100 marks

Kannada for Administration

Preparation and execution of assignments related to the subject.
### Vyavaharika Kannada

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18KVK28/39/49</th>
</tr>
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<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
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<td>CIE Marks</td>
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</tr>
<tr>
<td>Credits</td>
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</tbody>
</table>

#### Course Learning Objectives:
The course will enable the students to understand Kannada and communicate in Kannada language.

#### Table of Contents:
- Chapter - 1: Vyavaharika kannada – Parichaya (Introduction to Vyavaharika Kannada).
- Chapter - 2: Kannada Aksharamale haagu uchcharane (Kannada Alphabets and Pronunciation).
- Chapter - 3: Sambhashanegaagi Kannada Padagalu (Kannada Vocabulary for Communication).
- Chapter - 4: Kannada Grammar in Conversations (Sambhashaneyalli Kannada Vyakarana).
- Chapter - 5: Activities in Kannada.

#### Course Outcomes:
At the end of the course, the student will be able to understand Kannada and communicate in Kannada language.
B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (CPC)

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>CIE Marks</th>
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</tr>
<tr>
<td>Credits</td>
<td>01</td>
<td>Exam Hours</td>
<td>02</td>
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</tbody>
</table>

Course Learning Objectives: To
- know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

Module-1

Introduction to Indian Constitution:

Module-2

Union Executive and State Executive:

Module-3

Elections, Amendments and Emergency Provisions:

Constitutional special provisions:
Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

Module-4

Professional / Engineering Ethics:

Module-5

Internet Laws, Cyber Crimes and Cyber Laws:
Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

Course Outcomes: On completion of this course, students will be able to,
- CO 1: Have constitutional knowledge and legal literacy.
- CO 2: Understand Engineering and Professional ethics and responsibilities of Engineers.
- CO 3: Understand the the cybercrimes and cyber laws for cyber safety measures.

Question paper pattern for SEE and CIE:
- The SEE question paper will be set for 100 marks and the marks scored by the students will proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).
- For the award of 40 CIE marks, refer the University regulations 2018.
<table>
<thead>
<tr>
<th>Textbook/s</th>
<th>Title</th>
<th>Authors</th>
<th>Publisher</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constitution of India, Professional Ethics and Human Rights</td>
<td>Shubham Singles, Charles E. Haries, and et al</td>
<td>Cengage Learning India</td>
<td>2018</td>
</tr>
<tr>
<td>2</td>
<td>Cyber Security and Cyber Laws</td>
<td>Alfred Basta and et al</td>
<td>Cengage Learning India</td>
<td>2018</td>
</tr>
</tbody>
</table>

| Reference Books                               |                                            |                                             |                            |      |
| 3                                             | Introduction to the Constitution of India  | Durga Das Basu                              | Prentice –Hall,            | 2008 |
| 4                                             | Engineering Ethics                         | M. Govindarajan, S. Natarajan, V. S. Senthilkumar | Prentice –Hall,            | 2004 |
B. E. (Common to all Programmes)

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

SEMESTER - III

ADDITIONAL MATHEMATICS – I

(Mandatory Learning Course: Common to All Programmes)

(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech. programmes)

<table>
<thead>
<tr>
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<td>40</td>
<td>60</td>
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<td>03</td>
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</table>

Course Learning Objectives:
- To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
- To provide an insight into vector differentiation and first order ODE’s.

Module-1

Complex Trigonometry: Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand’s diagram, De-Moivre’s theorem (without proof).


Module-2


Module-3


Module-4

Integral Calculus: Review of elementary integral calculus. Reduction formulae for \(\sin^n x, \cos^n x\) (with proof) and \(\sin^m x \cos^n x\) (without proof) and evaluation of these with standard limits-Examples. Double and triple integrals-Simple examples.

Module-5


Course outcomes: At the end of the course the student will be able to:
- CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
- CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions.
- CO4: Learn techniques of integration including the evaluation of double and triple integrals.
- CO5: Identify and solve first order ordinary differential equations.

Question paper pattern:
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl No</th>
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<th>Name of the Author/s</th>
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<tr>
<td></td>
<td>Mathematics</td>
<td>Mathematics</td>
<td>Khanna Publishers</td>
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<td></td>
<td>Reference Books</td>
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</table>
IV SEMESTER DETAILED SYLLABUS

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - IV

COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS
(Common to all programmes)

<table>
<thead>
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<th>Exam Hours</th>
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<td>18MAT41</td>
<td>40</td>
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</table>

**Course Learning Objectives:**
- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

**Module-1**

**Calculus of complex functions:** Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences.

**Construction of analytic functions:** Milne-Thomson method-Problems.

**Module-2**

**Conformal transformations:** Introduction. Discussion of transformations: \( w = z^2, w = e^z, w = z + \frac{1}{z}, (z \neq 0), \) Bilinear transformations- Problems.

**Complex integration:** Line integral of a complex function-Cauchy’s theorem and Cauchy’s integral formula and problems.

**Module-3**

**Probability Distributions:** Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

**Module-4**

**Statistical Methods:** Correlation and regression-Karl Pearson’s coefficient of correlation and rank correlation -problems. Regression analysis- lines of regression –problems.

**Curve Fitting:** Curve fitting by the method of least squares- fitting the curves of the form-
\[
\begin{align*}
  y &= ax + b, \\
  y &= ax^2 + bx + c.
\end{align*}
\]

**Module-5**

**Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation and covariance.

**Sampling Theory:** Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student’s t-distribution, Chi-square distribution as a test of goodness of fit.

**Course Outcomes:** At the end of the course the student will be able to:
- Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
- Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
- Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.

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</tr>
</tbody>
</table>

### Reference Books


### Web links and Video Lectures:

1. [http://nptel.ac.in/courses.php?disciplineID=111](http://nptel.ac.in/courses.php?disciplineID=111)
2. [http://www.class-central.com/subject/math(MOOCs)](http://www.class-central.com/subject/math(MOOCs))
4. VTU EDUSAT PROGRAMME - 20
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - IV

POWER GENERATION AND ECONOMICS

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>CIE Marks</th>
<th>See Marks</th>
<th>Exam Hours</th>
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</thead>
<tbody>
<tr>
<td>18EE42</td>
<td>40</td>
<td>60</td>
<td>03</td>
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</table>

**Course Learning Objectives:**

- Explain the arrangement and operation of hydroelectric, steam, diesel, gas turbine and nuclear power plants and working of major equipment in the plants.
- Classification of substation and explain the operation of different substation equipment.
- Explain the importance of grounding and different grounding methods used in practice.
- Explain the economics of power generation and importance of power factor.

**Module-1**

**Hydroelectric Power Plants:** Hydrology, run off and stream flow, hydrograph, flow duration curve, Mass curve, reservoir capacity, dam storage. Hydrological cycle, merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, elements of the plant, Classification of the plants based on water flow regulation, water head and type of load the plant has to supply. Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines Governing of turbines, selection of water turbines. Underground, small hydro and pumped storage plants. Choice of size and number of units, plant layout and auxiliaries.

**Module-2**

**Steam Power Plants:** Introduction, Efficiency of steam plants, Merits and demerits of plants, selection of site. Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling. Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control, Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, plant auxiliaries.

**Diesel Power Plant:** Introduction, Merits and demerits, selection site, elements of diesel power plant, applications.

**Gas Turbine Power Plant:** Introduction, Merits and demerits, selection site, Fuels for gas turbines, Elements of simple gas turbine power plant, Methods of improving thermal efficiency of a simple steam power plant, Closed cycle gas turbine power plants. Comparison of gas power plant with steam power plant.

**Module-3**

**Nuclear Power Plants:** Introduction, Economics of nuclear plants, Merits and demerits, selection of site, Nuclear reaction, Nuclear fission process, Nuclear chain reaction, Nuclear energy, Nuclear fuels, Nuclear plant and layout, Nuclear reactor and its control, Classification of reactors, power reactors in use, Effects of nuclear plants, Disposal of nuclear waste and effluent, shielding.

**Module-4**

**Substations:** Introduction to Substation equipment; Transformers, High Voltage Fuses, High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters, High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors, Measuring Instruments, and power line carrier communication equipment. Classification of substations – indoor and outdoor, Selection of site for substation, Bus-bar arrangement schemes and single line diagrams of substations.

**Substations (continued):** Interconnection of power stations. Introduction to gas insulated substation, Advantages and economics of Gas insulated substation.


**Module-5**
**Economics:** Introduction, Effect of variable load on power system, classification of costs, Cost analysis. Interest and Depreciation, Methods of determination of depreciation, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants. Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, disadvantages, causes, methods of improving power factor. Advantages of improved power factor, economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment.

**Course Outcomes:** At the end of the course the student will be able to:
- Describe the working of hydroelectric, steam, nuclear power plants and state functions of major equipment of the power plants.
- Classify various substations and explain the functions of major equipments in substations.
- Explain the types of grounding and its importance.
- Infer the economic aspects of power system operation and its effects.
- Explain the importance of power factor improvement.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

<table>
<thead>
<tr>
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<tr>
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<tbody>
<tr>
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</table>
To understand the concepts of various methods of generation of power.
To understand the importance of HVAC, EHVC, UHVAC and HVDC transmission.
To design insulators for a given voltage level.
To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
To study underground cables for power transmission and evaluate different types of distribution systems.

Module-1
**Introduction to Power System:** Structure of electric power system: generation, transmission and distribution. Advantages of higher voltage transmission: HVAC, EHVC, UHVAC and HVDC. Interconnection. Feeders, distributors and service mains.

**Overhead Transmission Lines:** A brief introduction to types of supporting structures and line conductors—Conventional conductors; Aluminium Conductor steel reinforced (ACSR), All – aluminium alloy conductor (AAAC) and All –aluminium conductor (AAC). High temperature conductors; Thermal resistant aluminium alloy (ATI), Super thermal resistant aluminium alloy (ZTAI), Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR), Gap type super thermal resistant aluminium alloy conductor steel reinforced (GZTACSR). Bundle conductor and its advantages. Importance of sag, Sag calculation – supports at same and different levels, effect of wind and ice. Line vibration and vibration dampers. Overhead line protection against lightening; ground wires.

**Overhead Line Insulators:** A brief introduction to types of insulators, material used—porcelain, toughened glass and polymer (composite). Potential distribution over a string of suspension insulators. String efficiency, Methods of increasing string efficiency. Arcing horns.

Module-2
**Line Parameters:** Introduction to line parameters—resistance, inductance and capacitance. Calculation of inductance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Inductance of composite – conductors, geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines. Calculation of capacitance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of composite – conductor, geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines.

Module-3
**Performance of Transmission Lines:** Classification of lines – short, medium and long. Current and voltage relations, line regulation and Ferranti effect in short length lines, medium length lines considering Nominal T and nominal Z circuits, and long lines considering hyperbolic form equations. Equivalent circuit of a long line. ABCD constants in all cases.

Module-4
**Corona:** Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona.


Module-5
**Distribution:** Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system. Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution. AC distributors with concentrated loads. Effect of disconnection of neutral in a 3 phase four wire system.

**Reliability and Quality of Distribution System:** Introduction, definition of reliability, failure, probability concepts, limitation of distribution systems, power quality, Reliability aids.
Course Outcomes: At the end of the course the student will be able to:

- Explain transmission and distribution scheme, identify the importance of different transmission systems and types of insulators.
- Analyze and compute the parameters of the transmission line for different configurations.
- Assess the performance of overhead lines.
- Interpret corona, explain the use of underground cables.
- Classify different types of distribution systems; examine its quality & reliability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

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<thead>
<tr>
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<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Course in Electrical Power Design</td>
<td>Soni Gupta and DhanpatRai</td>
<td></td>
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<tr>
<td>3</td>
<td>Electrical Power</td>
<td>S.L. Uppal</td>
<td>Khanna Publication</td>
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<tr>
<td>4</td>
<td>Electrical power systems</td>
<td>C. L. Wadhwa</td>
<td>New Age</td>
<td>5th Edition,</td>
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<td>5</td>
<td>Electrical power systems</td>
<td>Ashfaq Hussain</td>
<td>CBS Publication</td>
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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - IV  

ELECTRIC MOTORS  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
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</thead>
<tbody>
<tr>
<td>18EE44</td>
<td></td>
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<td>03</td>
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</table>

Course Learning Objectives:  
- To study the constructional features of Motors and select a suitable drive for specific application.  
- To study the constructional features of Three Phase and Single phase induction Motors.  
- To study different test to be conducted for the assessment of the performance characteristics of motors.  
- To study the speed control of motor by a different methods.  
- Explain the construction and operation of Synchronous motor and special motors.

Module-1  
**DC Motors:** Classification, Back emf, Torque equation, and significance of back emf, Characteristics of shunt, series & compound motors. Speed control of shunt, series and compound motors. Application of motors. DC motor starters – 3 point and 4 point.  
**Losses and Efficiency**- Losses in DC motors, power flow diagram, efficiency, condition for maximum efficiency.

Module-2  
**Testing of DC Motors:** Direct & indirect methods of testing of DC motors-Brake test, Swinburne’s test, Retardation test, Hopkinson’s test, Field’s test, merits and demerits of tests.  
**Three Phase Induction Motors:** Review of concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring (No question shall be set from the review portion). Slip, Torque equation, torque-slip characteristic covering motoring, generating and braking regions of operation, Maximum torque, significance of slip.

Module-3  

Module-4  
**Starting and Speed Control of Three-Phase Induction Motors:** Need for starter. Direct on line, Star-Delta and autotransformer starting. Rotor resistance starting. Speed control by voltage,frequency, and rotor resistance methods  
**Single-Phase Induction Motor:** Double revolving field theory and principle of operation. Construction and operation of split-phase, capacitor start, capacitor run, and shaded pole motors. Comparison of single phase motors and applications.

Module-5  
**Synchronous Motor:** Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of change in excitation, V and inverted V curves. Synchronous condenser, hunting and damping. Methods of starting synchronous motors.  
**Other Motors:** Construction and operation of Universal motor, AC servomotor, Linear induction motor and stepper motors.

Course Outcomes:  
- Explain the construction, operation and classification of DC Motor, AC motor and Special purpose motors.  
- Describe the performance characteristics & applications of Electric motors.  
- Demonstrate and explain the methods of testing of DC machines and determine losses and efficiency.  
- Control the speed of DC motor and induction motor.  
- Explain the starting methods, equivalent circuit and phasor diagrams, torque angle, effect of change in excitation and change in load, hunting and damping of synchronous motors.
**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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- Students will have to answer 5 full questions, selecting one full question from each module.

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<tbody>
<tr>
<td>2</td>
<td>Electrical Machines</td>
<td>M.V. Deshpande</td>
<td>PHI Learning</td>
<td>2013</td>
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</table>
To study the time varying fields and propagation of waves in different media.

To study the application of Coulomb’s Law and Gauss Law for electric fields produced by different charge configurations.

To evaluate the energy and potential due to a system of charges.

To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.

To study the magnetic fields and magnetic materials.

To study the time varying fields and propagation of waves in different media.

**Course Learning Objectives:**
- To study different coordinate systems for understanding the concept of gradient, divergence and curl of a vector.
- To study the application of Coulomb’s Law and Gauss Law for electric fields produced by different charge configurations.
- To evaluate the energy and potential due to a system of charges.
- To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
- To study the magnetic fields and magnetic materials.
- To study the time varying fields and propagation of waves in different media.

**Module-1**


**Electrostatics:** Coulomb’s law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications. Maxwell’s first equation (Electrostatics). Divergence theorem, Numerical.

**Module-2**


**Conductor and Dielectrics:** Current and current density. Continuity of current. Metallic conductors, conductor’s properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Numerical.

**Module-3**

**Poisson’s and Laplace Equations:** Derivations and problems, Uniqueness theorem.

**Steady magnetic fields:** Biot - Savart’s law, Ampere’s circuitual law. The Curl. Stokes theorem.

**Module-4**


**Module-5**

**Time Varying Fields and Maxwell’s Equations:** Faraday’s law, Displacement current. Maxwell’s equations in point form and integral form. Numerical.

**Uniform plane wave:** Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Numerical.

**Course Outcomes:** At the end of the course the student will be able to:
- Use different coordinate systems, Coulomb’s Law and Gauss Law for the evaluation of electric fields produced by different charge configurations.
- Calculate the energy and potential due to a system of charges & Explain the behavior of electric field across a boundary conditions.
- Explain the Poisson’s, Laplace equations and behavior of steady magnetic fields.
- Explain the behavior of magnetic fields and magnetic materials.
- Assess time varying fields and propagation of waves in different media.
**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Text Books:</th>
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<table>
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<tr>
<th>Reference Books:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2  Electromagnetism -Theory (Volume -1) -Applications (Volume-2)</td>
</tr>
<tr>
<td>3  Electromagnetic Field Theory Fundamentals</td>
</tr>
</tbody>
</table>
## Course Learning Objectives:

- To understand the basics of Linear ICs such as Op-amp, Regulator, Timer & PLL.
- To learn the designing of various circuits using linear ICs.
- To use these linear ICs for specific applications.
- To understand the concept and various types of converters.
- To use these ICs, in Hardware projects.

### Module-1

**Operational Amplifiers:** Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve, open loop configuration, differential amplifier, inverting & non-inverting amplifier, Op-amp with negative feedback (excluding derivations).

**General Linear Applications:** A.C. amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, Instrumentation amplifier. ■ T1

### Module-2

**Active Filters:** First & Second order high pass & low pass Butterworth filters. Band pass filters, all pass filters.

**DC Voltage Regulators:** voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators. ■ T1

### Module-3

**Signal Generators:** Triangular / rectangular wave generator, phase shift oscillator, saw tooth oscillator.

**Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters. ■ T1

### Module-4

**Signal processing Circuits:** Precision half wave & full wave rectifiers

**A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC. ■ R1

### Module-5

**Phase Locked Loop (PLL):** Basic PLL, components, performance factors.

**Timer:** Internal architecture of 555 timer, Mono stable multivibrators and applications. ■ T1

### Course Outcomes:

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

- Describe the characteristics of ideal and practical operational amplifier.
- Design filters and signal generators using linear ICs.
- Demonstrate the application of Linear ICs as comparators and rectifiers.
- Analyze voltage regulators for given specification using op-amp and IC voltage regulators.
- Summarize the basics of PLL and Timer.

### Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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<tr>
<td>1</td>
<td>Operational Amplifiers and Linear ICs</td>
<td>David A. Bell</td>
<td>Oxford</td>
<td>3rd Edition 2011</td>
</tr>
<tr>
<td>2</td>
<td>Linear Integrated Circuits; Analysis, Design and</td>
<td>B. Somanthan Nair</td>
<td>Wiley India</td>
<td>2013</td>
</tr>
</tbody>
</table>
### Course Learning Objectives:
- To perform tests on DC machines to determine their characteristics.
- To control the speed of DC motor.
- To conduct test for pre-determination of the performance characteristics of DC machines.
- To conduct load test on single phase and three phase induction motor.
- To conduct test on induction motor to determine the performance characteristics.
- To conduct test on synchronous motor to draw the performance curves.

<table>
<thead>
<tr>
<th>S No.</th>
<th>Experiment</th>
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<tbody>
<tr>
<td>1</td>
<td>Load test on DC shunt motor to draw speed–torque and horse power–efficiency characteristics.</td>
</tr>
<tr>
<td>2</td>
<td>Field Test on DC series machines.</td>
</tr>
<tr>
<td>3</td>
<td>Speed control of DC shunt motor by armature and field control.</td>
</tr>
<tr>
<td>4</td>
<td>Swin burne's Test on DC motor.</td>
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<tr>
<td>5</td>
<td>Retardation test on DC shunt motor.</td>
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<tr>
<td>6</td>
<td>Regenerative test on DC shunt machines.</td>
</tr>
<tr>
<td>7</td>
<td>Load test on three phase induction motor.</td>
</tr>
<tr>
<td>8</td>
<td>No-load and Blocked rotor test on three phase induction motor to draw(i)equivalent circuit and(ii)circle diagram. Determination of performance parameters at different load conditions</td>
</tr>
<tr>
<td>9</td>
<td>Load test on induction generator.</td>
</tr>
<tr>
<td>10</td>
<td>Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.</td>
</tr>
<tr>
<td>11</td>
<td>Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.</td>
</tr>
<tr>
<td>12</td>
<td>Conduct an experiment to draw v and Inverted curves of synchronous motor at no load and load conditions.</td>
</tr>
</tbody>
</table>

### Course Outcomes:
At the end of the course the student will be able to:
- Test DC machines to determine their characteristics and also to control the speed of DC motor.
- Pre-determine the performance characteristics of DC machines by conducting suitable tests.
- Perform load test on single phase and three phase induction motor to assess its performance.
- Conduct test on induction motor to pre-determine the performance characteristics.
- Conduct test on synchronous motor to draw the performance curves.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made
# B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

## SEMESTER - IV

OP- AMP AND LINEAR ICS LABORATORY

<table>
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<th>Course Code</th>
<th>CIE Marks</th>
<th>Number of Practical Hours/Week</th>
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<td>0:2:2</td>
<td>60</td>
<td>02</td>
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</table>

### Course Learning Objectives:

- To conduct different experiments using OP-Amps
- To conduct experiments using Linear IC’s

#### a) Study of Pin details, specifications, application features of IC741 (LM741) and IC555 (Timer) through corresponding datasheets (Datasheets are instruction manuals for electronic components. They explain exactly what a component does and how to use it.).

#### b) Comparison of output performance quantity of an Operational Amplifier obtained by rigging up the circuit with the ideal value of

(i) A Non–Inverting Amplifier \( V_{out}=AV_{in} \)  
(ii) An Inverting Amplifier \( V_{out}=-AV_{in} \)  
(iii) A Difference Amplifier \( V_{out}=-A(V_{p}-V_{in}) \)  
(iv) A Difference Amplifier with floating inputs \( V_{out}=AV_{in} \)  
(v) A Non – Inverting Amplifier with negative feedback  
(ii) An Inverting Amplifier with negative and output transfer characteristics to analyse and conclude that op-amps are rarely used in open-loop.

#### c) Plot of input and output transfer characteristics to analyse and conclude that op-amps are rarely used in open-loop.

#### d) Testing of op – amp.

### Sl. No | Experiments
--- | ---
1 | Design and verify a precision full wave rectifier. Determine the performance parameters.
2 | Design and realize to analyse the frequency response of an op – amp amplifier under inverting and non - inverting configuration for a given gain.
3 | Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.
4 | Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).
5 | Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.
6 | Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.
7 | Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.
8 | Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.
9 | Design and realization of R-2R ladder DAC.
10 | Realization of Two bit Flash ADC
11 | Design and verify an IC 555 timer based pulse generator for the specified pulse.
12 | Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series.

### Course Outcomes:

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

- To conduct experiment to determine the characteristic parameters of OP-Amp
- To design test the OP-Amp as Amplifier, adder, subtractor, differentiator and integrator.
- To design test the OP-Amp as oscillators and filters.
- Design and study of Linear IC’s as multivibrator power supplies.

### Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

### Note:

Also verify the results of any four experiments using standard simulation package.
B.E.(Common to all Programmes)

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

SEMESTER - IV

ADDITIONAL MATHEMATICS – II

(Mandatory Learning Course: Common to All Programmes)

(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech. programmes)

Course Code 18MATDIP41  CIE Marks 40
Teaching Hours/Week (L:T:P) (2:1:0)  SEE Marks 60
Credits 0  Exam Hours 03

Course Learning Objectives:
• To provide essential concepts of linear algebra, second & higher order differential equations along with methods to solve them.
• To provide an insight into elementary probability theory and numerical methods.

Module-1

Module-2

Module-3
Higher order ODE’s: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators. [Population restricted to \( R(x) = e^{ax} \), \( ax \cos /\sin \) for \( f(D)y = R(x) \).]

Module-4
Partial Differential Equations(PDE’s):- Formation of PDE’s by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

Module-5

Course Outcomes: At the end of the course the student will be able to:
CO1: Solve systems of linear equations using matrix algebra.
CO2: Apply the knowledge of numerical methods in modelling and solving engineering problems.
CO3: Make use of analytical methods to solve higher order differential equations.
CO4: Classify partial differential equations and solve them by exact methods.
CO5: Apply elementary probability theory and solve related problems.

Question paper pattern:
• The question paper will have ten full questions carrying equal marks.
• Each full question will be for 20 marks.
• There will be two full questions (with a maximum of four sub-questions) from each module.
• Each full question will have sub-question covering all the topics under a module.
• The students will have to answer five full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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V SEMESTER DETAILED SYLLABUS

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - V

MANAGEMENT AND ENTREPRENEURSHIP

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<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
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</table>

Course Learning Objectives:
- To introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- To discuss the ways in which work is allocation, structure of organizations, modes of communication and importance of managerial control in business.
- To explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- To explain the role and importance of entrepreneurship and economic development and the concept of entrepreneurship.
- To explain various types of entrepreneurs and their functions, the myths of entrepreneurship and the factors required for capacity building for entrepreneurs.
- To discuss the importance of small-scale industries and related terms and problems involved.
- To discuss methods for generating new business ideas and business opportunities in India and the importance of business plan.
- To introduce the concepts of project management and discuss capital building process.
- To explain project feasibility study and project appraisal and discuss project financing.
- To discuss about different institutions at state and central levels supporting business enterprises.

Module-1


Module-2


Module-3

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. Entrepreneurship: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for

Module-4


Module-5

New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM.

**Course Outcomes**: At the end of the course the student will be able to:
- Explain the field of management, task of the manager, planning and steps in decision making.
- Discuss the structure of organization, importance of staffing, leadership styles, modes of communication, techniques of coordination and importance of managerial control in business.
- Explain the concepts of entrepreneurship and a businessman’s social responsibilities towards different groups.
- Show an understanding of role of SSI’s in the development of country and state/central level institutions/agencies supporting business enterprises.
- Discuss the concepts of project management, capital budgeting, project feasibility studies, need for project report and new control techniques.

**Question paper pattern**:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Books**

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<th>Publisher</th>
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<tr>
<td>1</td>
<td>Dynamics of Entrepreneurial Development and Management</td>
<td>Vasant Desai</td>
<td>Himalaya Publishing House</td>
<td>2007</td>
</tr>
</tbody>
</table>
Course Learning Objectives:
- To explain the internal organization and working of Computers, microcontrollers and embedded processors.
- Compare and contrast the various members of the 8051 family.
- To explain the registers of the 8051 microcontroller, manipulation of data using registers and MOV instructions.
- To explain in detail the execution of 8051 Assembly language instructions and data types.
- To explain loop, conditional and unconditional jump and call, handling and manipulation of I/O instructions.
- To explain different addressing modes of 8051, arithmetic, logic instructions, and programs.
- To explain develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic,

Module-1
8051 Microcontroller Basics: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM, 8051 Addressing Modes.

Module-2
Assembly Programming and Instruction of 8051: Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming.

Module-3
8051 Programming in C: Data types and time delay in 8051C, IO programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Accessing code ROM space in 8051C, Data serialization using 8051C.

8051 Timer Programming in Assembly and C: Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C.

Module-4
8051 Serial Port Programming in Assembly and C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C.

8051 Interrupt Programming in Assembly and C: 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C.

Module-5
Interfacing: LCD interfacing, Keyboard interfacing.
ADC, DAC and Sensor Interfacing: ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning.
Motor Control: Relay, PWM, DC and Stepper Motor: Relays and opt isolators, stepper motor interfacing, DC motor interfacing and PWM.
8051 Interfacing with 8255: Programming the 8255, 8255 interfacing, C programming for 8255.

Course Outcomes: At the end of the course the student will be able to:
- Outline the 8051 architecture, registers, internal memory organization, addressing modes.
- Discuss 8051 addressing modes, instruction set of 8051, accessing data and I/O port programming.
- Develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic and arithmetic operations, data conversion and timer/counter programming.
- Summarize the basics of serial communication and interrupts, also develop 8051 programs for serial data communication and interrupt programming.
- Program 8051 to work with external devices for ADC, DAC, Stepper motor control, DC motor control, Elevator control.
Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - V

POWER ELECTRONICS

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Course Learning Objectives:
- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.
- To explain power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and limitations.
- To explain different types of Thyristors, their gate characteristics and gate control requirements.
- To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.

Module-1

Introduction: Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches.


Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL load, Single-Phase Full-Wave Rectifiers with R load, Single-Phase Full-Wave Rectifier with RL Load. ■ T1 & R1

Module-2

Power Transistors: Introduction, Power MOSFETs – Steady State Characteristics, Switching Characteristics Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, IGBTs, MOSFET Gate Drive, BJTs, Base Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers. ■ T1

Module-3

Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn-On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dtProtection, dv/dtProtection, DIACs, Thyristor Firing Circuits, Unijunction Transistor. ■ T1

Module-4

Controlled Rectifiers: Introduction, Single phase half wave circuit with RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual Converters, Principle of operation of Three-Phase dual Converters.

AC Voltage Controllers: Introduction, Principle of phase control & Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads, Single-Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers. ■ T1 & R1

Module-5


DC-AC Converters: Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters. ■ T1

Course Outcomes: At the end of the course the student will be able to:
- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and limitations.
- To explain different types of Thyristors, their gate characteristics and gate control requirements.
- To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers. ■
Students will have to answer 5 full questions, selecting one full question from each module.

Each full question with sub questions will cover the contents under a module.

Each full question is for 20 marks.

The question paper will have ten questions.

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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

SIGNALS AND SYSTEMS

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<td></td>
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<tr>
<td>03</td>
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<td></td>
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</tbody>
</table>

Course Learning Objectives:
- To discuss arising of signals in different systems.
- To classify the signals and define certain elementary signals.
- To explain basic operations on signals and properties of systems.
- To explain the use of convolution integral and convolution summation in analyzing the response of linear time invariant systems in continuous and discrete time domains.
- To explain the properties of linear time invariant systems in terms of impulse response description.
- To explain determination of response of a given linear time invariant system and to provide a block diagram representation to it.
- To explain Fourier transform representation of continuous time and discrete time non-periodic signals and the properties of Fourier Transforms.
- To explain the applications of Fourier transform representation to study signals and linear time invariant systems. To explain the use of Z-transform in the complex exponential representation of discrete time signals and the analysis of systems.

Module-1
Introduction: Definitions of signals and a system, classification of signals, basic operations on signals. Elementary signals viewed as interconnections of operations, properties of systems.

Module-2

Module-3

Module-4

Module-5

Course Outcomes: At the end of the course the student will be able to:
- Explain the generation of signals, behavior of system and the basic operations that can be performed on signals and properties of systems.
- Apply convolution in both continuous and discrete domain for the analysis of systems given impulse response of a system.
- Solve the continuous time and discrete time systems by various methods and their representation by block diagram.
- Perform Fourier analysis for continuous and discrete time, linear time invariant systems.
- Apply Z-transform and properties of Z transform for the analysis of discrete time systems.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub-questions in one full question) from each module.
- Each full question with sub-questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text Book
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Signals and Systems</strong></td>
</tr>
<tr>
<td></td>
<td>Simon Haykin, Berry Van Veen</td>
</tr>
<tr>
<td></td>
<td>Wiley</td>
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<tr>
<td>2</td>
<td><strong>Fundamentals of Signals and Systems</strong></td>
</tr>
<tr>
<td></td>
<td>Michael J. Roberts, Govind K. Sharma</td>
</tr>
<tr>
<td></td>
<td>McGraw Hill</td>
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<td><strong>Signals and Systems</strong></td>
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<td>Nagoor Kani</td>
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<td><strong>Signals and Systems</strong></td>
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<tr>
<td></td>
<td>Matthew N.O. Sadiku, Warsame H. Ali</td>
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<td></td>
<td>CRC Press</td>
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<td>5</td>
<td><strong>Signals and Systems</strong></td>
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<tr>
<td></td>
<td>Anand Kumar</td>
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## B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

### SEMESTER - V

#### ELECTRICAL MACHINE DESIGN (Core Course)

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<tr>
<td>Credits</td>
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</table>

### Course Learning Objectives:
- To discuss design factors, limitations in design and modern trends in design and manufacturing of electrical machines.
- To discuss the properties of electrical, magnetic and insulating materials used in the design of electrical machines.
- To derive the output equation of DC machine, single phase, three phase transformers, induction motor and synchronous machines.
- To discuss the selection of specific loadings, for various machines.
- To discuss separation of main dimensions for different electrical machines.
- To discuss design of field windings for DC machines and synchronous machines. To evaluate the performance parameters of transformer, induction motor.
- To design of cooling tubes for the transformer for a given temperature rise.
- To explain design of rotor of squirrel cage rotor and slip ring rotor.
- To define short circuit ratio and discuss its effect on machine performance.

### Module-1

**Fundamental Aspects of Electrical Machine Design:** Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques.


### Module-2


### Module-3

**Design of Transformers:** Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.

### Module-4


### Module-5

**Course Outcomes:** At the end of the course the student will be able to:
- Identify and list, limitations, modern trends in design, manufacturing of electrical machines and properties of materials used in the electrical machines.
- Derive the output equation of DC machine, discuss selection of specific loadings and magnetic circuits of DC machines, design the field windings of DC machine, and design stator and rotor circuits of a DC machine.
- Derive the output equations of transformer, discuss selection of specific loadings, estimate the number of cooling tubes, no load current and leakage reactance of core type transformer.
- Develop the output equation of induction motor, discuss selection of specific loadings and magnetic circuits of induction motor, design stator and rotor circuits of an induction motor.
- Formulate the output equation of alternator, design the field windings of Synchronous machine, discuss short circuit ratio and its effects on performance of synchronous machines, design salient pole and non-salient pole alternators for given specifications.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

<table>
<thead>
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<th>Text Book</th>
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<table>
<thead>
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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

HIGH VOLTAGE ENGINEERING

<table>
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<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
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</tbody>
</table>

Credits - 03

Course Learning Objectives:

- To discuss conduction and breakdown in gases, liquid dielectrics.
- To discuss breakdown in solid dielectrics.
- To discuss generation of high voltages and currents and their measurement.
- To discuss overvoltage phenomenon and insulation coordination in electric power systems.

Module-1


Module-2


Module-3


Module-4


Module-5


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

- Explain conduction and breakdown phenomenon in gases, liquid dielectrics and breakdown phenomenon in solid dielectrics.
- Summarize generation of high voltages and currents
- Outline measurement techniques for high voltages and currents.
- Summarize overvoltage phenomenon and insulation coordination in electric power systems.
- Explain non-destructive testing of materials and electric apparatus, high-voltage testing of electric apparatus.
**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text Book

<table>
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<th>Reference Books</th>
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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

MICROCONTROLLER LABORATORY

<table>
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<tr>
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</tbody>
</table>

**Course Learning Objectives:**
- To explain writing assembly language programs for data transfer, arithmetic, Boolean and logical instructions.
- To explain writing assembly language programs for code conversions.
- To explain writing assembly language programs using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.
- To perform interfacing of stepper motor and DC motor for controlling the speed.
- To explain generation of different waveforms using DAC interface.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data transfer – Program for block data movement, sorting, exchanging, finding largest element in an array.</td>
</tr>
<tr>
<td>2</td>
<td>Arithmetic instructions: Addition, subtraction, multiplication and division. Square and cube operations for</td>
</tr>
<tr>
<td>3</td>
<td>Counters</td>
</tr>
<tr>
<td>4</td>
<td>Boolean and logical instructions (bit manipulation).</td>
</tr>
<tr>
<td>5</td>
<td>Conditional call and return instructions.</td>
</tr>
<tr>
<td>6</td>
<td>Code conversion programs – BCD to ASCII, ASCII to BCD, ASCII to decimal, Decimal to ASCII, Hexa</td>
</tr>
<tr>
<td>7</td>
<td>Programs to generate delay, Programs using serial port and on-chip timer/counters.</td>
</tr>
</tbody>
</table>

**Note:** For the experiments 1 to 6, 8051 assembly programming is to be used.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Stepper motor interface.</td>
</tr>
<tr>
<td>9</td>
<td>DC motor interface for direction and speed control using PWM.</td>
</tr>
<tr>
<td>10</td>
<td>Alphanumeric LCD panel interface.</td>
</tr>
<tr>
<td>11</td>
<td>Generate different waveforms: Sine, Square, Triangular, Ramp using DAC interface.</td>
</tr>
<tr>
<td>12</td>
<td>External ADC and Temperature control interface.</td>
</tr>
<tr>
<td>13</td>
<td>Elevator interface.</td>
</tr>
</tbody>
</table>

**Course Outcomes:** At the end of the course the student will be able to:
- Write assembly language programs for data transfer, arithmetic, Boolean and logical instructions and code conversions.
- Write ALP using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.
- Perform interfacing of stepper motor and DC motor for controlling the speed, elevator, LCD, external ADC and temperature control.
- Generate different waveforms using DAC interface.
- Work with a small team to carryout experiments using microcontroller concepts and prepare reports that present lab work.

**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

POWER ELECTRONICS LABORATORY

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Exam Hours</th>
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<tbody>
<tr>
<td>18EEL5</td>
<td>40</td>
<td>60</td>
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</tr>
</tbody>
</table>

### Course Learning Objectives:
- To conduct experiments on semiconductor devices to obtain their static characteristics.
- To study different methods of triggering the SCR.
- To study the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
- To control the speed of a DC motor, universal motor and stepper motors.
- To study single phase full bridge inverter connected to resistive load.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Experiments</th>
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<tbody>
<tr>
<td>1</td>
<td>Static Characteristics of SCR.</td>
</tr>
<tr>
<td>2</td>
<td>Static Characteristics of MOSFET and IGBT.</td>
</tr>
<tr>
<td>3</td>
<td>Characteristic of TRIAC.</td>
</tr>
<tr>
<td>4</td>
<td>SCR turn on circuit using synchronized UJT relaxation oscillator.</td>
</tr>
<tr>
<td>5</td>
<td>SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.</td>
</tr>
<tr>
<td>6</td>
<td>Single phase controlled full wave rectifier with R load, R-L load, R-L-E load with and without free wheeling diode.</td>
</tr>
<tr>
<td>7</td>
<td>AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.</td>
</tr>
<tr>
<td>8</td>
<td>Speed control of DC motor using single semi converter.</td>
</tr>
<tr>
<td>9</td>
<td>Speed control of stepper motor.</td>
</tr>
<tr>
<td>10</td>
<td>Speed control of universal motor using ac voltage regulator.</td>
</tr>
<tr>
<td>11</td>
<td>Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.</td>
</tr>
<tr>
<td>12</td>
<td>Single phase MOSFET/IGBT based PWM inverter.</td>
</tr>
</tbody>
</table>

### Course Outcomes:
At the end of the course the student will be able to:
- Obtain static characteristics of semiconductor devices to discuss their performance.
- Trigger the SCR by different methods.
- Verify the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.
- Control the speed of a DC motor, universal motor and stepper motors.
- Verify the performance of single phase full bridge inverter connected to resistive load.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
# Environmental Studies

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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<tbody>
<tr>
<td>2</td>
<td>Environmental Studies</td>
<td>S M Prakash</td>
<td>Pristine Publishing House, Mangalore</td>
<td>3rd Edition 2018</td>
</tr>
<tr>
<td>3</td>
<td>Environmental Studies – From Crisis to Cure</td>
<td>R Rajagopalan</td>
<td>Oxford Publisher</td>
<td>2005</td>
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<table>
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<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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<tr>
<td>1</td>
<td>Principals of Environmental</td>
<td>Raman Sivakumar</td>
<td>Cengage learning.</td>
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<td>Science and Engineering</td>
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<td>Singapur.</td>
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VI SEMESTER DETAILED SYLLABUS

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

CONTROL SYSTEMS (Core Subject)

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<tr>
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<td>Exam Hours</td>
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</table>

Course Learning Objectives:
- To define a control system
- To explain the necessity of feedback and types of feedback control systems.
- To introduce the concept of transfer function and its application the modeling of linear systems.
- To demonstrate mathematical modeling of control systems.
- To obtain transfer function of systems through block diagram manipulation and reduction
- To use Mason’s gain formula for finding transfer function of a system
- To discuss transient and steady state time response of a simple control system.
- To discuss the stability of linear time invariant systems and Routh-Hurwitz criterion
- To investigate the trajectories of the roots of the characteristic equation when a system parameter is varied.
- To conduct the control system analysis in the frequency domain.
- To discuss stability analysis using Bode plots.
- To determine the controller or compensator configuration and parameter values relative to how it is

Module-1

Introduction to Control Systems: Introduction, classification of control systems.
Mathematical models of physical systems: Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains.

Module-2

Block Diagram: Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function.
Signal Flow Graphs: Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.

Module-3

Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems.
Routh Stability Criterion: BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis.

Module-4

Frequency Response Analysis: Co-relation between time and frequency response – 2nd order systems only.
Bode Plots: Basic factors G(jw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin.

Module-5

Design of Control Systems: Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller.
Course Outcomes: At the end of the course the student will be able to:

- Analyze and model electrical and mechanical system using analogus.
- Formulate transfer functions using block diagram and signal flow graphs.
- Analyze the stability of control system, ability to determine transient and steady state time response.
- Illustrate the performance of a given system in time and frequency domains, stability analysis using Root locus and Bode plots.
- Discuss stability analysis using Nyquist plots, Design controller and compensator for a given specification.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Text Book

|---|-----------------|-------------|-----|------------------|
Course Code: 18EE62
Number of Lecture Hours/Week (L:T:P): 3:2:0
Credits: 04

Course Learning Objectives:
- To introduce the per unit system and explain its advantages and computation.
- To explain the concept of one line diagram and its implementation in problems.
- To explain the necessity and conduction of short circuit analysis.
- To explain analysis of three phase symmetrical faults on synchronous machine and simple power systems.
- To discuss selection of circuit breaker.
- To explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits.
- To explain the concept of sequence impedance and its analysis in three phase unbalanced circuits.
- To explain the concept of sequence networks and sequence impedances of an unloaded synchronous generator, transformers and transmission lines.
- To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- To discuss the dynamics of synchronous machine and derive the power angle equation for a synchronous machine.
- Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system.

Module-1


Module-2


Module-3


Module-4

**Module-5**


<table>
<thead>
<tr>
<th>Course Outcomes:</th>
<th>At the end of the course the student will be able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Model the power system components &amp; construct per unit impedance diagram of power system.</td>
</tr>
<tr>
<td></td>
<td>• Analyze three phase symmetrical faults on power system.</td>
</tr>
<tr>
<td></td>
<td>• Compute unbalanced phasors in terms of sequence components and vice versa, also develop sequence networks.</td>
</tr>
<tr>
<td></td>
<td>• Analyze various unsymmetrical faults on power system.</td>
</tr>
<tr>
<td></td>
<td>• Examine dynamics of synchronous machine and determine the power system stability.</td>
</tr>
</tbody>
</table>

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Book**


**Reference Books**

|------|--------------------------|------------------------|-------------|-------------------|
# B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VI

## DIGITAL SIGNAL PROCESSING (Core Subject)

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<td>SEE Marks</td>
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</tr>
<tr>
<td>Credits</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

### Course Learning Objectives:
- To define Discrete Fourier transform and its properties.
- To evaluate DFT of various signals using properties of DFT.
- To explain different linear filtering techniques.
- To explain the evaluation of DFT and inverse DFT using fast and efficient algorithms.
- To discuss impulse invariant transformation, bilinear transformation techniques and their properties.
- To design infinite impulse response Butterworth digital filters using impulse invariant and bilinear transformation techniques.
- To design infinite impulse response Chebyshev digital filters using impulse invariant and bilinear transformation techniques.
- To discuss direct, cascade, parallel and ladder methods of realizing a digital IIR filter.
- To discuss window functions used for the design of FIR filters.
- To discuss windowing technique of designing FIR filter.
- To discuss frequency sampling technique of designing FIR filter.
- To discuss direct, cascade and linear phase form of realizing a digital FIR filter.

### Module-1

**Discrete Fourier Transforms:** Definitions, properties-linearity, shift, symmetry Properties- circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stock ham’s method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods.

### Module-2

**Fast Fourier Transforms Algorithms:** Introduction, decimation in time algorithm, first decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithms, Inverse radix – 2 algorithms.

### Module-3

**Design of IIR Digital Filters:** Introduction, impulse invariant transformation, bilinear transformations, All pole analog filters- Butterworth & Chebyshev filters, design of digital Butterworth filter by impulse invariant transformation and bilinear transformation, Frequency transformations.

### Module-4

**Design of IIR Digital Filters (Continued):** Design of digital Chebyshev –type 1 filter by impulse invariant transformation and bilinear transformation, Frequency transformations.

**Realization of IIR digital systems:** direct form, cascade form and parallel form, Ladder structures for equal degree polynomial.

**Design of FIR Digital Filters:** Introduction, windowing, rectangular, modified rectangular, Hamming, Hanning, Blackman window, design of FIR digital filters by use of windows, Design of FIR digital filters-frequency sampling techniques.

**Realization of FIR systems:** direct form, cascade form, linear phase form.

### Course Outcomes:
At the end of the course the student will be able to:
- Apply DFT and IDFT to perform linear filtering techniques on given sequences to determine the output.
- Apply fast and efficient algorithms for computing DFT and inverse DFT of a given sequence.
- Design and realize infinite impulse response Butterworth and Chebyshev digital filters using impulse invariant and bilinear transformation techniques.
- Develop a digital IIR filter by direct, cascade, parallel, ladder and FIR filter by direct, cascade and linear phase methods of realization.
- Design and realize FIR filters by use of window function and frequency sampling method.
**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

<table>
<thead>
<tr>
<th>Text Book</th>
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<table>
<thead>
<tr>
<th>Reference Books</th>
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</thead>
</table>
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

INTRODUCTION TO NUCLEAR POWER ( PROFESSIONAL ELECTIVE )

<table>
<thead>
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<th>Course Code</th>
<th>18EE641</th>
<th>CIE Marks</th>
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<tr>
<td></td>
<td></td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:
- To explain the fission process in nuclear materials and how the nuclear reactors work and the basic components of nuclear reactors and their types.
- Explanation about cooling of reactors, features of coolant, different types of coolants used in the reactors and the losses of cooling.
- Discussion on loss of cooling accidents in different reactors.
- Discussion on postulated severe accidents in water cooled reactors and other reactors and cooling of reactor during removal and processing.
- Discussion on cooling and disposing the nuclear waste and prospect of fusion energy in the future.

Module-1


Module-2


Module-3


Module-4

Postulated Severe Accidents Introduction: Introduction, Postulated Severe Accidents in Water-Cooled Reactors, Specific Phenomena relating to Severe Accidents, Severe Accidents in other Reactor Types, Fission Product Dispersion following Containment Failure.

Module-5

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

- Explain the fission process in nuclear materials, basic components of nuclear reactors, types of nuclear reactors and their working.
- List different types of coolants, their features, and cooling of reactors.
- Summarize loss of cooling accidents in different reactors.
- Discuss postulated severe accidents in reactors and cooling of reactor during removal of spent fuel.
- Discuss cooling and disposing the nuclear waste and prospect of fusion energy in the future.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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</table>

Reference Books
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE) 
SEMESTER - VI  

**ELECTRICAL ENGINEERING MATERIALS (Professional Elective)**

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<tr>
<td>Credits</td>
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<td>Exam Hours</td>
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</table>

**Course Learning Objectives:**
- To impart the knowledge of conducting, dielectric, insulating and magnetic materials and their applications.
- To impart the knowledge of superconducting materials and their applications

**Module-1**


**Conductors:** Conductor materials, Factors affecting conductivity, Thermal conductivity, Heating effect of current, Thermodielectric effect, Seebeck effect, Thomson effect, Wiedemann – Franz law and Lorentz relation. Problems.

**Module-2**

**Conductive Materials and Applications:** Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing.

**Dielectrics:** Introduction to dielectric materials, classification of dielectric materials, Dielectric constant, Dielectric strength and Dielectric loss. Polarization, Mechanisms of polarization, Comparison of different polarization process, Factors affecting polarization, Spontaneous polarization, Behavior of polarization under impulse and frequency switching, Decay and build-up of polarization under ac field, Complex dielectric constant.

**Module-3**


**Module-4**

**Magnetic Materials (continued):** Types of magnetic materials, Soft and hard magnetic materials, High energy magnetic materials, Commercial grade soft and hard magnetic materials.

**Superconductive Materials:** Concept of superconductors, Meaning of phenomenon of superconductivity, Properties of superconductors, Types of superconductors, Critical magnetic field

**Module-4**

**Superconductive Materials (continued):** and critical temperature, Effects of Isotopic mass on critical temperature, Silsbee rule, Depth of penetration and coherence length. Ideal and Hard superconductors, Mechanism of super conduction, London’s theory for Type I superconductors, GLAG theory for Type I superconductors, BCS theory, Applications and limitations. Applications of high temperature superconductors, Superconducting solenoids and magnets, MRI for medical diagnostics.

**Module-5**
**Plastics:** Introduction, Thermoplastics, Rubbers, Thermosets, DC and AC properties, Mechanical properties and processing of plastic.


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

- Discuss electrical and electronics materials, their importance, classification and operational requirement
- Discuss conducting, dielectric, insulating and magnetic materials used in engineering, their properties and classification.
- Explain the phenomenon superconductivity, super conducting materials and their application in engineering.
- Explain the plastic and its properties and applications

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Book**

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
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</table>
To explain development of sectional views of Transformers, DC machine and alternators using Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

### COMPUTER AIDED ELECTRICAL DRAWING (PROFESSIONAL)

<table>
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<th>Course Code</th>
<th>CIE Marks</th>
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</thead>
<tbody>
<tr>
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</table>

#### Course Learning Objectives:
- To discuss the terminology of DC and AC armature windings.
- To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
- To discuss the substation equipment, their location in a substation and development of a layout for substation.
- To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
- To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches.

Suitable CAD software can be used for drawings

### PART - A

#### Module-1

**Winding Diagrams:**
- Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.
- Developed Winding Diagrams of A.C. Machines:
- Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.
- Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings.

### PART - B

#### Module-2


#### Module-3

**Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:** Transformers - Sectional Views Of Single And Three Phase Core And Shell Type Transformers.

#### Module-4

**Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:**

#### Module-5

**Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:**
Alternator – Sectional Views of Stator and Rotor dealt separately.

### Course Outcomes:
At the end of the course the student will be able to:
- Develop armature winding diagram for DC and AC machines
- Develop a Single Line Diagram of Generating Stations and substation using the standard symbols.
- Construct sectional views of core and shell types transformers using the design data
- Construct sectional views of assembled DC and AC machine and their parts using the design data or the sketches
Question paper pattern:
- The question paper will have two parts, PART – A and PART – B.
- Each part is for 50 marks.
- Part A is for Modules 1 and 2.
- Questions 1 and 2 of PART - A will be only on DC windings or only on AC windings. Students have to answer any one of them. The marks prescribed is 25.
- Question 3 of PART – A covering module 2 is compulsory. The marks prescribed is 15.
- Part B is for Modules 3, 4 and 5.
- Questions 4 and 5 will cover any two modules of modules 3, 4 and 5. Students have to answer any one of them. The marks prescribed is 40.

<table>
<thead>
<tr>
<th>Reference Books</th>
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## EMBEDDED SYSTEMS (PROFESSIONAL ELECTIVE)

<table>
<thead>
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<th>Course Code</th>
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<tr>
<td>18EE644</td>
<td>40</td>
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</table>

### Course Learning Objectives:
- To understand the concepts of Embedded system design such as ROM variants, RAM, SOC.
- To learn the technological aspects of Embedded system such as signal conditioning, Sample & Hold.
- To understand the design trade-offs.
- To study about the software aspects of Embedded system.

### Module-1

**Concept of Embedded System Design:** Components, classification, skills required. Embedded Microcontroller cores: Architecture of 6808 and 6811. Embedded Memories ROM variants, RAM. **T3 and R3**

### Module-2

**Technological Aspects of Embedded System:** Applications of embedded system: Examples of Embedded systems SOC for bar code scanner. Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Sample & hold, multiplexer interface Internal ADC interfacing (excluding 6805 & 6812). **T1**

### Module-3

**Design Trade Offs Due to Process Incompatibility, Thermal Considerations:** Data Acquisition System and Signal conditioning using DSP. Issues in embedded system design. Design challenge, design technology, trade-offs. Thermal considerations. **R1 and Internet Sources**

### Module-4

**Software aspects of Embedded Systems:** Real time programming Languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round Robin with interrupts, function queue-scheduling architecture. **T3 and R3**

### Module-5

**Subsystem interfacing:** With external systems user interfacing, Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing. **T1**

### Course Outcomes:
- Identify the Embedded system components.
- Apply technological aspects to various interfacing with devices.
- Elaborate various design tradeoffs.
- Apply software aspects and programming concepts to the design of Embedded System.
- Explain how to interface subsystems with external systems.

### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author</th>
<th>Publisher</th>
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</tr>
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<tbody>
<tr>
<td>1</td>
<td>Embedded Microcomputer Systems: Real time interfacing</td>
<td>Valvano, J.W</td>
<td>Cengage Learning</td>
<td>2nd</td>
</tr>
<tr>
<td>2</td>
<td>The Art of Designing Embedded systems- Ganssle</td>
<td>Jack, Newness</td>
<td></td>
<td>5th</td>
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<tr>
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<td>Reference Books:</td>
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<tr>
<td>1</td>
<td>A Unified Hardware/Software Introduction</td>
<td>Frank Vahid/Tony Givargis</td>
<td>Wiley student edition</td>
<td>2002</td>
</tr>
<tr>
<td>2</td>
<td>Motorola and Intel Manuals</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Embedded Software Premier</td>
<td>Simon David</td>
<td>Addison Wessly</td>
<td>2000</td>
</tr>
</tbody>
</table>
### Course Learning Objectives:
This course will enable students to:
- Define Encapsulation, Inheritance and Polymorphism.
- Solve the problem with object oriented approach.
- Analyze the problem statement and build object oriented system model.
- Describe the characters and behavior of the objects that comprise a system.
- Explain function overloading, operator overloading and virtual functions.
- Discuss the advantages of object oriented programming over procedure oriented programming.

### Module-1
**Beginning with C++ and its Features:**
What is C++?, Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, operator overloading and control structures in C++ . (Topics from Ch -2,3 of T1).

### Module-2
**Functions, Classes and Objects:**
Functions, Inline function, function overloading, friend and virtual functions, Specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, members, pointers to members and member functions. (Selected Topics from Chap-4,5 of T1).

### Module-3
**Constructors, Destructors and Operator Overloading:** Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators. (Selected topics from Chap-6, 7 of T1).

### Module-4
**Inheritance, Pointers, Virtual Functions, Polymorphism:**
Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions (Selected topics from Chap-8,9 of Text).

### Streams and Working with Files:
C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file, EOF (Selected topics from Chap- 10, 11 of Text).

### Course Outcomes: At the end of the course the student will be able to:
- Explain the basics of Object Oriented Programming concepts.
- Apply the object initialization and destroy concept using constructors and destructors.
- Apply the concept of polymorphism to implement compile time polymorphism in programs by using overloading methods and operators.
- Utilize the concept of inheritance to reduce the length of code and evaluate the usefulness.
- Apply the concept of run time polymorphism by using virtual functions, overriding functions and abstract class in programs.
- Utilize I/O operations and file streams in programs.

### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
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- Each full question with sub questions will cover the contents under a module.
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<tbody>
<tr>
<td><strong>1</strong> object-oriented programming with C++</td>
<td></td>
</tr>
<tr>
<td>E. Balaguruswamy, TMH</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong> object-oriented programming with C++</td>
<td></td>
</tr>
<tr>
<td>Robert Lafore Galgotia publication</td>
<td></td>
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<tr>
<td><strong>3</strong> object-oriented programming with C++</td>
<td></td>
</tr>
<tr>
<td>Sourav Sahay Oxford University</td>
<td></td>
</tr>
</tbody>
</table>

**Reference Books**

| 1 | object-oriented programming with C++                                     | Robert Lafore Galgotia publication                                          |
|   |                                                                     |                                                                                |
| 2 | object-oriented programming with C++                                   | Sourav Sahay Oxford University                                              |
Course Learning Objectives:

- To determine the time and frequency domain reponses of a given second order system using software package or discrete components.
- To design and analyze Lead, Lag and Lead – Lag compensators for given specifications.
- To draw the performance characteristics of ac and DC servomotors and synchro-transmitter receiver pair.
- To study the DC position & feedback control system and to study the effect of P, PI, PD and PID controller Lead compensator on the step response of the system.
- To write a script files to plot root locus, bode plot, to study the stability of the system using a

SL NO | Experiments |
--- | --- |
1 | Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor |
2 | Experiment to draw synchronous characteristics |
3 | Experiment to determine frequency response of a second order system |
4 | (a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response. |
5 | (a) To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. |
6 | (a) To determine experimentally the transfer function of the lag compensating network. |
7 | Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function. |
8 | (a) To simulate a typical second order system and determine step response and evaluate time response specifications. |
(b) To evaluate the effect of adding poles and zeros on time response of second order system. |
(c) To simulate DC position control system and obtain its step response. |
9 | (a) To simulate a D.C. Position control system and obtain its step response. |
(b) To verify the effect of input waveform, loop gain and system type on steady state errors. |
(c) To perform trade-off study for lead compensator. |
(d) To design PI controller and study its effect on steady state error. |
10 | (a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response. |
(b) To study the effect of open loop gain on transient response of closed loop system using root locus. |
11 | (a) To study the effect of open loop poles and zeros on root locus contour. |
(b) Comparative study of Bode, Nyquist and root locus with respect to stability. |

Note:

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Description</th>
<th>Experiment numbers</th>
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<tr>
<td>1</td>
<td>Perform experiments using suitable components/equipment’s</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>2</td>
<td>Perform experiments using suitable components/equipment’s and verify the results using standard simulation package</td>
<td>3,4,5,6 and 7</td>
</tr>
<tr>
<td>3</td>
<td>Perform simulation only using standard package</td>
<td>8,9,10 and 11</td>
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</tbody>
</table>
Course Outcomes: At the end of the course the student will be able to:

- Utilize software package and discrete components in assessing the time and frequency domain response of a given second order system.
- Design, analyze and simulate Lead, Lag and Lag – Lead compensators for given specifications.
- Determine the performance characteristics of ac and DC servomotors and synchro-transmitter receiver pair used in control systems.
- Simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
- Develop a script files to plot Root locus, Bode plot and Nyquist plot to study the stability of

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
### Course Learning Objectives:
- To explain the use of MATLAB/Scilab/Python software in evaluating the DFT and IDFT of given sequence.
- To verify the convolution property of the DFT.
- To design and implementation of IIR and FIR filters for given frequency specifications.
- To realize IIR and FIR filters.
- To help the students in developing software skills.

### Course Outcomes:
At the end of the course the student will be able to:
- Explain physical interpretation of sampling theorem in time and frequency domains.
- Evaluate the impulse response of a system.
- Perform convolution of given sequences to evaluate the response of a system.
- Compute DFT and IDFT of a given sequence using the basic definition and/or fast methods.
- Provide a solution for a given difference equation.
- Design and implement IIR and FIR filters.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
# VII SEMESTER DETAILED SYLLABUS

**B. E. ELECTRICAL AND ELECTRONICS ENGINEERING**

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER – VII

<table>
<thead>
<tr>
<th>Course Code</th>
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<td></td>
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### POWER SYSTEM ANALYSIS – 2(Core Course)

<table>
<thead>
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<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
<th>Exam Hours</th>
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</thead>
<tbody>
<tr>
<td>18EE71</td>
<td></td>
<td>60</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**

- To explain formulation of network models and bus admittance matrix for solving load flow problems.
- To discuss optimal operation of generators on a bus bar and optimum generation scheduling.
- To explain symmetrical fault analysis and algorithm for short circuit studies.
- To explain formulation of bus impedance matrix for the use in short circuit studies on power systems.
- To explain numerical solution of swing equation for multi-machine stability

### Module-1


### Module-2

**Load Flow Studies:** Introduction, Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidal iterative method. Illustrative examples.

### Module-3


### Module-4

**Economic Operation of Power System:** Introduction and Performance curves Economic generation scheduling neglecting losses and generator limits Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses Derivation of transmission loss formula. Illustrative examples.

**Unit Commitment:** Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flow chart and Algorithm only).
Module-5

**Symmetrical Fault Analysis:** Z Bus Formulation by Step by step building algorithm without mutual coupling between the elements by addition of link and addition of branch. Illustrative examples. Z bus Algorithm for Short Circuit Studies excluding numerical. T1

**Power System Stability:** Numerical Solution of Swing Equation by Point by Point method and Runge Kutta Method. Illustrative examples. T1

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

- Formulate network matrices and models for solving load flow problems.
- Perform steady state power flow analysis of power systems using numerical iterative techniques.
- Solve issues of economic load dispatch and unit commitment problems.
- Analyze short circuit faults in power system networks using bus impedance matrix.
- Apply Point by Point method and Runge Kutta Method to solve Swing Equation.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- Module 1 Y_bus Matrix size limited to 3X3 for illustrative examples.
- Module 2 NR Method limited to 3 bus system with one iteration for illustrative examples.

**Text Books**

<table>
<thead>
<tr>
<th>Module</th>
<th>Book Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
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**Reference Books**

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<th>Book Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
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### POWER SYSTEM PROTECTION (Core Subject)

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<td>SEE Marks</td>
<td>60</td>
</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

#### Course Learning Objectives:
- To discuss performance of protective relays, components of protection scheme and relay terminology.
- To explain relay construction and operating principles.
- To explain Over current protection using electromagnetic and static relays and Over current protective schemes.
- To discuss types of electromagnetic and static distance relays, effect of arc resistance, power swings, line length and source impedance on performance of distance relays.
- To discuss pilot protection; wire pilot relaying and carrier pilot relaying.
- To discuss construction, operating principles and performance of various differential relays for differential protection.
- To discuss protection of generators, motors, Transformer and Bus Zone Protection.
- To explain the principle of circuit interruption and different types of circuit breakers.
- To describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.
- To discuss protection Against Over voltages and Gas Insulated Substation (GIS). ■

#### Module-1


**Relay Construction and Operating Principles:** Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.


#### Module-2


**Distance Protection:** Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays. ■

#### Module-3

**Pilot Relaying Schemes:** Introduction, Wire Pilot Protection, Carrier Current Protection


**Rotating Machines Protection:** Introduction, Protection of Generators.

**Transformer and Buszone Protection:** Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection. ■
Module-4


Module-5

**Fuses:** Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination.

**Protection against Overvoltages:** Causes of Overvoltages, Lightning phenomena, Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning, Klydonograph and Magnetic Link, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub – Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL).

**Modern Trends in Power System Protection:** Introduction, gas insulated substation/switchgear (GIS).

**Course Outcomes:** At the end of the course the student will be able to:
- Discuss performance of protective relays, components of protection scheme and relay terminology over current protection.
- Explain the working of distance relays and the effects of arc resistance, power swings, line length and source impedance on performance of distance relays.
- Discuss pilot protection, construction, operating principles and performance of differential relays and discuss protection of generators, motors, transformer and Bus Zone Protection.
- Explain the construction and operation of different types of circuit breakers.
- Outline features of fuse, causes of overvoltages and its protection, also modern trends in Power System Protection.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Books**

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<td>1</td>
<td>Power System Protection and Switchgear</td>
<td>Badri Ram, D.N. Vishwakarma</td>
<td>McGraw Hill</td>
<td>2nd Edition</td>
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**Reference Books**

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER – VII

**SOLAR AND WIND ENERGY** (Professional Elective)

<table>
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**Course Learning Objectives:**

- To discuss the importance of energy in human life, relationship among economy and environment with energy use.
- To discuss the increasing role of renewable energy, energy management, energy audit, energy efficiency, energy intensity.
- To discuss energy consumption status in India, energy saving potential and energy conservation efforts in India.
- To explain the concept of energy storage and the principles of energy storage devices.
- To discuss the characteristics and distribution of solar radiation, measurement of components of solar radiation and analysis of collected solar radiation data.
- To explain availability of solar radiation at a location and the effect of tilting the surface of collector with respect to horizontal surface.
- To describe the process of harnessing solar energy in the form of heat and working of solar collectors.
- To discuss applications of solar energy including heating and cooling.
- To discuss the operation of solar cell and the environmental effects on electrical characteristics of solar cell.
- To discuss sizing and design of typical solar PV systems and their applications.
- To discuss basic Principles of Wind Energy Conversion and to compute the power available in the wind.
- To discuss forces on the Blades, Wind Energy Conversion, collection of Wind Data, energy estimation and site selection.
- To discuss classification of WEC Systems, its advantages and disadvantages of WECS, and Types of Wind Machines (Wind Energy Collectors).
- To evaluate the performance of Wind-machines, Generating Systems.

### Module-1


### Module-2

### Module-3

### Module-4
**Wind energy systems:** Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis.

### Module-5

### Course Outcomes:
At the end of the course the student will be able to:
- Discuss the importance of the role of renewable energy, the concept of energy storage and the principles of energy storage devices.
- Discuss the concept of solar radiation data and solar PV system fabrication, operation of solar cell, sizing and design of PV system.
- Describe the process of harnessing solar energy and its applications in heating and cooling.
- Explain basic Principles of Wind Energy Conversion, collection of wind data, energy estimation and site selection.
- Discuss the performance of Wind-machines, energy storage, applications of Wind Energy and environmental aspects.

### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Textbook

### Reference Books
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
SENSORS AND TRANSDUCERS (Professional Elective)

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Course Learning Objectives:
- To discuss need of transducers, their classification, advantages and disadvantages.
- To discuss working of different types of transducers and sensors.
- To discuss recent trends in sensor technology and their selection.
- To discuss basics of signal conditioning and signal conditioning equipment.
- To discuss configuration of Data Acquisition System and data conversion. To discuss the basics of Data transmission and telemetry.
- To explain measurement of various non-electrical quantities.

Module-1


Module-2


Module-3


Data Acquisition Systems and Conversion: Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.

Module-4

Data Transmission and Telemetry: Data/Signal Transmission, Telemetry.


Module-5

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

- Classify the transducers and explain the need of transducers, their classification, advantages and disadvantages.
- Explain the working of various transducers and sensors.
- Outline the recent trends in sensor technology and their selection.
- Analyze the signal conditioning and signal conditioning equipment.
- Illustrate different configuration of Data Acquisition System and data conversion.
- Show knowledge of data transmission and telemetry.
- Explain measurement of non-electrical quantities -temperature, flow, speed, force, torque, power and viscosity.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER – VII

INTEGRATION OF DISTRIBUTED GENERATION (Professional Elective)

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Course Learning Objectives:

- To explain power generation by alternate energy source like wind power and solar power.
- To explain selection of size of units and location for wind and solar systems.
- Discuss the effects of integration of distributed generation on the performance of the system.
- To provide practical and useful information about grid integration of distributed generation.

Module-1


Module-2


Module-3


Module-4


Module-5
Course Outcomes: At the end of the course the student will be able to:

- Explain energy generation by wind power and solar power.
- Discuss the variation in production capacity at different time scales, the size of individual units, and the flexibility in choosing locations with respect to wind and solar systems.
- Explain the performance of the system when distributed generation is integrated to the system.
- Discuss effects of the integration of DG: the increased risk of overload, increased losses, increased risk of overvoltages and increased levels of power quality disturbances.
- Discuss effects of the integration of DG: incorrect operation of the protection.
- Discuss the impact the integration of DG on power system stability and operation.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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<tr>
<td>1</td>
<td>Integration of Distributed Generation in the Power System</td>
<td>Math Bollen</td>
<td>Wiley</td>
<td>2011</td>
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</tbody>
</table>
To explain application of vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.

- To explain development of state models for linear continuous – time and discrete – time systems.
- To explain controllability and observability of a system and testing techniques for controllability and observability of a given system.
- To explain design techniques of pole assignment and state observer using state feedback.
- To explain about inherent and intentional nonlinearities that can occur in control system and developing the describing function for the nonlinearities.
- To explain stability analysis of nonlinear systems using describing function analysis.
- To explain the analysis of nonlinear systems using Lyapunov function and design of Lyapunov function for stable systems.

### Module-1

**State Variable Analysis and Design:** Introduction, Concept of State, State Variables and State Model, State Models for Linear Continuous – Time Systems, State Variables and Linear Discrete – Time Systems.

### Module-2

**State Variable Analysis and Design (continued):** Diagonalization, Solution of State Equations, Concepts of Controllability and Observability.

### Module-3


### Module-4


### Module-5

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

- Discuss state variable approach for linear time invariant systems in both the continuous and discrete time systems.
- Develop state models for linear continuous–time and discrete–time systems.
- Apply vector and matrix algebra to find the solution of state equations for linear continuous–time and discrete–time systems.
- Define controllability and observability of a system and test for controllability and observability of a given system.
- Design pole assignment and state observer using state feedback.
- Develop the describing function for the nonlinearity present to assess the stability of the system.
- Develop Lyapunov function for the stability analysis of nonlinear systems.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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### Course Learning Objectives:
- To identify the necessity of reactive power compensation.
- To describe load compensation.
- To select various types of reactive power compensation in transmission systems.
- To characterize distribution side and utility side reactive power management.
- To contrast reactive power coordination system.

### Module 1


### Module 2

**Theory of Steady State Reactive Power in Uncompensated & Compensated Transmission Line:** Fundamental requirement in AC power transmission, advantages & disadvantages of different types of compensating equipment for transmission systems, fundamental transmission line equation, surge impedance and natural loading, voltage and current profiles of uncompensated line on open circuit, uncompensated line under load, effect of line length, load power and power factor on voltage and reactive power.

**Compensated Transmission Line:** Types of compensation, passive and active compensators, Uniformly distributed fixed compensation: Effect of distributed compensation on voltage control and effect of distributed compensation on line charging reactive power. T1

### Module 3


**Passive shunt compensation:** Control of open circuit voltage with shunt reactors, required reactance values of shunt reactors. T1

**Series compensation:** Objectives and practical limitations, Symmetrical line with mid-point series capacitor and shunt reactor, Power transfer characteristics and maximum transmissible power. Fundamental concepts of compensation by sectioning. T1

### Module 4

**Static Compensation:** Practical applications of static compensators in electrical power systems, main types of compensators, principle of operation of Thyristor Controlled Reactor (TCR), Thyristor Controlled Transformer, TCR with shunt capacitors and Thyristor Switched Capacitor (TSC), principle of operation of saturated reactor compensators.

**Series Capacitors:** compensation factor, protective gear, Varistor protective gear, Resonance effects with series capacitors

**Synchronous Condenser:** Condenser operation, Power system Voltage control, Emergency reactive power supply, HVDC application.

Comparison of basic types of compensator. T1
## Module-5

**Harmonics:** Effect of harmonics on electrical equipment, resonance, shunt capacitors and filters, telephone interferences.

**Reactive Power Co-ordination:** Reactive power management, transmission benefits, reactive power dispatch & equipment impact. T1

**Reactive Power Planning:** Economic justification for reactive power planning, methods followed by the electricity boards in India, zonal reactive power requirements EHV & MV, low tension capacitors, placement in distribution, line capacitors. T3

**Course Outcomes:** At the end of the course the student will be able to:
- Distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads.
- Observe various compensation methods in transmission lines.
- Distinguish demand side reactive power management & user side reactive power management.
- Construct model for reactive power coordination and effects of harmonics on electrical equipments.
- Discuss the Reactive Power Planning for the electricity boards.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
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**Text Books**

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<tr>
<td>1</td>
<td>Reactive power control in electric power systems</td>
<td>T. J. E. Miller</td>
<td>John Wiley &amp; Sons NY</td>
<td>2009</td>
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<th>Title</th>
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</table>
Course Learning Objectives:

- To define electric drive, its parts, advantages and explain choice of electric drive.
- To explain dynamics and modes of operation of electric drives.
- To explain selection of motor power ratings and control of DC motor using rectifiers.
- To analyze the performance of induction motor drives under different conditions.
- To explain the control of induction motor, synchronous motor and stepper motor drives.
- To discuss typical applications electrical drives in the industry.

**Module-1**

**Electrical Drives:** Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives.


**Control Electrical Drives:** Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives.

**Module-2**

**Direct Current Motor Drives:** Controlled Rectifier Fed DC Drives, Single Phase Fully Controlled Rectifier Control of DC Separately Excited Motor, Single Phase Half Controlled Rectifier Control of DC Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of DC Separately Excited Motor, Three Phase Half Controlled Rectifier Control of DC Separately Excited Motor, Multiquadrant Operation of DC Separately Excited Motor Fed Form Fully Controlled Rectifier, Rectifier Control of DC Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited DC Motor, Chopper Control of Series Motor.

**Module-3**

**Induction Motor Drives:** Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.

**Module-4**

**Induction Motor Drives (continued):** Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control, speed control of single phase induction motors.

**Synchronous Motor Drives:** Operation from fixed frequency supply-starting, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors.

**Module-5**

**Synchronous Motor Drives (continued):** Self-controlled synchronous motor drive employing load commutated thyristor inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless DC Motor Drives.

**Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor.

**Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.
**Course Outcomes:** At the end of the course the student will be able to:
- Explain the advantages, choice and control of electric drive
- Explain the dynamics, generating and motoring modes of operation of electric drives
- Explain the selection of motor power rating to suit industry requirements
- Analyze the performance & control of DC motor drives using controlled rectifiers
- Analyze the performance & control of converter fed Induction motor, synchronous motor & stepper motor drives.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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**Text Book**

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**Reference Books**

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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

UTILIZATION OF ELECTRICAL POWER (Professional Elective)

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Course Learning Objectives:
- To discuss electric heating, air-conditioning and electric welding.
- To explain laws of electrolysis, extraction and refining of metals and electro deposition.
- To explain the terminology of illumination, laws of illumination, construction and working of electric lamps.
- To explain design of interior and exterior lighting systems- illumination levels for various purposes light fittings- factory lighting- flood lighting-street lighting
- To discuss systems of electric traction, speed time curves and mechanics of train movement.
- To discuss motors used for electric traction and their control.
- To discuss braking of electric motors, traction systems and power supply and other traction systems.
- Give awareness of technology of electric and hybrid electric vehicles.

Module-1


Module-2


Module-3


Motors for Electric traction: Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors (Series Type) are used to drive a Motor Car, Tractive Effort and Horse Power, AC Series Motor, Three Phase Induction Motor.

Control of motors: Control of DC Motors, Tapped Field Control or Control by Field Weakening, Multiple Unit Control, Control of Single Phase Motors, Control of Three Phase Motors.

Module-4

Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes.


Module-5


Hybrid Electric Vehicles: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains.
Course Outcomes: At the end of the course the student will be able to:

- Discuss different methods of electric heating & welding.
- Discuss the laws of electrolysis, extraction, refining of metals and electro deposition process.
- Discuss the laws of illumination, different types of lamps, lighting schemes and design of lighting systems.
- Analyze systems of electric traction, speed time curves and mechanics of train movement.
- Explain the motors used for electric traction, their control & braking and power supply system used for electric traction.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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<tr>
<td>1</td>
<td>A Text Book on Power System Engineering</td>
<td>A. Chakrabarti et al</td>
<td>Dhanpat Rai and Co</td>
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<td>Edition, 2010</td>
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<td>2</td>
<td>Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design (Chapters 04 and 05 for module 5)</td>
<td>Mehrdad Ehsani et al</td>
<td>CRC Press</td>
<td>1st</td>
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<tr>
<td>1</td>
<td>Utilization, Generation and Conservation of Electrical Energy</td>
<td>Sunil S Rao</td>
<td>Khanna</td>
<td>1st</td>
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<td>2</td>
<td>Utilization of Electric Power and Electric Traction</td>
<td>G.C. Garg</td>
<td>Khanna</td>
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### Course Learning Objectives:

- To explain advantages and disadvantages, main parts and their functions, basic sequence of operation of PLC.
- To describe the hardware components: I/O modules, CPU, memory devices, other support devices and the functions of PLC memory map.
- To describe program scan sequence, the communication of information to the PLC using different languages, internal relay instruction.
- To explain identification of common operating modes found in PLCs, writing and entering the ladder logic programs.
- To define the functions of Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-in Circuits and Latching Relays.
- To discuss the operation of various processes, structures of control systems and the method of communication between different industrial processes.
- To understand SCADA and how it deals with the control and data acquisition from systems.
- To understand what RTU does, how it does and what.

### Module-1

**Programmable Logic Controllers:** Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application.

**PLC Hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).

**Basics of PLC Programming:** Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of operation.

### Module-2

**Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs:** Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-in Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description.

**Programming Timers:** Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.

### Module-3

**Programming Counters:** Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions.

**Program Control Instructions:** Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction.
Module-4

SCADA Fundamentals: Introduction, Open system: Need and advantages, Building blocks of SCADA systems, Remote terminal unit (RTU): Evolution of RTUs, Components of RTU, Communication subsystem, Logic subsystem, Termination subsystem, Power supplies, Advanced RTU functionalities, Intelligent electronic devices (IEDs), Data concentrators and merging units, SCADA communication systems,

Master Station: Master station software components, Master station hardware components, Server systems in the master station, Small, medium, and large master stations, Global positioning systems (GPS), Master station performance.

Module-5

Human-Machine Interface (HMI): HMI components, HMI software functionalities, Situational awareness, Intelligent alarm filtering: Need and technique, Alarm suppression techniques, Operator needs and requirements,

SCADA Systems: Building the SCADA systems, legacy, hybrid, and new systems, Classification of SCADA systems, SCADA implementation: A laboratory model: The SCADA laboratory, System hardware, System software, SCADA lab field design.

Course Outcomes: At the end of the course the student will be able to:
- Discuss history of PLC, its sequence of operation, advantages and disadvantages, main parts and their functions.
- Describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.
- Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module.
- Convert relay schematics and narrative descriptions into PLC ladder logic programs.
- Analyse PLC timer and counter ladder logic programs.
- Understand about SCADA systems and its subsystems.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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<tbody>
<tr>
<td>1</td>
<td>Programmable Logic Controllers</td>
<td>Frank D Petruzella</td>
<td>McGraw Hill</td>
<td>4th</td>
</tr>
<tr>
<td>2</td>
<td>Power System SCADA and Smart Grids</td>
<td>Mini S. Thomas</td>
<td>CRC Press</td>
<td>3rd</td>
</tr>
</tbody>
</table>

Reference Book

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
<th>Author</th>
<th>Publisher</th>
<th>Edition</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Programmable Logic Controllers an Engineer’s Guide</td>
<td>E A Parr</td>
<td>Newnes</td>
<td>3rd</td>
</tr>
<tr>
<td>2</td>
<td>Introduction Programmable Logic Controllers</td>
<td>Gary Dunning</td>
<td>Cengage</td>
<td>3rd</td>
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</table>
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

Table:

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<th>Course Code</th>
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<th>Exam Hours</th>
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<tbody>
<tr>
<td>18EE744</td>
<td>40</td>
<td>60</td>
<td>03</td>
</tr>
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</table>

**Course Learning Objectives:**
- To understand the basic concept of smart grid, attributes of Smart Grid
- To describe the overview of the perfect power system configuration
- To know about DC power delivering systems, data centers and information technology loads
- To educate the importance of Technology Alternatives in smart Grid
- To understand the Dynamic energy systems in Smart Grid
- To describe the overview of Demand side planning and evaluation

**Module-1**

**Introduction:** Introduction to smart grid, electricity network, local energy networks, electric transportation, low carbon central generation, attributes of the smart grid.

**Smart Grid to Evolve a Perfect Power System:** Introduction, overview of the perfect power system configurations, device level power system, building integrated power systems, distributed power systems, fully integrated power system.

**Module-2**

**DC Distribution and Smart Grid:** AC Vs. DC sources, benefits of and drives of DC power delivery systems, powering equipment and appliances with DC, data centers and information technology loads, potential future work and research

**Intelligrid Architecture for the Smart Grid:** Introduction, launching intelligrid, intelligrid today, smart grid vision based on the intelligrid architecture.

**Module-3**

**Dynamic Energy Systems Concept:** Smart energy efficient end use devices, smart distributed energy resources, advanced whole building control systems, integrated communications architecture, energy management, role of technology in demand response, current limitations to dynamic energy management, distributed energy resources, overview of a dynamic energy management, key characteristics of smart devices, key characteristics of advanced whole building control systems, key characteristics of dynamic energy management system.

**Module-4**

**Efficient Electric End Use Technology Alternatives:** Existing technologies, lighting, space conditioning, indoor air quality, domestic water heating, hyper efficient appliances, ductless residential heat pumps and air conditioners, variable refrigerant flow air conditioning, heat pump water heating, hyper efficient residential appliances, data center energy efficiency, LED street and area lighting, industrial motors and drives, equipment retrofit and replacement, process heating, cogeneration, thermal energy storage, industrial energy management programs, manufacturing process, electro-technologies, residential, commercial and industrial sectors.
Module-5

**Demand side planning:** Introduction, Selecting Alternatives, Issues Critical to the Demand-side, The Utility Planning Process, Demand-side Activities, Alternatives that Are Most Beneficial.

**Demand-Side Evaluation:** Levels of Analysis. General Information Requirements, System, Context, Transferability, Data Requirement, Cost/Benefit Analysis, Program Interaction.

**Course Outcomes:** At the end of the course the student will be able to:
- Explain the concept of Smart grid enables the ElectricNet and need of smart grid.
- Outline the benefits and drivers of DC Power delivery system.
- Summarize the Intelligrid Architecture for the smart grid.
- Explain the Efficient Electric End-use Technology Alternatives.
- Discuss Demand side planning and Evaluation.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Students will have to answer 5 full questions, selecting one full question from each module.

**Textbook**

<table>
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<tr>
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<th>Edition</th>
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<th>Publisher</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smart Grid: Technology and Applications</td>
<td>Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu</td>
<td>Wiley</td>
<td>2012</td>
</tr>
</tbody>
</table>
Course Learning Objectives:
• To understand the fundamental concepts and models of Artificial Neural Systems.
• To understand neural processing, learning and adaptation, Neural Network learning rules.
• Ability to analyze multilayer feed forward networks.
• Ability to develop various ancillary techniques applied to power system and control of power systems.

Module-1
Fundamental Concepts and Models of Artificial Neural Systems

Module-2
Neural Processing, Learning and Adaptation, Neural Network Learning Rules

Module-3
Multilayer Feedforward Networks

Module-4
Neural Network and its Ancillary Techniques as Applied to Power Systems
Introduction, Learning versus Memorization, Determining the Best Net Size, Network Saturation, Feature Extraction, Inversion of Neural Networks, Alternative Training Method: Genetic Based Neural Network, Fuzzified Neural Network. ■

Module – 5
Control of Power Systems
Introduction, Background, Neural Network Architectures for modeling and control, Supervised Neural Network Structures, Diagonal Recurrent Neural Network based Control System, Convergence and Stability. ■
**Course Outcomes:** At the end of the course the student will be able to:

- Develop Neural Network and apply elementary information processing tasks that neural network can solve.
- Develop Neural Network and apply powerful, useful learning techniques.
- Develop and Analyze multilayer feed forward network for mapping provided through the first network layer and error back propagation algorithm.
- Analyze and apply algorithmic type problems to tackle problems for which algorithms are not available.
- Develop and Analyze supervised/unsupervised, learning modes of Neural Network for different applications.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Books**

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<th></th>
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<th>Author</th>
<th>Publisher</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Artificial Neural Systems</td>
<td>Jacek M. Zurada</td>
<td>JAICO Publishing House</td>
<td>2006</td>
</tr>
<tr>
<td>2</td>
<td>Artificial Neural Networks with Applications to Power Systems</td>
<td>Edited by – Mohamed El – Sharkawi and Dagmar Niebur</td>
<td>IEEE, Inc.</td>
<td>1996</td>
</tr>
</tbody>
</table>
### Course Learning Objectives:

To explain the use of standard software package:
- Use of suitable standard software package.
- To solve power flow problem for simple power systems.
- To perform fault studies for simple radial power systems.
- To study optimal generation scheduling problems for thermal power plants.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formation for symmetric π /T configuration for Verification of Determination of Efficiency and Regulation.</td>
</tr>
<tr>
<td>2</td>
<td>Determination of Power Angle Diagrams, Reluctance Power, Excitation, EMF and Regulation for Salient and Non-Salient Pole Synchronous Machines.</td>
</tr>
<tr>
<td>3</td>
<td>To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.</td>
</tr>
<tr>
<td>4</td>
<td>Y Bus Formation for Power Systems with and without Mutual Coupling, by Singular</td>
</tr>
<tr>
<td>5</td>
<td>Formation of Z Bus(without mutual coupling) using Z-Bus Building Algorithm.</td>
</tr>
<tr>
<td>6</td>
<td>Determination of Bus Currents, Bus Power and Line Flow for a Specified System Voltage</td>
</tr>
<tr>
<td>7</td>
<td>Formation of Jacobian for a System not Exceeding 4 Buses in Polar Coordinates.</td>
</tr>
<tr>
<td>9</td>
<td>To Determine Fault Currents and Voltages in a Single Transmission Line System with</td>
</tr>
<tr>
<td>10</td>
<td>Optimal Generation Scheduling for Thermal power plants by simulation.</td>
</tr>
</tbody>
</table>

### Course Outcomes:

- Develop a program in suitable package to assess the performance of medium and long transmission lines.
- Develop a program in suitable package to obtain the power angle characteristics of salient and non-salient pole alternator.
- Develop a program in suitable package to assess the transient stability under three phase fault at different locations in a of radial power systems.
- Develop programs in suitable package to formulate bus admittance and bus impedance matrices of interconnected power systems.
- Use suitable package to solve power flow problem for simple power systems.
- Use suitable package to study unsymmetrical faults at different locations in radial power systems.
- Use of suitable package to study optimal generation scheduling problems for thermal power plants.
<table>
<thead>
<tr>
<th>Conduct of Practical Examination:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All laboratory experiments are to be included for practical examination.</td>
</tr>
<tr>
<td>2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.</td>
</tr>
<tr>
<td>3. Students can pick one experiment from the questions lot prepared by the examiners.</td>
</tr>
<tr>
<td>4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.</td>
</tr>
</tbody>
</table>
### B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

#### SEMESTER – VII

**RELAY AND HIGH VOLTAGE LABORATORY**

<table>
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<td>SEE Marks</td>
<td>60</td>
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<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To conduct experiments to verify the characteristics of over current, over voltage, under voltage relays both electromagnetic and static type.
- To verify the operation of negative sequence relay.
- To conduct experiments to verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.
- To conduct experiments on generator, motor and feeder protection.
- To conduct experiments to study the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
- To measure high AC and DC voltages.
- To experimentally measure the breakdown strength of transformer oil.
- To experimentally measure the capacitance of different electrode configuration models using Electrolytic Tank. To generate standard lightning impulse voltage and determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation.

<table>
<thead>
<tr>
<th>SL NO</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of Six experiments are to be conducted by selecting Two experiments from each Part – A, Part – B and Part – C. Five out of six experiments are to be conducted under Part – D.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Part - A Over Current Relay: (a)Inverse Definite Minimum Time(IDMT)Non-Directional Characteristics (b) Directional Features (c) IDMT Directional. IDMT Characteristics of Over Voltage or Under Voltage Relay (Solid State or Electromechanical type).</td>
</tr>
<tr>
<td>2</td>
<td>Operation of Negative Sequence Relay.</td>
</tr>
<tr>
<td>4</td>
<td>Part - B Operating Characteristics of Microprocessor Based (Numeric) Over –Current Relay.</td>
</tr>
<tr>
<td>5</td>
<td>Operating Characteristics of Microprocessor Based (Numeric) Distance Relay.</td>
</tr>
<tr>
<td>6</td>
<td>Operating Characteristics of Microprocessor Based (Numeric) Over/Under Voltage Relay.</td>
</tr>
<tr>
<td>7</td>
<td>Part - C Generation Protection: Merz Price Scheme.</td>
</tr>
<tr>
<td>8</td>
<td>Feeder Protection against Faults.</td>
</tr>
<tr>
<td>9</td>
<td>Motor Protection against Faults.</td>
</tr>
<tr>
<td>10</td>
<td>Part - D Spark Over Characteristics of Air subjected to High Voltage AC with Spark Voltage Corrected to Standard Temperature and Pressure for Uniform [as per IS1876: 2005]and Non-uniform [as per IS2071(Part 1) : 1993] Configurations: Sphere – Sphere, Point –Plane,</td>
</tr>
<tr>
<td>11</td>
<td>Spark Over Characteristics of Air subjected to High voltage DC.</td>
</tr>
<tr>
<td>12</td>
<td>Measurement of HVAC and HVDC using Standard Spheres as per IS 1876 :2005</td>
</tr>
<tr>
<td>13</td>
<td>Measurement of Breakdown Strength of Transformer Oil as per IS 1876 :2005</td>
</tr>
<tr>
<td>14</td>
<td>Field Mapping using Electrolytic Tank for any one of the following Models: Cable/ Capacitor/</td>
</tr>
<tr>
<td>15</td>
<td>(a) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator. (b) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage.</td>
</tr>
</tbody>
</table>
### Course Outcomes:
At the end of the course the student will be able to:

- Verify the characteristics of over current, over voltage, under voltage and negative sequence relay both electromagnetic and static type.
- Verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.
- Show knowledge of protecting generator, motor and feeders.
- Analyze the spark over characteristics for both uniform and non-uniform configurations using High A and DC voltages.
- Measure high AC and DC voltages and breakdown strength of transformer oil.
- Draw electric field and measure the capacitance of different electrode configuration models.
- Show knowledge of generating standard lightning impulse voltage to determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation.

### Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
**B. E. ELECTRICAL AND ELECTRONICS ENGINEERING**

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMESTER – VII**

### PROJECT PHASE – I

<table>
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<th>Credit</th>
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<tr>
<td>Number of Practical Hours/Week</td>
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<td></td>
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</table>

**Course Learning Objectives:**
- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organization, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

**Project Phase-I** Students in consultation with the guide/s shall carry out literature survey/visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

**Course Outcomes:** At the end of the course the student will be able to:
- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilizing a systems approach.
- Communicate with engineers and the community at large in written and oral forms.

**Continuous Internal Evaluation**

CIE marks for the project phase I 100 marks.
- i. Report 50 marks
- ii. Partial result and presentation 50 marks

Marks shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman.
 VIII SEMESTER DETAILED SYLLABUS

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER – VIII

POWER SYSTEM OPERATION AND CONTROL (Core Course)

<table>
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<tr>
<td>Credits</td>
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<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives:

- To describe various levels of controls in power systems and the vulnerability of the system.
- To explain components, architecture and configuration of SCADA.
- To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control
- To explain automatic generation control, voltage and reactive power control in an interconnected power system.
- To explain reliability and contingency analysis, state estimation and related issues.

Module-1


Supervisory Control and Data acquisition (SCADA): Introduction, components, application in Power System, basic functions and advantages. Building blocks of SCADA system, components of RTU, communication subsystem, IED functional block diagram. R2

Classification of SCADA system: Single master–single remote; Single master–multiple RTU; Multiple master–multiple RTUs; and Single master, multiple submaster, multiple remote. R2

Module-2

Automatic Generation Control (AGC): Introduction, Schematic diagram of load frequency and excitation voltage regulators of turbo generators, Load frequency control (Single area case), Turbine speed governing system, Model of speed governing system, Turbine model, Generator load model, Complete block diagram of representation of load frequency control of an isolated power system, Steady state analysis, Control area concept, Proportional plus Integral Controller. T1

Module-3

Automatic Generation Control in Interconnected Power system: Two area load frequency control, Optimal (Two area) load frequency control by state variable, Automatic voltage control, Load frequency control with generation rate constraints (GRCs), Speed governor dead band and its effect on AGC, Digital LF Controllers, Decentralized control. T1

Module-4

Control of Voltage and Reactive Power: Introduction, Generation and absorption of reactive power, Relation between voltage, power and reactive power at a node, Methods of voltage control: i. Injection of reactive power, Shunt capacitors and reactors, Series capacitors, Synchronous compensators, Series injection. ii Tap changing transformers. Combined use of tap changing transformers and reactive power injection, Booster transformers, Phase shift transformers, Voltage collapse. T3
Module-5

**Power System Security:** Introduction, Factors affecting power system security, Contingency Analysis, Linear Sensitivity Factors, AC power flow methods, Contingency Selection and Ranking, T2

**State estimation of Power Systems:** Introduction, Linear Least Square Estimation, T2

**Course Outcomes:** At the end of the course the student will be able to:
- Describe various levels of controls in power systems, architecture and configuration of SCADA.
- Develop and analyze mathematical models of Automatic Load Frequency Control.
- Develop mathematical model of Automatic Generation Control in Interconnected Power system
- Discuss the Control of Voltage, Reactive Power and Voltage collapse.
- Explain security, contingency analysis, state estimation of power systems.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Book**

<table>
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<th>Publisher</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Power System SCADA and Smart Grid</td>
<td>Mini S Thom and John D. McDonald</td>
<td>CRC Press</td>
<td>2015</td>
</tr>
</tbody>
</table>
Module-1


Module-2


Module-3


Module-4

Module-5

**Control of HVDC Converter and System:** Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.

**Course Outcomes:** At the end of the course the student will be able to:
- Discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- Explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- Describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- Describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- Explain advantages of HVDC power transmission, overview and organization of HVDC system.
- Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
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### ELECTRICAL ESTIMATION AND COSTING (Professional Elective)

<table>
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<th>Course Code</th>
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<td>CIE Marks</td>
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<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To discuss the purpose of estimation and costing.
- To discuss market surveys, estimates, purchase enquiries, tenders, comparative statements and payment of bills and Indian Electricity Act and some of the rules.
- To discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories, fittings and fuses.
- To discuss design of lighting points and its number, total load, sub-circuits, size of conductor.
- To discuss different types of service mains and estimation of power circuits.
- To discuss estimation of overhead transmission and distribution systems and its components.
- To discuss main components of a substation, their graphical representation and preparation of single line diagram of a substation.

#### Module-1


#### Module-2

**Wiring:** Introduction, Distribution of energy in a building, PVC Casing and Capping, Conduit Wiring, Desirabilities of Wiring. Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables

**Wiring (continued):** Main Switch and Distribution Board, Conduits and its accessories and Fittings Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse Units, Earthing Conductor Internal Wiring: General rules for wiring, Design of Lighting Points (Refer to Seventh Chapter of the Text Book), Number of Points, Determination of Total Load, Number of Sub-Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout.

#### Module-3


#### Module-4


**Module-4 (continued)**

**Estimation of Overhead Transmission and Distribution Lines (continued):** Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulator s, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead Lines, Clearances of Conductor From Ground, Spacing Between Conductors, Important Specifications.

#### Module-5

**Estimation of Substations:** Main Electrical connection, Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation main Connection Diagram, Single Line Diagram of Typical Substations, Equipment for Substation, Substation Auxiliaries Supply, Substation Earthing.
Course Outcomes: At the end of the course the student will be able to:
- Explain general principles of estimation and major applicable I.E. rules.
- Discuss wiring methods, cables used, design of lighting points and sub-circuits, internal wiring, wiring accessories and fittings, fuses and types.
- Discuss estimation of service mains and power circuits.
- Discuss estimation of overhead transmission and distribution system its components.
- Discuss types of substation, main components and estimation of substation.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
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Text Book

# B. E. ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER – VIII

## ELECTRIC VEHICLE TECHNOLOGIES (Professional Elective)

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### Course Learning Objectives:
- To understand working of Electric Vehicles and recent trends.
- Ability to analyze different power converter topology used for electric vehicle application.
- Ability to develop the electric propulsion unit and its control for application of electric vehicles.
- Ability to design converters for battery charging and explain transformer less topology.

### Module-1

**Electric and Hybrid Electric Vehicles**


### Module-2

**Energy storage for EV and HEV**

Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.

### Module-3

**Electric Propulsion**

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.

### Module – 4

**Design of Electric and Hybrid Electric Vehicles**

Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.

### Module – 5

**Power Electronic Converter for Battery Charging**

Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z- converter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology.

### Course Outcomes:
At the end of the course the student will be able to:
- Explain the working of electric vehicles and recent trends.
- Analyze different power converter topology used for electric vehicle application.
- Develop the electric propulsion unit and its control for application of electric vehicles.
- Design converters for battery charging and explain transformer less topology.

### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

### Text Books

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<tr>
<td>2</td>
<td>Electric and Hybrid Vehicles: Design Fundamentals</td>
<td>Iqbal Husain</td>
<td>CRC Press</td>
<td>2003</td>
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<tr>
<td>2</td>
<td>Modern Electric Vehicle Technology</td>
<td>C.C. Chan and K.T. Chau</td>
<td>OXFORD University</td>
<td>2001</td>
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<tr>
<td>3</td>
<td>Hybrid Electric Vehicles Principles And Applications With Practical Perspectives</td>
<td>Chris Mi, M. Abul Masrur, David Wenzhong Gao</td>
<td>Wiley Publication</td>
<td>2011</td>
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</table>
### Course Learning Objectives:

- To discuss primary components of power system planning namely load curtailment, evaluation of energy resources, provisions of electricity Act and Energy Conservation Act.
- To explain planning methodology for optimum power system expansion, various types of generation, transmission and distribution.
- To explain forecasting of anticipated future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
- To discuss methods to mobilize resources to meet the investment requirement for the power sector.
- To perform economic appraisal to allocate the resources efficiently and take proper investment decisions.
- To discuss expansion of power generation and planning for system energy in the country.
- To discuss evaluation of operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions.
- To discuss principles of distribution planning, supply rules, network development and the system studies.
- To discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis.
- To discuss grid reliability, voltage disturbances and their remedies.
- To discuss planning and implementation of electric –utility activities designed to influence consumer uses of electricity.
- To discuss market principles and the norms framed by CERC for online trading and exchange in the interstate power market.

### Module-1


**Electricity Forecasting:** Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.

### Module-2


**Generation Expansion:** Generation Capacity and Energy, Generation Mix, Clean Coal Technologies Renovation and Modernisation of Power Plants.

### Module-3


### Module-4

**Distribution:** Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity,
Module-4 (continued)

**Distribution (continued):** Upgradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification.


Module-5


Course Outcomes: At the end of the course the student will be able to:
- Discuss primary components of power system planning, planning methodology for optimum power system expansion and load forecasting.
- Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions.
- Discuss expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.
- Discuss principles of distribution planning, supply rules, network development and the system studies.
- Discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis, grid reliability, voltage disturbances and their remedies.
- Discuss planning and implementation of electric –utility activities, market principles and the norms framed.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook

<table>
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<th>Textbook</th>
<th>Author</th>
<th>Publisher</th>
<th>Edition</th>
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</table>
### Course Code: [8EE825]
### Course Learning Objectives:
- Review definitions and standards of common power quality phenomena.
- Understand power quality monitoring and classification techniques.
- Investigate different power quality phenomena causes and effects.
- Understand different techniques for power quality problems mitigation.
- Understand the various power quality phenomenon, their origin and monitoring and mitigation methods.
- Understand the effects of various power quality phenomenon in various equipment’s

#### Module-1
**Introduction:** Power quality-voltage quality, power quality evaluation procedures term and definitions: general classes of power quality problems, transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, power quality terms.

#### Module-2
**Voltage sags and interruptions:** Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags.

**Transient over voltages:** Sources of transient over voltages, principles of over voltages protection, utility capacitor switching transients.

#### Module-3
**Transient over voltages:** Fundamentals of harmonics: Harmonic distortion, voltage versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from Industrial loads, effects of harmonic distortion, intra harmonics.

#### Module-4
**Applied harmonics:** Harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters, standards of harmonics.

**POWER QUALITY BENCHMARK:** Introduction, benchmark process, power quality contract.

#### Module-5
**Power quality benchmark:** Power quality state estimation, including power quality in distribution planning.

**Distributed generation and quality:** DG technologies, interface to utility system, power quality issues, interconnection standards.

#### Course Outcome:
At the end of the course the student will be able to:
- Define Power quality; evaluate power quality procedures and standards.
- Estimate voltage sag performance; explain principles of protection and Sources of transient over voltages.
- Identify various sources of harmonics, explain effects of harmonic distortion.
- Evaluate harmonic distortion, control harmonic distortion.
- Estimate power quality in distribution planning. Identify power quality issues in utility system.

#### Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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<tbody>
<tr>
<td>2</td>
<td>Understanding power quality problems voltage sags and interruptions</td>
<td>Math H. J. Bollen.</td>
<td>IEEE Press</td>
<td>2000</td>
</tr>
<tr>
<td>3</td>
<td>Power quality in power systems and electrical machines</td>
<td>Ewald F Fuchs, Mohammad, A.S., Masoum</td>
<td>Academic Press, Elsevier</td>
<td>2009</td>
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</tbody>
</table>
### Internship

Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further:

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public.

**Internship:** Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

**Seminar:** Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

### Course Outcomes

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.

### Continuous Internal Evaluation

CIE marks : 40 Marks

i. Successful completion of Internship training in an organization and certification from competitive authority-20 marks

ii. Presentation and report -20 Marks

(based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman.

### Semester End Examination

SEE marks – 60 Marks based on presentation skill, participation in the question and answer session by the student to the examiners appointed by the University.
### Open Electives A/B

**B. E. ELECTRICAL AND ELECTRONICS ENGINEERING**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER – VI  

**INDUSTRIAL SERVO CONTROL SYSTEMS (Open Elective)**

<table>
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**Course Learning Objectives:**
- To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- To discuss system analogs and vectors, with a review of differential equations.
- To discuss the concept of transfer functions for the representation of differential equations.
- To discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- To represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- To determine the frequency response techniques for proper servo compensation.

#### Module-1


#### Module-2

**Machine Servo Drives:** Types of Drives, Feed Drive Performance.  
**Troubleshooting Techniques:** Techniques by Drive, Problems: Their Causes and Cures.  
**Machine Feed Drives:** Advances in Technology, Parameters for making Application Choices.  

#### Module-3

**Generalized Control Theory:** Servo Block Diagrams, Frequency-Response Characteristics and Construction of Approximate (Bode) Frequency Charts, Nichols Charts, Servo Analysis Techniques, Servo Compensation.  
**Indexes of Performance:** Definition of Indexes of Performance for Servo Drives, Indexes of Performance for Electric and Hydraulic Drives.

#### Module-4

**Performance Criteria:** Percent Regulation, Servo System Responses.  
**Servo Plant Compensation Techniques:** Dead-Zone Nonlinearity, Change-in-Gain Nonlinearity, Structural Resonances, Frequency Selective Feedback, Feed forward Control.  
**Machine Considerations:** Machine feed drive Considerations, Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives.

#### Module-5

**Machine Considerations:** Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed Considerations, Drive Ratio Considerations, Drive Thrust/Torque And Friction Considerations, Drive Duty Cycles.
**Course Outcomes:** At the end of the course the student will be able to:

- Explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- Discuss system analogs, vectors and transfer functions of differential equations.
- Discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- Represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- Determine the frequency response techniques for proper servo compensation.
- Explain performance indices and performance criteria for servo systems and discuss the mechanical considerations of servosystems.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

<table>
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<tr>
<td><strong>1</strong></td>
<td>Servo Motors and Industrial Control Theory</td>
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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VI

PLC and SCADA (Open Elective)

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Course Learning Objectives:

- To explain advantages and disadvantages, main parts and their functions, basic sequence of operation of PLC.
- To describe the hardware components: I/O modules, CPU, memory devices, other support devices and the functions of PLC memory map.
- To describe program scan sequence, the communication of information to the PLC using different languages, internal relay instruction.
- To explain identification of common operating modes found in PLCs, writing and entering the ladder logic programs.
- To define the functions of Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits and Latching Relays.
- To explain conversion of relay schematics into PLC ladder logic programs and writing PLC programs directly from narrative descriptions.
- To explain the functions of PLC counter instructions, applying combinations of counters and timers to control systems.
- To describe the function of selectable timed interrupt and fault routine files and use of temporary end instruction.
- To explain the execution of data transfer instructions, interruption of data transfer and data compare instructions.
- To explain the basic operation of PLC closed-loop control system, various forms of mechanical sequencers and their operations.
- To describe the operation of bit and word shift registers and develop programs that use shift registers.
- To discuss the operation of various processes, structures of control systems and the method of communication between different industrial processes.

Module-1

Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application.

PLC Hardware Components: The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).

Basics of PLC Programming: Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of Operation

Module-2

Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description.

Programming Timers: Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.
Module-3

**Programming Counters:** Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions.

**Program Control Instructions:** Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction.

Module-4

**Data Manipulation Instructions:** Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control.

**Math Instructions:** Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations.

Module-5

**Sequencer and Shift Register Instructions:** Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations.

**Process Control, Network Systems, and SCADA:** Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA).

**Course Outcomes:** At the end of the course the student will be able to:
- Discuss history of PLC and describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.
- Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module.
- Analyze PLC timer and counter ladder logic programs and describe the operation of different program control instructions.
- Discuss the execution of data transfer instructions, data compare instructions and the basic operation of PLC closed-loop control system.
- Describe the operation of mechanical sequencers, bit and word shift registers, processes and structure of control systems and communication between the processes.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Textbook**

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**Reference Book**

|---|---------------------------------------------------|---------|--------|-------------------|
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VI

RENEWABLE ENERGY RESOURCES (Open Elective)

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Course Learning Objectives:
- To discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- To explain sun – earth geometric relationship, Earth – Sun Angles and their Relationships
- To discuss about solar energy reaching the Earth’s surface and solar thermal energy applications.
- To discuss types of solar collectors, their configurations and their applications.
- To explain the components of a solar cell system, equivalent circuit of a solar cell, its characteristics and applications.
- To discuss benefits of hydrogen energy, production of hydrogen energy, storage its advantages and disadvantages.
- To discuss wind turbines, wind resources, site selection for wind turbine.
- To discuss geothermal systems, their classification and geothermal based electric power generation.
- To discuss waste recovery management systems, advantages and disadvantages.
- To discuss biomass production, types of biomass gasifiers, properties of producer gas.
- To discuss biogas, its composition, production, benefits.
- To discuss tidal energy resources, energy availability, power generation.
- To explain motion in the sea wave, power associated with sea wave and energy availability and the devices for harnessing wave energy.

Module-1


Module-2


Module-3


| **Biogas Energy:** | Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics. |

**Module-5**

| **Sea Wave Energy:** | Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. |

**Course Outcomes:** At the end of the course the student will be able to:
- Discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- Outline energy from sun, energy reaching the Earth’s surface and solar thermal energy applications.
- Discuss types of solar collectors, their configurations, solar cell system, its characteristics and their applications.
- Explain generation of energy from hydrogen, wind, geothermal system, solid waste and agriculture refuse.
- Discuss production of energy from biomass, biogas.
- Summarize tidal energy resources, sea wave energy and ocean thermal energy.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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**B. E. ELECTRICAL AND ELECTRONICS ENGINEERING**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
**SEMESTER –VI**

**TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS (Open Elective)**

<table>
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<td>Number of Lecture Hours/Week</td>
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<td>SEE Marks</td>
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<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
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**Course Learning Objectives:**
- Describe the process to plan, control and implement commissioning of electrical equipment’s.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Identification of tools and equipment’s used for installation and maintenance of electrical equipment.
- Explain the operation of an electrical equipment’s such as isolators, circuit breakers, insulators and switchgears.

**Module-1**

**Electrical Tools, accessories:** Tools, Accessories and Instruments required for Installation, Maintenance and Repair Work, India Electricity Rules, Safely Codes Causes and Prevention of Accidents, Artificial Respiration, Workmen’s Safety Devices.


**Module-2**


**Module-3**


**Module-4**

**Laying of Underground Cables:** Inspection, Storage, Transportation and Handling of Cables, Cable Handling Equipment, Cable Laying Depths and Clearances from other Services such as Water Sewerage, Gas, Heating and other Mains, Series of Power and Telecommunication Cables and Coordination with these Services, Excavation of Trenches, Cable Jointing and Terminations Testing and Commissioning. Location of Faults using Megger, Effect of Open or Loose Neutral Connections, Provision of Proper Fuses on Service Lines and Their Effect on System, Causes and Dim, and Flickering Lights.
Module-5


Course Outcomes: At the end of the course the student will be able to:
- Describe the process to plan, control and implement commissioning of electrical equipment’s.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Describe corrective and preventive maintenance of electrical equipment’s.
- Explain the operation of an electrical equipment’s such as isolators, circuit breakers, induction motor and synchronous machines.

Question paper pattern:
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
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<th>Title</th>
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<th>Edition</th>
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</table>
Module-1

Types of Motors DC Motor: Motor Principle, Back emf, Equivalent Circuit of DC Motor Armature, Torque, Types, Characteristics of Shunt Series and Compound Motors.

Module-2

Starting and Breaking of Motors:
DC Motor: Necessity of Starter, Three Point and Four Point Starter, Representation of on four quadrant diagram, Electric breaking of DC motor, Regenerative Breaking and Plugging or Reverse Current Breaking.

Module-3

Speed Control of Motors:
DC Motor: Rheostatic Control, Field Flux Control, Armature Voltage Control (Ward –Leonard Method) and Solid State Control (Block Diagram Approach Only).

Module-4

Selection of Motors for Industrial Drives and Applications:
Motor Applications: Motors for Textile, Machine Tool, Cranes, Compressors, Water Supply, Coal Mining and Distribution Board, Main Switch and Starter, Problems on Estimation of material required of Motor Installation.

Module-5

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

- Basic principles of electric motors explain the procedure of selecting rating of the motor for any application.
- Classify DC motors, explain the torque speed characteristics and select a motor for an application.
- Classify Induction Motors, explain the torque speed characteristics and select a motor for an application.
- Explain the types of Starting and Breaking of Motors
- Explain the different types of Speed Control of Motors
- Selection of Motors for Industrial Drives & Economic Selection of Electric Motors.
- Discuss Electrical Drawings, Installation, Maintenance & Safety

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

**Text Book**

<table>
<thead>
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<th>No</th>
<th>Title</th>
<th>Author</th>
<th>Publisher</th>
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<tr>
<td>1</td>
<td>Electric Machines</td>
<td>Ashfaq Husain</td>
<td>Dhanpat Rai &amp; Co</td>
<td>2013</td>
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<tr>
<td>3</td>
<td>Electrical motors applications and control.</td>
<td>M V Deshapande</td>
<td>PHI publications</td>
<td>2010</td>
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<td>4</td>
<td>Electric Motors and Control Systems-Career Education</td>
<td>Frank Petruzella</td>
<td>McGraw-Hill Companies, Inc.</td>
<td>2010</td>
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**SENSORS AND TRANSDUCERS (Open Elective)**

<table>
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<tr>
<th>Course Code</th>
<th>Type</th>
<th>CIE Marks</th>
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<td>Credits</td>
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**Course Learning Objectives:**
- To discuss need of transducers, their classification, advantages and disadvantages.
- To discuss working of different types of transducers and sensors.
- To discuss recent trends in sensor technology and their selection.
- To discuss basics of signal conditioning and signal conditioning equipment.
- To discuss configuration of Data Acquisition System and data conversion.
- To discuss the basics of Data transmission and telemetry.
- To explain measurement of various non-electrical quantities.

**Module-1**

**Sensors and Transducers:** Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.

**Module-2**


**Module-3**

**Signal Condition:** Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers.

**Data Acquisition Systems and Conversion:** Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.

**Module-4**

**Data Transmission and Telemetry:** Data/Signal Transmission, Telemetry.

**Measurement of Non – Electrical Quantities:** Pressure Measurement

**Module-5**

**Course Outcomes:** At the end of the course the student will be able to:
- Classify the transducers and explain the need of transducers, their classification, advantages and disadvantages.
- Explain the working of various transducers and sensors.
- Outline the recent trends in sensor technology and their selection.
- Analyze the signal conditioning and signal conditioning equipment.
- Illustrate different configuration of Data Acquisition System and data conversion.
- Show knowledge of data transmission and telemetry.
- Explain measurement of non-electrical quantities - temperature, flow, speed, force, torque, power and viscosity.

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

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</table>
### Course Learning Objectives:
- To understand the fundamental laws and vehicle mechanics.
- To understand working of Electric Vehicles and recent trends.
- Ability to analyze different power converter topology used for electric vehicle application.
- Ability to develop the electric propulsion unit and its control for application of electric vehicles.

### Module-1

**Vehicle Mechanics**

### Module-2

**Electric and Hybrid Electric Vehicles**

### Module-3

**Energy storage for EV and HEV**
Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.

### Module-4

**Electric Propulsion**
EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.

### Module-5

**Design of Electric and Hybrid Electric Vehicles**
Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.
**Course Outcomes:** At the end of the course the student will be able to:

- Explain the roadway fundamentals, laws of motion, vehicle mechanics and propulsion system design.
- Explain the working of electric vehicles and hybrid electric vehicles in recent trends.
- Model batteries, Fuel cells, PEMFC and super capacitors.
- Analyze DC and AC drive topologies used for electric vehicle application.
- Develop the electric propulsion unit and its control for application of electric vehicles.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
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<tbody>
<tr>
<td>2</td>
<td>Electric and Hybrid Vehicles: Design Fundamentals</td>
<td>Iqbal Husain</td>
<td>CRC Press</td>
<td>2003</td>
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<tr>
<td>2</td>
<td>Modern Electric Vehicle Technology</td>
<td>C.C. Chan and K.T. Chau</td>
<td>OXFORD University</td>
<td>2001</td>
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<tr>
<td>3</td>
<td>Hybrid Electric Vehicles Principles And Applications With Practical Perspectives</td>
<td>Chris Mi, M. Abul Masrur, David Wenzhong Gao</td>
<td>Wiley Publication</td>
<td>2011</td>
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B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII

ELECTRICAL ENERGY CONSERVATION AND AUDITING (Open Elective)

<table>
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<th>Subject Code</th>
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Course Learning Objectives:
- Understand the current energy scenario and importance of energy conservation.
- Understand the methods of improving energy efficiency in different electrical systems.
- Realize energy auditing.
- Explain about various pillars of electricity market design.
- To explain the scope of demand side management, its concept and implementation issues and strategies.

Module-1

**Energy Scenario:** Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module-2

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

Module-3

**Energy auditing:** Introduction, Elements of energy audits, different types of audit, energy use profiles measurements in energy audits, presentation of energy audit results.

Module-4

**Electricity vis-à-vis Other Commodities:** Distinguishing features of electricity as a commodity, Four pillars of market design: Imbalance, Scheduling and Dispatch, Congestion Management, Ancillary Services. Framework of Indian power sector and introduction to the availability based tariff (ABT).

Module-5

**Energy Audit Applied to Buildings:** Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings, Demand side Management: Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM.

Course Outcomes: At the end of the course the student will be able to:
- Analyze about energy scenario nationwide and worldwide, also outline Energy Conservation Act and its features.
- Discuss load management techniques and energy efficiency.
- Understand the need of energy audit and energy audit methodology.
- Understand various pillars of electricity market design.
- Conduct energy audit of electrical systems and buildings.
- Show an understanding of demand side management and energy conservation.
**Question paper pattern:**
- The question paper will have ten questions.
- Each full question is for 20 marks.
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<tr>
<td>1. Energy Management Handbook</td>
<td>W.C. Turner</td>
<td>Publisher John Wiley and Sons</td>
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<tr>
<td>3. Energy Management Author Publisher</td>
<td>W. R. Murphy, G. Mckay</td>
<td>Butterworths</td>
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