ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (AUTONOMOUS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING -CURRICULUM

REGULATIONS – R20

## 3rd Year

### Semester - I

| Course Code | Title of the course | Category | Periods | | | | | | Sessional Marks | Semester end Exam marks | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | E | O | Total | | | | |
| EEE311 | Open Elective-I | OE | 3 | 0 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE312 | Embedded Systems | SC | 3 | 0 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE313 | Pulse, Digital and Integrated Circuits | PC | 3 | 0 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE314 | Linear Control Systems | PC | 2 | 1 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE315 | Performance of Induction and Synchronous Machines | PC | 2 | 1 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE316 | Power Transmission and Distribution | PC | 2 | 1 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE317 | Quantitative Aptitude –I / Verbal Aptitude-I | HS | 0 | 0 | 3 | 0 | 3 | 6 | 100 | 0 | 100 | 1.5 |
| EEE318 | Design Thinking | SC | 2 | 0 | 2 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| EEE319 | Embedded Systems Laboratory | PC | 0 | 0 | 3 | 0 | 2 | 5 | 50 | 50 | 100 | 1.5 |
| EEE3110 | Electronics Laboratory –II | PC | 0 | 0 | 3 | 0 | 2 | 5 | 50 | 50 | 100 | 1.5 |
| EEE3111 | Summer Internship | PR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **Total** | | | **15** | **3** | **9** | **6** | **25** | **62** | **440** | **460** | **900** | **24.5** |

| Open Elective-I | |
|---|---|
| **S. No.** | **Name of the Course** |
| 1. | **Python - The Practical and Hands-on approach** |
| 2. | Introduction to Java |
| 3 | Competitive Programming |
| 4. | Computer Architecture and Organization |
| | **Infosys Springboard Courses** |
| 4. | Computational Problem Solving |
| 5. | Programming Fundamentals using Python - Part 1 |
| 6. | Data Structures and Algorithms: The Complete Master class |
| 7. | Data Structures and Algorithms using Python - Part 1 |
| 8. | Machine Learning, NLP & Python |
| 9. | Data Analysts Toolbox: Excel, Python, Power BI |
| 10. | Advanced Python Concepts |
| 11. | Programming Fundamentals using Python - Science Graduates - Foundation Program |
| 12. | Hands-On Deep Learning on Artificial Neural Networks |
| 13. | Learn Python and Ethical Hacking from Scratch |
| 14. | Data Structures and Algorithms using Java |

**Value Added Course:** Introduction to MATLAB/PSPICE etc. (3-1)

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (AUTONOMOUS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING -CURRICULUM

REGULATIONS – R20

## 3rd Year

### Semester - II

| Course Code | Title of the course | Category | Periods | | | | | | Sessional Marks | Semester end Exam marks | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | E | O | Total | | | | |
| EEE321 | **Open Elective-II** | OE | 3 | 0 | 0 | 1 | 2 | 6 | 40 | 60 | 100 | 3 |
| EEE322 | **Professional Elective –I** | PE | 3 | 0 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE323 | **Professional Elective –II** | PE | 3 | 0 | 0 | 1 | 3 | 7 | 40 | 60 | 100 | 3 |
| EEE324 | Power Electronics | PC | 3 | 0 | 0 | 1 | 5 | 9 | 40 | 60 | 100 | 3 |
| EEE325 | Power System Analysis | PC | 2 | 1 | 0 | 1 | 6 | 10 | 40 | 60 | 100 | 3 |
| EEE326 | Engineering Economics & Management | HS | 2 | 1 | 0 | 1 | 6 | 10 | 40 | 60 | 100 | 3 |
| EEE327 | Quantitative Aptitude –II / Soft Skills | HS | 0 | 0 | 3 | 0 | 2 | 5 | 100 | 0 | 100 | 1.5 |
| EEE328 | Research Methodology | SC | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| EEE329 | Control Systems Lab | PC | 0 | 0 | 3 | 0 | 1 | 4 | 50 | 50 | 100 | 1.5 |
| EEE3210 | Electrical Machines Lab – II | PC | 0 | 0 | 3 | 0 | 1 | 4 | 50 | 50 | 100 | 1.5 |
| **Total** | | | **16** | **2** | **9** | **6** | **29** | **62** | **440** | **460** | **900** | **22.5** |

| Open Elective-II | |
|---|---|
| **S. No.** | **Name of the Course** |
| 1. | **DBMS/SQL** |
| 2. | Competitive Programming |
| 3. | Introduction to Java |
| 4. | Computer Architecture and Organization |
| | **Infosys Springboard Courses** |
| 5. | Computational Problem Solving |
| 6. | Programming Fundamentals using Python - Part 1 |
| 7. | Python - The Practical and Hands-on approach |
| 8. | Data Structures and Algorithms: The Complete Master class |
| 9. | Data Structures and Algorithms using Python - Part 1 |
| 10. | Machine Learning, NLP & Python |
| 11. | Data Analysts Toolbox: Excel, Python, Power BI |
| 12. | Advanced Python Concepts |
| 13. | Programming Fundamentals using Python - Science Graduates - Foundation Program |
| 14. | Hands-On Deep Learning on Artificial Neural Networks |
| 15. | Learn Python and Ethical Hacking from Scratch |
| 16. | Data Structures and Algorithms using Java |

| Professional Elective –I |
|---|
| 1. **Advanced Control Systems** |
| 2. HVDC |
| 3. VLSI |
| 4. Electrical Engineering Materials |

| Professional Elective –II |
|---|
| 1. **Power System Protection** |
| 2. Electrical Drives & Traction |
| 3. Digital Control Systems |
| 4. Digital Signal Processing |

# Third Year Semester-II

| Professional Elective-I<br>**ADVANCED CONTROL SYSTEM** | |
|---|---|
| **EEE 322** | **Credits : 3** |
| **Instruction : 3 Periods /Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

| | |
|---|---|
| CO-1 | To analyze the performance various control system components |
| CO-2 | Analyse state space representation from transfer function and vice versa |
| CO-3 | Analyse the nature of stability of the system and Develop state feedback controller |
| CO-4 | Identify the needs of different types of conventional controllers |
| CO-5 | Identify the needs of different types compensator to ascertain the required dynamic response from the system. |

## SYLLABUS

**UNIT-I:** **[10 Periods]**

Control Systems Components: D.C & A.C. tachometers; synchros; A.C. and D.C. servo motors; stepper motors and its use in control systems; amplidyne, metadyne; magnetic amplifier—principle, operation and characteristics; ward- leonard system.

**UNIT-II:** **[10 Periods]**

State Variable Analysis: Concept of state variables & state models, state model for line a continuous time systems, solution of state equation, state transition matrix (Matrix exponential and laplace methods only).

**UNIT-III:** **[10 Periods]**

Concept of controllability & observability (simple problems to understand theory), pole placement by state feedback method, design of state feedback controller.

**UNIT-IV:** **[10 Periods]**

Introduction and effect of proportional (P), Proportional plus Integral (PI), Proportional plus Derivative (PD), Proportional plus Integral plus Derivative (PID) controller and finding the system response.

**UNIT-V:** **[10 Periods]**

Introduction to lag, lead, lag-lead compensating networks and realization of networks. Design of lag, lead and lag-lead compensators by using Root locus technique, design of lag, lead, lag-lead compensators by using Bode plot method.

**Text Books:**


1. Control Systems Engineering by IJ. Nagrath and M.Gopal, New Age International Publications.
2. Control systems components by G.J. Gibson Tuetor
3. Automatic control systems by B.C. Kuo, Prentice Hall of India, 1988.


Reference Books:


1. Modern Control Engineering by Ogata K., 4th Edition, Prentice Hall
2. System Dynamics by Ogata K. 3rd Edition, Prentice Hall
3. Control Systems Principles and Design by M. Gopal, 2™ Edition, Tata McGraw Hill
4. Control System Design Guide — A Practical Guide by George Ellis,3rd Edition, Academic Press

| Professional Elective-I<br>**VLSI** | |
|---|---|
| **EEE 322** | **Credits : 3** |
| **Instruction : 3 Periods /Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

**Prerequisites:** Digital Electronics, ECA-I, ECA-II, IC analysis

**Course Outcomes:**

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

| | |
|---|---|
| 1. | Delineate IC Production process, fabrication processes for NMOS, PMOS, BiCMOS Technologies. |
| 2. | Analyze CMOS electrical properties with circuit concepts. |
| 3. | Draw stick diagrams, layouts for CMOS circuits and compute delays of CMOS circuits using modern tools. |
| 4. | Design and test the CMOS digital Circuits at different levels of abstraction using modern tools. |
| 5. | Apply testing methods on the digital designs for DFT. |

## SYLLABUS

**UNIT I** **[10 Periods]**

**IC Technology:** MOS, PMOS, NMOS, CMOS &BiCMOS technologies- Oxidation, Lithography, Diffusion, Ion implantation, Metallization, Encapsulation, Integrated Resistors and Capacitors.

**UNIT II** **[10 Periods]**

**CMOS Electrical Properties:**Basic Electrical Properties of MOS and BiCMOS Circuits: Ids-Vds relationships, MOS transistor threshold Voltage, gm, gds, figure of merit, Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, Bi-CMOS Inverters.

**Basic circuit concepts:**

Sheet Resistance $R_S$ and its concept to MOS, Area Capacitance Units, Calculations-Delays, driving large Capacitive Loads, Wiring Capacitances, Fan-in and fan-out, Choice of layers

**UNIT III** **[10 Periods]**

VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, 2 micron CMOS Design rules, Contacts and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling.

**UNIT IV** **[10 Periods]**

**Gate Level Design:** Logic Gates and Other complex gates, Switch logic, Alternate gate circuits. Different CMOS logic Circuits-Pseudo, Dynamic, Domino, $C^2MOS$.

**Subsystem Design:** Subsystem Design, Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators.

**UNIT V** **[10 Periods]**

**VLSI Testing:** CMOS Testing, Need for testing, Test Principles, Design Strategies for test, Chip level Test Techniques, System-level Test Techniques, Design for testability, Practical design for test guidelines, Buil-In-Self-Test

**TEXT BOOKS:**

1. Douglas A, Pucknell, Kamran Eshraghian,"Basic VLSI Design",3rd Edition,Prentice Hall, l996.**(UNITS I, II, III, IV & V)**
2. Weste and Eshraghian, "Principles of CMOS VLSI Design", Pearson Education, 1999

**REFERENCE BOOKS:**

1. John .P. Uyemura,"Introduction to VLSI Circuits and Systems",JohnWiley, 2003.
2. Wayne Wolf, "Modern VLSI Design", 3rd Edition, Pearson Education, 1997

| Professional Elective-I<br>**ELECTRICAL ENGINEERING MATERIALS** | |
|---|---|
| **EEE 322** | **Credits : 3** |
| **Instruction : 3 Periods /Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

## SYLLABUS

**UNIT-I: Conducting Materials:** Hardening, Annealing - Low Resistive Materials – Requirements – Properties and applications of Copper and Aluminum - Comparison between Copper and Aluminum - ACSR Conductors, AAAC, High Resistive Materials – Requirements- Properties and applications.

**UNIT-II: Semi and Insulating:** Semi conducting Materials Semi-conductors - Intrinsic and extrinsic semi-conductors-`P' and `N' type Materials Insulating Materials Properties -Insulation resistance - Factors effecting Insulation resistance - Classification of Insulation materials - Properties – Applications.

**UNIT-III: Di- electric materials**: Permittivity of di -electric materials- Polarisation - Dielectric Loss – Application of Dielectrics – Colour codes.
**Magnetic Materials**: Classification of magnetic materials - Soft & Hard magnetic materials- B-H Curves Hysteresis loop - Hysteresis loss - Steinmetz constant - Eddy Current Loss -- Curie Point – Magnetostriction.

**UNIT-IV: Special Purpose Materials:** Protective materials – Thermocouple - Bi-Metals- Soldering- Fuses -Galvanizing and Impregnating - Nano Materials.

**UNIT-V: Batteries**: Primary cell and Secondary cells-Lead acid, Nickel iron and Nickel - cadmium-Chemical reactions during charging and discharging – Charging of Batteries- Constant current method and constant voltage method-Trickle charging - Capacity of Battery - Amperehour efficiency and watt-hour efficiency - Maintenance free batteries

**REFERENCES:**


1. Electronic Components -Dr. K.Padmanabham
2. Electronic Components -D.V.Prasad
3. Electrical Engineering Materials – N.I T.T.T.R Publications
4. Introduction to Engineering materials – B.K.Agarwal.
5. Materials science for Electrical and Electronic Engineers – Ian P.Jones (Oxford Publications)
6. Electrical Engineering Materials and Semiconductors-J.B.Guptha and Rena Guptha,SK Kotaria &Sons Publishers

| Professional Elective-II<br>**POWER SYTEM PROTECTION** | |
|---|---|
| **EEE 323** | **Credits : 3** |
| **Instruction : 3 Periods /Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

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

| CO | BL | CO Statement |
|---|---|---|
| CO1 | BL-3 | **Compare** the construction, operation and applications of electromagnetic relays and Over Current protection. **Determine** the settings of PSM and TMS of Over Current relay.<br>**Explain** the construction, operation and applications of Distance and Differential Protection. **Determine** the minimum value of earthing resistance and percentage of winding unprotected for Alternators. **Determine** relay setting and CT ratio of transformer protected by percentage differential protection. |
| CO2 | BL-2 | **Explain** operation of Static Over current, Distance, Differential protection and Microprocessor based relay. **Identify** the difference between electromagnetic and static relays. |
| CO3 | BL-3 | **Explain** the construction, operation and applications of various types of Lightning arresters. **Determine** reflected, refracted voltages and currents of Travelling waves. |
| CO4 | BL-3 | **Explain** the construction, operation and application of various types of Fuses and Circuit Breakers. **Determine** the TRV/RRRV. **Construct** substation layout and bus bar arrangement using single diagram. |

**CO1:** Action Verb (BT)-**Compare, Explain, Determine**/ Cognitive level- Application (BL-3)

**CO2:** Action Verb (BT)-**Explain, Identify**/Cognitive level- Understanding (BL-2)

**CO3:** Action Verb (BT)-**Explain**, **Determine**/Cognitive level- Application (BL-3)

**CO4**: Action Verb (BT)-**Explain, Determine, Construct**/Cognitive level- Application (BL-3)

## Program Matrix

| | **Program Outcomes (POs)** | | | | | | | | | | | | **PSOs** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Domain Specific POs** | | | | | **Domain Independent POs** | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 3 | 2 | - | - | - | - | | | | - | 1 | 3 | |
| CO2 | 2 | 2 | - | - | - | - | - | | | | - | 1 | 3 | |
| CO3 | 2 | 1 | - | - | - | - | - | | | | - | 1 | 3 | |
| CO4 | 2 | 3 | 2 | - | 2 | - | - | | | | - | 1 | 3 | |

### SYLLABUS

**UNIT-I** **[15 Periods]**

**PROTECTIVE RELAYING**

Faults, causes and effects, Importance of protective relaying, Evolution of protective relays, Protective zones, Primary and backup protection, Desirable qualities of protective relaying, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology Operating principle and construction of electromagnetic relays

**Over Current and Earth Fault Protection-** Applications of over current protection, relays used in over current protection, time current characteristics, directional relays, protection of parallel feeders, and protection of ring mains. Phase fault and earth fault protection, combined earth fault and phase fault protective scheme, Directional earth fault relay.

**UNIT-II** **[10 Periods]**

**Distance and Differential Protection:**

**Distance Protection -** Principle of operation of distance protection, R-X diagram, universal torque equation, impedance, reactance and mho relay. Zones of protection, auto reclosing. Pilot wire protection and carrier current protection.

**Differential Protection -**Types, protection of generators, protection of transformers and bus-zone protection.

**UNIT-III** **[10 Periods]**

**STATIC AND NUMERICAL RELAYS**

Block diagram representation, Merits and demerits of static relays, amplitude and phase comparators, basic block diagrams of static over current, distance and differential protection. Block diagram of microprocessor based relay, advantages.

**UNIT-IV** **[10 Periods]**

**PROTECTION AGAINST OVER VOLTAGES**

Causes of over voltages, over voltages due to lightning, Protection against lightning and travelling waves – earth wire, effects of series inductances, shunt capacitance, spark gap, surge arresters, lightning arresters, insulation co-ordination.

**UNIT-V** **[15 Periods]**

**CIRCUIT BREAKERS AND SUBSTATION LAYOUT**

**Fuses -**Types of fuses, high voltage HRC fuses applications, selection and discrimination.

**Circuit Breakers-**Principle of operation, formation of arc, methods of arc extinction, transient recovery voltage, resistance switching, switching of capacitor banks and un-loaded lines, current chopping, ratings and characteristics of circuit breakers, Classification, constructional features of air circuit breakers, oil circuit breakers, air blast circuit breakers, SF-6 circuit breakers and vacuum circuit breakers, testing of circuit breakers.

**Sub-Station Layout & B us Bars:** Classification of substations, substation equipment and their function, bus-bar design and schemes of layout.

**TEXT BOOKS:**


1. Sunil S. Rao, "Switchgear Protection and Power Systems" Khanna Publishers, 13th, edition, 2013,
2. B. Ram and D.N. Viswakarma, "Power System protection and Switchgear" TMH Publications, 2nd, edition, 2013.


**REFERENCE BOOKS:**


1. C.L. Wadhwa, "Electrical power Systems", New Age International Publishers, 6th edition, 2010.
2. L. P. Singh, "Protective relaying from Electromechanical to Microprocessors", New Age International Publishers, 2nd edition, 2004.

| Professional Elective-II<br>**ELECTRICAL DRIVES AND TRACTION** | |
|---|---|
| **EEE 323** | **Credits : 3** |
| **Instruction : 3 Periods /Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

**Course Outcomes:**

| CO | BL | CO Statement |
|---|---|---|
| CO1 | BL-3 | **CLASSIFY** the electric drives and **ANALYZE** their stability |
| CO2 | BL-3 | **MODIFY** speed torque characteristics of three phase induction motors, d.c. motors and synchronous motors. |
| CO3 | BL-3 | **ANALYZE** in detail the starting of dc & ac motors. |
| CO4 | BL-3 | **ANALYZE** electric braking in detail employed to dc & ac motors. |
| CO5 | BL-3 | **DETERMINE** the specific energy consumption for a particular run and **EXPLAIN** the factors affecting it. |

| COs | Program Outcomes (POs) | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Domain Specific POs | | | | | Domain Independent POs | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| CO2 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | - | - |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| CO4 | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| CO5 | 3 | - | - | - | - | - | - | - | - | - | - | 1 | - | - |

**SYLLABUS**

**UNIT-I** **[10 Periods]**

**ELECTRIC DRIVE: C**oncept and classification of electric drives, four quadrant operation, types of loads, dynamics of motor load combination, steady-state and transient stability of drive.

**UNIT-II** **[15 Periods]**

**CHARACTERISTICS OF MOTORS:** Basic relations and characteristics and modified speed torque characteristics of D.C shunt and series motors, characteristics of 3- phase induction and synchronous motors and modification of their speed – torque characteristics

**UNIT-III** **[ 10 Periods]**

**ELECTRIC STARTING:** Effect of starting on power supply, motor and load, methods of starting, acceleration time, energy relations during starting, and methods to reduce energy loss during starting.

**UNIT-IV** **[10 Periods]**

**ELECTRIC BRAKING:** Types of braking, braking of D.C motors during lowering of loads, braking while stopping, braking of induction and synchronous motors, energy relations during braking.

**UNIT-V** **[15 Periods]**

**ELECTRICAL TRACTION:** General features and systems of traction electrification, traction motors, loco wheel arrangement and riding qualities, transmission of drive, traction motor control (series-parallel control), traction equipment and collection gear, train movement, speed-time curve and speed distance curve, specific energy consumption (sec) and factors affecting it.

**TEXT BOOKS**


1. S. K. PILLAI , “A First Course On Electric Drives”,2nd edition, 2004, wiley esastren ltd.
2. E. OPEN SHAW TAYLOR AND V.V.L. RAO ORIENTLONG man “Utilisation of electrical energy”, 2nd edition, 2004, Tata Mc Graw Hill Pub.


**REFERENCE BOOKS**


1. H. PARTAB , “Modern Electric Traction”. 3rd edition, 2003, DHANPAT ROY & Co.
2. VEDAM SUBRAMANYAM , “ELECTRIC DRIVES” 4th edition,2006 TMH Pub.

| Professional Elective-II<br>**DIGITAL CONTROL SYSTEMS** | |
|---|---|
| **EEE 323** | **Credits : 3** |
| **Instruction : 3 Periods /Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

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

| CO's Number | CO's Description |
|---|---|
| **CO1** | Able to understand the effects of sampling in performance |
| **CO2** | Able to represent sampled data system using difference equations, transfer function, block diagram |
| **CO3** | Able to understand and design discrete control system using transform techniques |
| **CO4** | Analyze discrete time systems using signal flow graph and state space analysis |
| **CO5** | Able to understand the stability of sampled data signals |

**Mapping of course outcomes with program outcomes:**

| CO's No. | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| CO4 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| CO5 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

## SYLLABUS

**UNIT-I**

**SIGNAL CONVERSION AND PROCESSING: I**ntroduction, block diagram representation of s/h device, mathematical modelling of the sampling process, finite-pulse width sampler, folding frequency. The sampling theorem, mathematical modelling of the sampling, ideal sampler, sample and hold devices, expressions of f*(s), s-plane properties of f*(s), zero-order hold, frequency-domain characteristics of zoh, first order hold, fractional hold device.

**UNIT-II**

**THE Z-TRANSFORM:** The Z-Transform Definition, Relationship With Laplace Transform, Alternate Expression For F(Z), Evaluation Of Z-Transform, Relationship Between S-Plane And Z-Plane, Inverse Z-Transform, Non Uniqueness Of The Z-Transform, Defining Equations Of The Inverse Z-Transform, Theorems Of The Z-Transform, Limitations Of The Z-Transform.

**UNIT-III**

**TRANSFER FUNCTION, BLOCK DIAGRAMS & SIGNAL FLOW GRAPHS:** Transfer functions, block diagrams, signal flow graphs, the pulse transfer function and z-transform function, systems with cascaded elements separated by a sampler & not separated by a sampler, pulse transform function of zoh and relation between g(s) and g(z), closed loop systems, characteristic equation, physical realizability.

**UNIT-IV**

**THE STATE VARIABLE TECHNIQUES:** State equations of descrete systems with sample and hold devices, state transition equations, the recursive method, the z-transform method, state equations and transfer function, characteristic equation, eigen values, eigen vectors, diagonalization of the ‘a’ matrix, jordan canonical form computing state transition matrix.

**CONTROLLABILITY, OBSERVABILITY, STABILITY**: Definition of controllability, theorem on controllability, definition of observability, theorem on observability, relationships between controllability and observability and transfer function, stability of linear digital control systems, definition & theorem, stability tests, bi-linear transformation method, jury's stability test.

**Text Books:**


1. Digital control systems by B.C. Kuo, second edition, Saunders college publication-1992.
2. Digital Control Systems by Ogata.
3. Digital Control Systems (Software & Hardware) by Lay mount & Azzo.

| Professional Elective-II<br>**DIGITAL SIGNAL PROCESSING** | |
|---|---|
| **EEE 323** | **Credits : 3** |
| **Instruction : 3 Periods /Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

**Course Outcomes:**

| By the end of the course, the student will be able to: | |
|---|---|
| **CO1** | Acquired knowledge on different types of signals and properties of systems.. |
| **CO2** | Use Z - transforms and discrete time Fourier transforms to analyze a digital system. |
| **CO3** | Acquired knowledge on FFT for fast computation of DFT. |
| **CO4** | Ability to design and realize IIR using different techniques. |
| **CO5** | Ability to design and realize FIR using different techniques. |

## SYLLABUS

**UNIT I** **[12 Periods]**

**Introduction to D igital Signal Processing & A pplications of Z -Transforms:** Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Review of Z-transforms, Applications of Z – transforms, solution of difference equations , Block diagram representation of linear constant-coefficient difference equations.

**UNIT IV:** **[12 Periods]**

**Discrete Fourier series and Discrete Fourier Transforms:** Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT. Relation between Z–transform and DFS.

**UNIT III:** **[12 Periods]**

**Fast Fourier Transforms**: Frequency domain representation of discrete time signals and systems – Fast Fourier transforms (FFT) – Radix–2 decimation in time and decimation in frequency FFT Algorithms – Inverse FFT – and FFT for composite N.

**UNIT IV:** **[12 Periods]**

**IIR Digital Filter Design Techniques:** Introduction, Analog low pass filter design, Butterworth and Chebyshev approximations, Frequency transformations, Design of HPF, Design of IIR Digital filters from analog filters, Bilinear Transformations method, Impulse invariance method. Realization of Digital filter: Direct form-I, Direct form-II, cascade form, Parallel form.

**UNIT V:** **[12 Periods]**

**FIR Digital Filter Design Techniques:** Introduction, Fourier Series method to design digital filter, Design of FIR Digital Filters using Window Techniques, Frequency Sampling technique, Comparison of IIR & FIR filters.

**TEXT BOOKS:**


1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.
2. Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006
3. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House.


**Reference Books:**


1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006
2. Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA McGraw Hill, 2007.
3. DSP Primer - C. Britton Rorabaugh, Tata McGraw Hill, 2005.
4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris,Thomson, 2007.

| POWER ELECTRONICS | |
|---|---|
| **EEE 324** | **Credits : 3** |
| **Instruction : 2 Periods & 1 Tut/Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

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

| CO | BL | CO Statement |
|---|---|---|
| CO1 | BL-3 | **Discuss** thyristor operation and characteristics to **calculate** ratings and design parameters of thyristors. |
| CO2 | BL-4 | **Illustrate** the commutation circuits, triggering circuits & series-parallel operation of thyristors to **Select** the appropriate circuit & connection for a particular application of thyristor/thyristors. |
| CO3 | BL-3 | **Demonstrate** the operation and waveforms of phase controlled rectifiers to **Compute** the performance parameters of rectifiers. |
| CO4 | BL-3 | **Classify** various types of inverters to **Examine** their use in specific applications. |
| CO5 | BL-3 | **Illustrate** the operation of DC Choppers & AC to AC Converters to **Utilize** these converters for electric drive applications, **Summarize** the operation and characteristics of DIAC & TRIAC |

| CO | Bloom's Level |
|---|---|
| CO1 | Action Verb from Blooms Taxonomy-**Calculate**/ Cognitive level- Application (BL-3) |
| CO2 | Action Verb from Blooms Taxonomy-**Select**/ Cognitive level- Application (BL-4) |
| CO3 | Action Verb from Blooms Taxonomy-**Compute**/Cognitive level- Analysis (BL-3) |
| CO4 | Action Verb from Blooms Taxonomy-**Examine**/Cognitive level- Analysis (BL-3) |
| CO5 | Action Verb from Blooms Taxonomy-**Utilize**/Cognitive level- Analysis (BL-3) |

## Program Matrix

| COs | Program Outcomes (POs) | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Domain Specific POs | | | | | Non-Domain Independent POs | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | - | 2 |
| CO2 | 2 | 3 | 1 | - | 2 | - | - | - | - | - | - | 1 | - | 2 |
| CO3 | 2 | 3 | 1 | - | 2 | - | - | - | - | - | - | 1 | - | 2 |
| CO4 | 2 | 3 | - | - | 2 | - | - | - | - | - | - | 1 | - | 2 |
| CO5 | 2 | 3 | - | | 2 | - | - | - | - | - | - | 1 | - | 2 |

**SYLLABUS**

**UNIT I:** **[8 Periods]**

**Thyristors:** Introduction, principle of operation, two transistor model, static V-I characteristics, dynamic characteristics, gate characteristics, turn on methods, thyristor ratings, measurement of thyristor parameters, protection circuits.

**UNIT II:** **[12 Periods]**

**Gate Triggering Circuits and Commutation Circuits:** Resistance firing, resistance-capacitor firing, UJT triggering, class A, class B, class C, class D, class E, class F commutation circuits.

**Series and Parallel Operation of Thyristors:** Equalizing networks, string efficiency, derating.

**UNIT III:** **[10 Periods]**

**Phase Controlled Rectifiers:** Single phase -half wave, full wave & bridge controlled rectifiers. Three phase half wave and full wave controlled rectifiers, three phase fully controlled bridge rectifier effect of source inductance on single phase and three phase converters.

**UNIT IV:** **[10 Periods]**

**Inverters:** Classification, voltage source inverters, current source inverters, the Mc-Murray inverter, series and parallel inverters,

**UNIT V:** **[10 Periods]**

**Choppers:** Principle of operation, step-up, step-down choppers, two quadrant type A chopper, four quadrant chopper, Jones chopper, Buck converter, Boost Converter and Buck-Boost converter, AC voltage controllers R, R-L loads.

**Cyclo Converters:** Principle of operation, single phase to single phase Cycloconverter. Principle of operation and static characteristics of Diac & Triac.

**Text Books:**


1. Power Electronics by Dr. P.S. Bimbra, 4th Edition, 2012, Khanna Publishers.
2. Power Electronics by M.D. Singh, K.B. Khanchandani, 2nd edition, 2006,Tata McGraw –Hill Publishing Company Limited.


**Reference Books:**


1. Power Electronics, Circuits, Devices & Applications by Muhammad H Rashid, 4th Edition, 2003, Pearson Education.
2. Power Electronics for Technology by Ashfeq Ahmed, Prentice hall Education, 1998.

| POWER SYSTEM ANALYSIS | |
|---|---|
| **EEE 325** | **Credits : 3** |
| **Instruction : 2 Periods & 1 Tut/Week** | **Sessional Marks : 40** |
| **End Exam : 3 Hours** | **End Exam Marks : 60** |

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

| CO | BL | CO Statement |
|---|---|---|
| CO1 | BL-3 | **Apply** per unit calculations to **Develop** reactance diagram for a given single line diagram. |
| CO2 | BL-3 | **Apply** Gauss-Seidel, Newton-Raphson and Fast Decoupled methods to **Compute** different parameters of the load flow problem. |
| CO3 | BL-4 | **Analyze** symmetrical and unsymmetrical faults to **Compute** fault current of the given single line diagram. |
| CO4 | BL-4 | **Analyze** the steady state and transient stability on single machine connected to infinite bus system to **Determine** steady state and transient stability limit. |

| CO | Bloom's Level |
|---|---|
| CO1 | Action Verb from Blooms Taxonomy-**Develop**/ Cognitive level- Application (BL-3) |
| CO2 | Action Verb from Blooms Taxonomy-**Apply**/ Cognitive level- Application (BL-3) |
| CO3 | Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4) |
| CO4 | Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4) |

## Program Matrix

| COs | Program Outcomes (POs) | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Domain Specific POs | | | | | Domain Independent POs | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO2 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | 1 | 3 | - |
| CO3 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | 1 | 3 | - |
| CO4 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | 1 | 3 | - |

**SYLLABUS**

**UNIT-I** **[8 Periods]**

**Per Unit System of Representation**

Single line diagram, per unit system, per unit impedance of a 3-winding transformer, per unit impedance and reactance diagram of a power system.

**UNIT-II** **[12 Periods]**

**Power Flow Analysis**

Formulation of bus admittance matrix, classification of buses, power flow problem, Gauss-Seidel Method, Newton-Raphson method, Decoupled & Fast decoupled method of solving power flow problem.

**UNIT-III** **[10 Periods]**

**Symmetrical Fault Analysis**

Formulation of bus impedance matrix, 3-phase short circuit currents and reactance of a synchronous machine, methods of calculating symmetrical fault currents, selection of circuit-breakers, fault limiting reactors.

**UNIT-IV** **[10 Periods]**

**Un-Symmetrical Fault Analysis**

Symmetrical components, 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, phase shift in delta/star Transformers.

Unsymmetrical faults –L-G, L-L, L-L-G on an unloaded alternator.

**UNIT-V** **[10 Periods]**

**Power System Stability**

Concepts of stability (steady state and transient), swing equation, steady state stability limit, equal area criterion, critical clearing angle and time for transient stability, step by step method of solution, methods of improving transient stability, Introduction to voltage stability.

**Text Books:**


1. Power System Analysis by Hadi Sadat, TMC Publications, 3rd edition, 2010.
2. Elements of Power System Analysis by John J. Grainger & William D. Stevenson, Jr.TMH Publications, 2014.
3. Modern Power System Analysis by I.G. Nagrath & D.P. Kothari, TMH Publications, 4th edition, 2011.


**Reference Books:**


1. Electric Power Systems by B. M. Weedy & B. Cory, Wiley Publications, 4th edition, 2012.
2. Power System Analysis &Design Systems by J. Duncan Glover, M.S.Sarma & Thomas J. Overbye, CLI Private Ltd., 2012.

| ENGINEERING ECONOMICS AND MANAGEMENT | |
|---|---|
| **EEE 336** | **Credits: 3** |
| **Instruction: 3 Periods & 1 Tut/Week** | **Sessionals Marks:40** |
| **End Exam: 3 Hours** | **End Exam Marks:60** |

**Course Objectives:**

- To familiarize the students with the concepts of Economics.
- To gain basic understanding of management and manage organizations effectively and to relate the concepts of management with industrial organizations
- To help the students to understand the factors affecting productivity and to acquaint them with the major aspects of production management
- To make them to know the basics of Accounting, entrepreneurship and marketing management.

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

| | |
|---|---|
| CO1 | Understand the concepts of Economics |
| CO2 | Gain basic understanding of management and to relate the concepts of management with industrial organizations and manage organizations efficiently |
| CO3 | Have the basic knowledge of production management and make decisions proficiently |
| CO4 | Understand the basic concepts of accounting, finance and marketing management |

## Program Matrix

| | **Program Outcomes (POs)** | | | | | | | | | | | | **PSOs** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Domain Specific POs** | | | | | **Domain Independent POs** | | | | | | | | |
| **COs** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | - | - | - | - | - | - | - | 1 | 2 | - | 3 | 1 | | |
| CO2 | - | - | - | - | - | - | - | 1 | 2 | - | 3 | 1 | | |
| CO3 | - | - | - | - | - | - | - | 1 | 2 | - | 3 | 1 | | |
| CO4 | - | - | - | - | - | - | - | 1 | 2 | - | 3 | 1 | | |

### SYLLABUS

**UNIT I: Fundamentals of Economics: [10 Periods]**

Wealth, Welfare and Scarce Definitions of Economics; Micro and Macro Economics; Demand- Law of Demand, Elasticity of Demand, Types of Elasticity and Factors determining price elasticity of Demand: Utility- Law of Diminishing Marginal Utility, its limitations and exceptions.

**UNIT II: Forms of Business Organizations: [10 Periods]**

Features, merits and demerits of Sole Proprietorship, Partnership and Joint Stock Company- Public Enterprises and their types.

**UNIT III: Introduction to Management: [20 Periods]**

Functions of Management- Taylor's Scientific Management; Henry Fayol's Principles of Management; **Human Resource Management** –Basic functions of Human Resource Management (in brief).

**Production Management:** Production Planning and Control, Plant Location, Break-Even Analysis- Assumptions, limitations and applications.

**UNIT IV: Financial Management: [10 Periods]**

Types of Capital: Fixed and Working Capital and Methods of Raining Finance; Final Accounts- Trading Account, Statement of Profit and Loss and Balance Sheet (simple problems)

**UNIT V: Marketing Management and Entrepreneurship: [10 Periods]**

Marketing Management: Functions of marketing and Distribution Channels. **Entrepreneurship**: Definition, Characteristics and Functions of an Entrepreneur.

**Text Books:**

1. S.C. Sharma and Banga T. R., Industrial Organization & Engineering Economics, khanna Publications, Delhi-6. (2006) **(Units covered – 3,4 and 6)**

2. A.R. AryaSri, Managerial Economics and Financial Analysis, TMH Publications, new Delhi, (2014) **(Units covered – 1,2,4 and 5)**

3. S.N.Maheswari, SK Maheswari, Financial Accounting Fifth Edition, Vikas Publishing HousePvt. Ltd., New Delhi, (2012) **(Units covered – 5)**

| RESEARCH METHODOLOGY | |
|---|---|
| **EEE 328** | **Credits : 0** |
| **Instruction : 2 Periods /Week** | **Sessional Marks : 00** |
| **End Exam : 0 Hours** | **End Exam Marks : 00** |

**SYLLABUS**

**Unit-1: Introduction, Problem Identification & Formulation**

Introduction to Research: Foundation, Objectives, Motivation, Concept of Utility theory, empiricism, deductive and inductive theories. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Research Process. Problem Identification & Formulation – Research Questionnaires – Investigation Questionnaires – Measurement Issues – Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

**Unit-2: Research Design & Qualitative, Quantitative Approaches**

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

**Unit-3: Experimental Design & Sampling**

Concept of Independent & Dependent variables. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. Guidelines for designing experiments, Experiments with single factor: Analysis of Variance, Analysis of the fixed effects model, Model adequacy checking, sample computer output, Regression approach to the Analysis of Variance.

**Unit-4: Data Analysis**

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

**Unit-5: Interpretation and Writing of Paper**

Layout of a Research Paper, Journals in Mechanical Engineering, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopaedias, Research Guides, Handbook etc., Academic Data bases for Mechanical Engineering Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

**REFERENCE BOOKS:**

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari

| CONTROL SYSTEM LABORATORY | |
|---|---|
| **EEE 329** | **Credits : 1.5** |
| **Instruction : 3 Periods Week** | **Sessional Marks : 50** |
| **End Exam : 3 Hours** | **End Exam Marks : 50** |

**Course Outcomes:**

At the end of the lab course student should able to

| | |
|---|---|
| CO1 | Develop the mathematical modelling of ac and dc servomotors. |
| CO2 | Analysis of Synchro pair (error detector). |
| CO3 | Analyse the response of $1^{st}$,$2^{nd}$ and $3^{rd}$ order systems with and without feedback |
| CO4 | Design a compensator to improve the response. |

## LIST OF EXPERIMENTS

1. Characteristics of magnetic amplifier
2. Digital control systems (microprocessor based)
3. Digital control systems (pc interface)
4. Synchro pair
5. Characteristics of ac servo motor
6. Characteristics of dc servo motor
7. Temperature controller(thermal system)
8. Linear system simulator
9. Speed-Torque characteristics of dc motor(closed loop)

| ELECTRICAL MACHINES LABORATORY-II | |
|---|---|
| **EEE 330** | **Credits : 1.5** |
| **Instruction : 3 Periods Week** | **Sessional Marks : 50** |
| **End Exam : 3 Hours** | **End Exam Marks : 50** |

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

| | |
|---|---|
| **CO1** | Analyze the Transformer for 3 phase to 2 phase or 2 phase to 3 phase conversion and also separate the losses. |
| **CO2** | Analyze the speed control and performance characteristics of 3 phase Induction machine. |
| **CO3** | Analyze the voltage regulation and performance characteristics of 3 phase Synchronous machine. |

## LIST OF EXPERIMENTS

1. Verification of Scott connection.
2. Load test on a 3-ϕ Induction motor.
3. No load and Block rotor tests on 3-ϕ Induction motor.
4. Speed control of 3-ϕ Slip-ring Induction motor.
5. Regulation of an alternator by EMF and MMF methods.
6. Regulation of an alternator by ZPF method.
7. 'V' and 'Inverted V' Curves of Synchronous motor.
8. Slip test on Salient pole Synchronous machine.
9. 3-ϕ Induction motor runs as a 1-ϕ Induction motor.
10. Sumpner's Test on Three identical 1-ϕ Transformers connected in Δ/Δ.
11. R-L-C Load Test on a 1-ϕ Transformer.
12. Equivalent circuit of a 1-ϕ Induction motor.
13. Line-excited Induction generator
14. Separation of losses in single phase transformer