# JOGINPALLY B.R. ENGINEERING COLLEGE

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**Approved by AICTE & Affiliated to JNTUH, Hyderabad**

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

## COURSE OUTCOMES (COs)

### M.Tech. I Year I Sem R19 Syllabus Power Electronics And Electrical Drives

| Course Code | Course Title / Name | Course Outcomes |
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| Professional Core - I | Power Electronic Converters | **At the end of this course, each student should be able to:**<br>**CO1:** Choose appropriate device for a particular converter topology.<br>**CO2:** Use power electronic simulation packages for analyzing and designing power converters. |
| Professional Core - II | Machine Modeling and Analysis | **At the end of this course, each student should be able to:**<br>**CO1:** Develop the mathematical models of various AC and DC machines<br>**CO2:** Analyze the developed models in various reference frames. |
| Professional Elective - I | Power Electronics for Renewable Energy Systems | **At the end of this course, each student should be able to:**<br>**CO1:** Ability to understand and analyze power system operation, stability, control and protection.<br>**CO2:** Ability to handle the engineering aspects of electrical energy generation and utilization. |
| Professional Elective - I | Smart Grid Technologies | **At the end of this course, each student should be able to:**<br>**CO1:** Appreciate the difference between smart grid & conventional grid<br>**CO2:** Apply smart metering concepts to industrial |

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| | | and commercial installations<br>**CO3:** Formulate solutions in the areas of smart substations,distributed generation and wide area measurements<br>**CO4:** Come up with smart grid solutions using modern communication technologies |
| Professional Elective - I | Dynamics of Electrical Machines | **At the end of this course, each student should be able to:**<br>**CO1:** Understand the basic mathematical analysis of electrical machines and its characteristics.<br>**CO2:** Understand behavior of electrical machines under steady state and transient state.<br>**CO3:** Understand dynamic modeling of electrical machines. |
| Professional Elective - I | Modern Control Theory | **At the end of this course, each student should be able to:**<br>**CO1:** Various terms of basic and modern control system for the real time analysis and design of control systems.<br>**CO2:** To perform state variables analysis for any real time system.<br>**CO3:** Apply the concept of optimal control to any system.<br>**CO4:** Able to examine a system for its stability, controllability and observability.<br>**CO5:** Implement basic principles and techniques in designing linear control systems.<br>**CO6:** Formulate and solve deterministic optimal control problems in terms of performance indices.<br>**CO7:** Apply knowledge of control theory for practical implementations in engineering and network analysis. |
| Professional Elective - II | Power Semiconductor Devices and Modelling | **At the end of this course, each student should be able to:**<br>**CO1:** Know the operating charectertics of various basic semiconductor devices and switches<br>**CO2:** Understand the advanced power semiconductor devices operation.<br>**CO3:** Know the modeling of basic and advanced |

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| | | semiconductor devices and switches through simulation<br>**CO4:** Analyze the applications of various power semiconductor switches |
| Professional Elective - II | Reactive Power Compensation and Management | **At the end of this course, each student should be able to:**<br>**CO1:** Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads<br>**CO2:** Observe various compensation methods in transmission lines<br>**CO3:** Construct model for reactive power coordination<br>**CO4:** Distinguish demand side reactive power management & user side reactive power management |
| Professional Elective - II | High Frequency Magnetic Components | **At the end of this course, each student should be able to:**<br>**CO1:** Design of magnetic components (i.e., inductor and transformer) in a converter.<br>**CO2:** Perform steady-state analysis of switched mode power supply.<br>**CO3:** Understand core loss in an electromagnetic device, recognize & describe its effect.<br>**CO4:** Describe the engineering uses of electromagnetic waves, by frequency band, and the respective hazards associated with them |
| Professional Elective - II | Hybrid Electric Vehicles | **At the end of this course, each student should be able to:**<br>**CO1:** Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.<br>**CO2:** To learn electric drive in vehicles / traction. |
| | Research Methodology and IPR | **At the end of this course, each student should be able to:**<br>**CO1:** Understand research problem formulation.<br>**CO2:** Analyze research related information<br>**CO3:** Follow research ethics<br>**CO4:** Understand that today's world is controlled by Computer, Information Technology, but |

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| | | tomorrow world will be ruled by ideas, concept, and creativity.<br>**CO5:** Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.<br>**CO6:** Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits. |
| Lab - I | Machine Modelling and Analysis Lab | **At the end of this course, each student should be able to:**<br>**CO1:** Develop the mathematical models of various machines like, induction motor and Synchronous machines ,permenant magnet synchronous motor,brushless DC motor using modeling equations.<br>**CO2:** Analyze the developed models in various reference frames. |
| Lab - II | Power Electronic Converters Lab | **At the end of this course, each student should be able to:**<br>**CO1:** Simulate AC-AC Converters<br>**CO2:** Simulate AC-DC Converters<br>**CO3:** Simulate DC-DC Converters<br>**CO4:** Simulate DC-AC Converters<br>**CO5:** Analysis of various converter topologies developed |
| **Audit - I** | **Audit Course - I** | |

**M.Tech. I Year II Sem R19 Syllabus Power Electronics And Electrical Drives**

| Course Code | Course Title / Name | Course Outcomes |
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| Professional Core - III | Advanced Power Electronic Converters | **At the end of this course, each student should be able to:**<br>**CO1:** Develop and analyze various converter topologies.<br>**CO2:** Design AC or DC switched mode power supplies. |
| Professional Core - IV | Electrical Drives | **At the end of this course, each student should be able to:**<br>**CO1:** Develop induction motor for variable speed operations using scalar and vector control techniques.<br>**CO2:** Identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives.<br>**CO3:** Develop controllers for synchronous motor and variable reluctance motor. |
| Professional Elective - III | Industrial Load Modelling and Control | **At the end of this course, each student should be able to:**<br>**CO1:** Knowledge about load control techniques in industries and its application.<br>**CO2:** Different types of industrial processes and optimize the process using tools like LINDO and LINGO.<br>**CO3:** Apply load management to reduce demand of electricity during peak time.<br>**CO4:** Apply different energy saving opportunities in industries. |
| Professional Elective - III | Advanced Digital Signal Proceesing | **At the end of this course, each student should be able to:**<br>**CO1:** Know about the time domain and frequency domain representations as well analysis of discrete time signals and systems<br>**CO2:** Study the design techniques for IIR and FIR filters and their realization structures. |

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| | | **CO3:** Acquire knowledge about the finite word length effects in implementation of digital filters.<br>**CO4:** Know about the various linear signal models and estimation of power spectrum of stationary Random signals<br>**CO5:** Design optimum FIR and IIR filters |
| Professional Elective - III | SCADA Systems and Applications | **At the end of this course, each student should be able to:**<br>**CO1:** Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their Typical applications**.**<br>**CO2:** Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.<br>**CO3:** Knowledge about single unified standard architecture IEC 61850.<br>**CO4:** To learn about SCADA system components: remote terminal units, PLCs, intelligent electroni devices, HMI systems, SCADA server.<br>**CO5:** Learn and understand about SCADA applications in transmission and distribution sector, industries etc. |
| Professional Elective - III | PWM Converters and Applications | **At the end of this course, each student should be able to:**<br>**CO1:** Knowledge concepts and basic operation of PWM converters, including basic circuit operation and design<br>**CO2:** Learn the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality<br>**CO3:** Able to recognize and use the following concepts and ideas:Steady-State and transient modeling and analysis of power converters with various PWM techniques. |
| Professional Elective - IV | Advanced Microcontroller Based Systems | **At the end of this course, each student should be able to:**<br>**CO1:** learn how to program a processor in assembly language and develop an advanced processor |

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| | | based system<br>**CO2:** learn configuring and using different peripherals in a digital system<br>**CO3:** compile and debug a Program<br>**CO4:** generate an executable file and use it |
| Professional Elective - IV | Distributed Generation | **At the end of this course, each student should be able to:**<br>**CO1:** understand the planning and operational issues related to Distributed Generation.<br>**CO2:** Acquire Knowledge about Distributed Generation Learn Micro-Grids |
| Professional Elective - IV | Power Quality | **At the end of this course, each student should be able to:**<br>**CO1:** Know the different characteristics of electric power quality in power systems,<br>**CO2:** Learn about the applications of non-linear loads,<br>**CO3:** Know the applications of Hartley and Wavelet Transforms,<br>**CO4:** Learn how to mitigate the power quality problems<br>**CO5:** Learn about the application of FACTS device on DG side. |
| Professional Elective - IV | Integration of Energy Sources | **At the end of this course, each student should be able to:**<br>**CO1:** Identify the characteristics of renewable energy sources and converters.<br>**CO2:** Analyze the importance of storage and sizing of hybrid systems.<br>**CO3:** Realize the problems related to isolated systems.<br>**CO4:** Analyze the challenges faced by the grid by integrating renewable energy sources. |
| | Mini Project with Seminar | **At the end of this course, each student should be able to:**<br>**CO1:** Demonstrate a sound technical knowledge of their selected mini project topic.<br>**CO2:** Undertake problem identification, formulation and solution. |

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| | | **CO3:** Design engineering solutions to complex problems utilising a systems approach.<br>**CO4:** Communicate with engineers and the community at large.<br>**CO5:** Demonstrate the knowledge, skills and attitudes of a professional engineer |
| Lab - III | Advanced Power Electronic Converters Lab | **At the end of this course, each student should be able to:**<br>**CO1:** Know the speed control strategies of AC and DC drives<br>**CO2:** Design speed, current controllers for AC and DC drives<br>**CO3:** Get the knowledge on multi-level inverter/ converter topologies<br>**CO4:** Perform the open loop and closed loop speed control analysis of AC and DC drives<br>**CO5:** Design the gate driver circuits for converter topologies<br>**CO6:** Know the complete study of advanced converter technologies |
| Lab - IV | Electrical Drives Lab | **At the end of this course, each student should be able to:**<br>**CO1:** Develop induction motor for variable speed operations using scalar and vector control techniques.<br>**CO2:** Identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives.<br>**CO3:** Develop controllers for synchronous motor and variable reluctance motor. |
| **Audit - II** | **Audit Course - II** | |

**M.Tech. II Year III Sem R19 Syllabus Power Electronics And Electrical Drives**

| Course Code | Course Title / Name | Course Outcomes |
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| Professional Elective - V | Reliability Engineering | **At the end of this course, each student should be able to:**<br>**CO1:** Apply fundamental knowledge of Reliability to modeling and analysis of seriesparallel and Non-series parallel systems.<br>**CO2:** Solve some practical problems related<br>**CO3:** Understand or become aware of various failures, causes of failures and remedies for failures in practical systems. |
| Professional Elective - V | Flexible AC Transmission Systems | **At the end of this course, each student should be able to:**<br>**CO1:** Choose proper controller for the specific application based on system requirements<br>**CO2:** Understand various systems thoroughly and their requirements<br>**CO3:** Interpret the control circuits of Shunt Controllers SVC & STATCOM for various functions viz.Transient stability Enhancement, voltage instability prevention and power oscillation damping<br>**CO4:** Detect the Power and control circuits of Series Controllers GCSC, TSSC and TCSC |
| Professional Elective - V | HVDC Transmission | **At the end of this course, each student should be able to:**<br>**CO1:** Expose the students to the state of the art HVDC technology.<br>**CO2:** Knowledge of modelling and analysis of HVDC system for inter-area power flow regulation.<br>**CO3:** Study of Neetishatakam will help in developing. |
| Professional Elective - V | Energy Storage Technologies | **At the end of this course, each student should be able to:**<br>**CO1:** Understand the role of electrical energy storage technologies in electricity usage<br>**CO2:** Know the behavior and features of electrical 9 energy storage systems<br>**CO3:** Analyze the applications of energy storage |

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| | | system<br>**CO4:** Understand the hierarchy, demand for energy storage and valuation techniques.<br>**CO5:** Get knowledge about energy storage forecasting methods |
| **Open Elective** | **Open Elective** | |

**LIST OF AUDIT COURSE-I & II OFFERED FOR R19 M.TECH PROGRAMMES ( CSE, EEE)**

| Course Code | Course Title / Name | Course Outcomes |
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| Audit Course I & II | English for Research Paper Writing | **At the end of this course, each student should be able to:**<br>**CO1:** Understand relevant legislation and codes of ethics.<br>**CO2:** Computer forensics and digital detective and various processes, policies and procedures.<br>**CO3:** E-discovery, guidelines and standards, E-evidence, tools and environment.<br>**CO4:** Email and web forensics and network forensics. |
| Audit Course I & II | Disaster Management | **At the end of this course, each student should be able to:**<br>**CO1:** Understanding the concepts in grid computing<br>**CO2:** Ability to set up cluster and run parallel applications<br>**CO3:** Ability to understand the cluster projects and cluster OS<br>**CO4:** Understanding the concepts of pervasive computing & quantum computing. |
| Audit Course I & II | Sanskrit for Technical Knowledge | **At the end of this course, each student should be able to:**<br>**CO1:** Understanding basic Sanskrit language<br>**CO2:** Ancient Sanskrit literature about science & technology can be understood<br>**CO3:** Being a logical language will help to develop logic in students |
| Audit Course I & II | Value Education | **At the end of this course, each student should be able to:**<br>**CO1:** Knowledge of self-development<br>**CO2:** Learn the importance of Human values<br>**CO3:** Developing the overall personality |
| Audit Course I & II | Constitution of India | **At the end of this course, each student should be able to:**<br>**CO1:** Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. |

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| | | **CO2:** Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.<br>**CO3:** Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.<br>**CO4:** Discuss the passage of the Hindu Code Bill of 1956. |
| Audit Course I & II | Pedagogy Studies | **At the end of this course, each student should be able to:**<br>**CO1:** What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?<br>**CO2:** What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?<br>**CO3:** How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? |
| Audit Course I & II | Stress Management by yoga | **At the end of this course, each student should be able to:**<br>**CO1:** Develop healthy mind in a healthy body thus improving social health also<br>**CO2:** Improve efficiency |
| Audit Course I & II | Personality Development Through Life Enlightenment Skills | **At the end of this course, each student should be able to:**<br>**CO1:** Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life<br>**CO2:** The person who has studied Geeta will lead the nation and mankind to peace and prosperity<br>**CO3:** Study of Neetishatakam will help in developing versatile personality of students |

**LIST OF OPEN ELECTIVES OFFERED FOR R19 M.TECH PROGRAMMES ( CSE,EEE )**

| Course Code | Course Title / Name | Course Outcomes |
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| Open Elective | Numerical methods | **At the end of this course, each student should be able to:**<br>**CO1:** Know the approximations in any calculations and solutions to equations<br>**CO2:** Solve simultaneous equations using matrix methods<br>**CO3:** Calculate differentiation and integration problems using numerical methods<br>**CO4:** Solve ordinary and partial differential equations |
| Open Elective | Construction Management | **At the end of this course, each student should be able to:**<br>**CO1:** Plan, coordinate and control of project from beginning to completion.<br>**CO2:** Distinguish different types of contracts that can be used for a project<br>**CO3:** Adopt the most effect method for meeting the requirement in order to produce a functionally and financially viable project. |
| Open Elective | Finite Element Methods | **At the end of this course, each student should be able to:**<br>**CO1:** To understand the fundamental theory of the Finite Element Method<br>**CO2**: To apply the Finite Element theory to solve soil behavior under external loads. |
| Open Elective | Artificial Intelligence: Techniques | **At the end of this course, each student should be able to:**<br>**CO1:** Asses the applicability, strengths and weakness of problems and methods for particular engineering problem.<br>**CO2:** Develop intelligent system for particular problem.<br>**CO3:** Understand the concepts of Fuzzy logic, Applications in water resource engineering. |
| Open Elective | Operation Research | **At the end of this course, each student should be able to:**<br>**CO1:** Apply the dynamic programming to solve |

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| | | problems of discreet and continuous variables.<br>**CO2:** Apply the concept of non-linear programming<br>**CO3:** Carry out sensitivity analysis<br>**CO4:** Model the real-world problem and simulate it. |
| Open Elective | Industrial Safety | **At the end of this course, each student should be able to:**<br>**CO1:** Know how to take safety measures in executing works<br>**CO2:** Identify the need for maintenance (or) replacement of equipment<br>**CO3:** Understand the need for periodic and preventive maintenance |
| Open Elective | Environmental Legislation & Audit | **At the end of this course, each student should be able to:**<br>**CO1:** Interpret the Environment Protection (EP) Act 1986.<br>**CO2:** Interpret the Water Act 1974 and Water Cess Act<br>**CO3:** Interpret the Air Act 1981.<br>**CO4:** Interpret the Hazardous waste Act 1989<br>**CO5:** Analyze the 'Environmental Audit' done of an Industry and debate the method used to do so.<br>**CO6:** Undertake Environmental Audit |
| Open Elective | GIS & IoT For Planning & Policy Making for Smart Cities/Urban Areas | **At the end of this course, each student should be able to:**<br>**CO1:** The importance of National and International policies for smart cities<br>**CO2:** Applications of with GIS for urban cities.<br>**CO3:** Applications of IoT for smart cities<br>**CO3:** The concepts of GIS and IoT at analytics level.<br>**CO4:** Applications of IoT and GIS to reduce congestion and pollution in urban cities. |
| Open Elective | Disaster Management | **At the end of this course, each student should be able to:**<br>**CO1:** Understanding Disasters, man-made Hazards and Vulnerabilities.<br>**CO2:** Understanding disaster management mechanism.<br>**CO3:** Understanding capacity building concepts |

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| | | and planning of disaster managements. |
| Open Elective | Disaster Analytics | **At the end of this course, each student should be able to:**<br>**CO1:** Understand the various disasters and their impact<br>**CO2:** Understand the urban policies related to disaster<br>**CO3:** Find methods to monitor disasters<br>**CO4:** Understand ways to quantify and plan infrastructure<br>**CO5:** Understand the concepts of Mapping and measuring disasters |
| Open Elective | Principles of Automation | **At the end of this course, each student should be able to:**<br>**CO1:** Explain various reasons for employing automation in a manufacturing environment and describe various applications.<br>**CO2:** Describe the basic function of a sensor and an actuator in an automated system and give examples of both categories.<br>**CO3:** Select an appropriate sensor and/or actuator for a given automated application.<br>**CO4:** Describe the fundamentals of NC technology.<br>**CO5:** Use a Programmable Logic Controller (PLC) and embedded microcontroller, to perform specified control functions.<br>**CO6:** Describe the basic anatomy and attributes of an industrial robot.<br>**CO7:** Identify and distinguish the different components and interfaces in a Flexible Manufacturing System.<br>**CO8:** Troubleshoot a system and take appropriate action(s) to resolve the issue(s).<br>**CO9:** Design an automated system to meet defined operational specifications. |
| Open Elective | Artificial Neural Networks | **At the end of this course, each student should be able to:**<br>**CO1:** To understand artificial neural network models and their training algorithms |

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| | | **CO2:** To understand the concept of fuzzy logic system components, fuzzification and defuzzification<br>**CO3:** Applies the above concepts to real-world problems and applications. |
| Open Elective | Fundamentals of Nano Technology | **At the end of this course, each student should be able to:**<br>**CO1:** To understand the evolution of Nano systems, and various fabrication techniques.<br>**CO2:** Learn about nano materials and various nano measurements techniques. |
| Open Elective | Concurrent Engineering | **At the end of this course, each student should be able to:**<br>**CO1:** Understand the need of concurrent engineering and strategic approaches for product design.<br>**CO2:** Apply concurrent design principles to product design.<br>**CO3:** Design assembly workstation using concepts of simultaneous engineering.<br>**CO4:** Design automated fabricated systems – Case studies. |
| Open Elective | Mechanics of Composite Materials | **At the end of this course, each student should be able to:**<br>**CO1:** Understanding of types, manufacturing processes, and applications of composite materials.<br>**CO2:** Basic understanding of linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior.<br>**CO3:** Ability to analyze problems on macro and micro mechanical behavior of lamina<br>**CO4:** Ability to analyze problems on macro mechanical behavior of laminate<br>**CO5:** An ability to predict the loads and moments that cause an individual composite layer and a composite laminate to fail and to compute hygro thermal loads in composites.<br>**CO6:** An ability to compute the properties of a composite laminate with any stacking |

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| | | sequence. |
| Open Elective | Waste to Energy | **At the end of this course, each student should be able to:**<br>Understood and acquired fundamental knowledge on the science and engineering of energy technologies and systems. Acquired the expertise and skills required for energy auditing and management, economical calculation of energy cost, development, implementation, maintenance of energy systems. Become capable of analysis and design of energy conversion systems. Acquired skills in the scientific and technological communications and project preparation, planning and implementation of energy projects |
| Open Elective | Concurrent Engineering | **At the end of this course, each student should be able to:**<br>**CO1:** Understand the need of concurrent engineering and strategic approaches for product design.<br>**CO2:** Apply concurrent design principles to product design.<br>**CO3:** Design assembly workstation using concepts of simultaneous engineering.<br>**CO4:** Design automated fabricated systems – Case studies. |
| Open Elective | Principles of Automation | **At the end of this course, each student should be able to:**<br>**CO1:** Understand characteristics, and working principle of different types of Power electronic devices and their applications.<br>**CO2:** Analyse the various Triggering and Commutation methods of Thyristors.<br>**CO3:** Describe the working of Choppers, Inverters and cycloconverter circuits and their applications.<br>**CO4:** Select Thyristors circuits for various industrial / controlled applications.<br>**CO5:** Understand basic concepts of PLC and develop application programs.<br>**CO6:** Identify and interpret the functionality of DCS |

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| | | and various elements of SCADA. |
| Open Elective | Entrepreneurship | **At the end of this course, each student should be able to:**<br>**CO1:** To assess the commercial viability of a new technology-based idea. The candidate can use various methods and tools for this purpose.<br>**CO2:** To transform research-based ideas into feasibility and business plans. The candidate can use (tacit and explicit) methods and tools for this purpose.<br>**CO3:** To present new ideas to the market.<br>**CO4:** To assess the need for innovation, initiate the process and run innovations in organizations.<br>**CO5:** To seize opportunities, organize and finance viable initiatives through to fruition. |
| Open Elective | Optimization Techniques & Applications | **At the end of this course, each student should be able to:**<br>**CO1:** Apply appropriate optimization techniques and solve optimization problem like single variable or multivariable<br>**CO2:** Make sensitivity analysis to study effect of changes in parameters of LPP on the optimal solution without reworking.<br>**CO3:** Simulate the system to estimate specified performance measures.<br>**CO4:** Solve integer programming problem by either geometry cutting plane algorithm or branch band method.<br>**CO5:** Apply chance constrained algorithm and solve stochastic linear programme.<br>**CO6:** Formulate GP model and solve it.<br>**CO7:** Solve given optimization problem by genetic algorithm or simulated annealing or PSO. |
| Open Elective | Advanced Finite Element and Boundary Element Methods | **At the end of this course, each student should be able to:**<br>**CO1:** Understand the background of mathematical equations used for development of modeling software modules to develop the various structural related applications |

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| | | **CO2:** Identify mathematical model for solution of common engineering problems.<br>**CO3:** Solve structural, thermal, fluid flow problems.<br>**CO4:** Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer. |
| Open Elective | Fundamentals of Production Engineering | **At the end of this course, each student should be able to:**<br>**CO1:** Acquire fundamental knowledge and understanding of Production and Industrial Engineering.<br>**CO2:** Acquire abilities and capabilities in the areas of advanced manufacturing methods, quality assurance and shop floor management.<br>**CO3:** Formulate relevant research problems; conduct experimental and/or analytical work and analyzing results using modern mathematical and scientific methods.<br>**CO4:** Review and document the knowledge developed by scholarly predecessors and critically assess the relevant technological issues.<br>**CO5:** Design and validate technological solutions to defined problems and write clearly and effectively for the practical utilization of their work. |
| Open Elective | Testing & Evaluation | **At the end of this course, each student should be able to:**<br>**CO1:** Explain central concepts and issues in language testing, such as basic types of language tests (and their specific features).<br>**CO2:** Explain central concepts and issues in evaluation of language proficiency.<br>**CO3:** Understand the key principles of test construction and validation, and apply them in the development of a specific language test.<br>**CO4:** Administer a language test and analyse its results.<br>**CO5:** Appraise validity and reliability aspects of |

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| | | language testing. |
| Open Elective | Basics of Refrigeration Systems | **At the end of this course, each student should be able to:**<br>**CO1:** Illustrate the basic concepts of refrigeration system.<br>**CO2:** Analyze the vapour compression cycle and interpret the usage of refrigerants.<br>**CO3:** Explain the components of vapour absorption system.<br>**CO4:** Demonstrate the use of refrigerants.<br>**CO5:** Discuss the theory Ozone depletion potential and global warming potential. |
| Open Elective | Introduction to Thermal Storage Systems | **At the end of this course, each student should be able to:**<br>**CO1:** To be able to state the types-energy storage devices – comparison of energy storage technologies.<br>**CO2:** To be able to identify and describe Basic concepts and modeling of heat storage units – modeling of simple water and rock bed storage system.<br>**CO3:** To be able to explain at a level understandable by a non-technical person how various Parallel flow and counter flow regenerators.<br>**CO4:** To be able to calculate Modeling of phase change problems.<br>**CO5:** To be able to explain greenhouse heating – power plant applications – drying and heating for process industries. |
| Open Elective | Cogeneration & Waste Heat Recovery Systems | **At the end of this course, each student should be able to:**<br>**CO1:** Analyze the basic energy generation cycles<br>**CO2:** Do the economic analysis of waste heat recovery systems |
| Open Elective | Business Analytics | **At the end of this course, each student should be able to:**<br>**CO1:** Students will demonstrate knowledge of data analytics.<br>**CO2:** Students will demonstrate the ability of think critically in making decisions based on data |

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| | | and deep analytics.<br>**CO3:** Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.<br>**CO4:** Students will demonstrate the ability to translate data into clear, actionable insights. |
| Open Elective | Industrial Safety | **At the end of this course, each student should be able to:**<br>**CO1:** Know how to take safety measures in executing works<br>**CO2:** Identify the need for maintenance (or) replacement of equipment<br>**CO3:** Understand the need for periodic and preventive maintenance |
| Open Elective | Operations Research | **At the end of this course, each student should be able to:**<br>**CO1:** Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.<br>**CO2:** Students should able to apply the concept of non-linear programming<br>**CO3:** Students should able to carry out sensitivity analysis<br>**CO4:** Student should able to model the real-world problem and simulate it. |
| Open Elective | Cost Management of Engineering Projects | **At the end of this course, each student should be able to:**<br>**CO1:** Understand project characteristics and various stages of a project.<br>**CO2:** Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.<br>**CO3:** Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.<br>**CO4:** Apply the risk management plan and analyse the role of stakeholders.<br>**CO5:** Understand the contract management, Project |

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| | | Procurement, Service level Agreements and productivity.<br>**CO6:** Understand the How Subcontract Administration and Control are practiced in the Industry. |
| Open Elective | Composite Materials | **At the end of this course, each student should be able to:**<br>**CO1:** Explain the mechanical behavior of layered composites compared to isotropic materials.<br>**CO2:** Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.<br>**CO3:** Determine stresses and strains relation in composites materials. |
| Open Elective | Energy from Waste | **At the end of this course, each student should be able to:**<br>**CO1:** Apply the knowledge about the operations of Waste to Energy Plants. <br>**CO2:** Analyse the various aspects of Waste to Energy Management Systems. <br>**CO3:** Carry out Techno-economic feasibility for Waste to Energy Plants.<br>**CO4:** Apply the knowledge in planning and operations of Waste to Energy plants. |