Dr. B. C. Roy Engineering College, Durgapur

An Autonomous Institute
(approved by AICTE & affiliated to MAKAUT)

Programme Code: 016
Programme : B.Tech in Electrical Engineering
Year (Semester) : 3rd Year (5th Semester)

Sl. No.	Broad Category	Course Category	Course Type	Course Code	Course Name	Contact Hours/Week				Credits
						L	T	P	Total	
A. Theory										
1	ENGG	Major	PC	EE-501	Electrical Machines-II	3	0	0	3	3
2	ENGG	Major	PC	EE-502	Power System-I	3	0	0	3	3
3	ENGG	Major	PC	EE-503	Control System	3	0	0	3	3
4	ENGG	Major	PC	EE-504	Power Electronics	3	0	0	3	3
5	ENGG	Minor	PC	EE-505	Embedded Systems	3	0	0	3	3
6	ENGG	Minor	PC	EE-506	Artificial Intelligence & Machine Learning	3	0	0	3	3
TOTAL Theory						18	0	0	18	**18**
B. Practical/Sessional										
1	ENGG	Major	PC	EE-591	Electrical Machines-II Laboratory	0	0	2	2	1
2	ENGG	Major	PC	EE-592	Power System-I Laboratory	0	0	2	2	1
3	ENGG	Major	PC	EE-593	Control System Laboratory	0	0	2	2	1
4	ENGG	Major	PC	EE-594	Power Electronics Laboratory	0	0	2	2	1
5	ENGG	Minor	PC	EE-595	Embedded Systems Laboratory	0	0	2	2	1
6	ENGG	Minor	PC	EE-596	Artificial Intelligence & Machine Learning using Python Laboratory	0	0	2	2	1
TOTAL Practical/Sessional						0	0	12	12	**6**
Total of Semester						18	0	12	30	**24**

Dr. Shibendu Mahata
Chairman, BOS(EE)

ELECTRICAL MACHINE-II
Course Code: EE-501

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1. **Course Prerequisite:**
   1. Basic Electrical
   2. Electrical Circuit Theory
   3. Electrical Machine-I
   4. Electromagnetic Field Theory

2. **Course Learning Objectives:**

The course learning objectives (CLOs) for an Electrical Machines course typically cover the fundamental concepts, principles, analysis, and application of electrical machines in electrical engineering. Here are some typical course learning objectives for an Electrical Machines course:

1. Understand the Principles of Electrical Machines
2. Analyse the Operation of Induction Machines and Synchronous Machines
3. Understand the Concept of Power and Efficiency in Electrical Machines
4. Study of Starting, Speed Control, and Protection Techniques
5. Apply the Knowledge to Real-World Applications

3. **Course Name:** Electrical Machine-II
   Course Code: EE-501
   Hours per Week: 3
   Credits: 3
   Course Content:

Module	**Topics**		**40L**
Module 1	**Three Phase Alternator**	Synchronous Generator: Constructional Features of Salient Pole and Non-Salient Pole Machines, Arrangement of Field Winding in the two types of Machines. Armature Winding: Distribution factor and Pitch factor	5
		Cylindrical Rotor Theory: Phasor Diagram, Open Circuit and Short Circuit Characteristics, Synchronous Reactance, Load Characteristics, Zero Power Factor Characteristics, Voltage Regulation by different methods, Power Angle Characteristics, Capability Curve	5
		Salient-Pole Theory: Blondel's Two-Reaction Concept, Direct Axis and Quadrature Axis Synchronous Reactance, Power Angle Characteristics, Slip Test. Parallel Operation of generators.	4
Module 2	**Three phase Synchronous Motor**	Synchronous Motor: Constructional features, Phasor Diagram, Torque and Power Relations in Non-Salient Pole and Salient Pole Motors, V-Curves, Various Types of Excitations, Synchronous Condenser, Methods of Starting, Applications.	6
Module 3	**Three Phase Induction Motor**	Three Phase Induction Motor: Constructional Features of Slip Ring and Squirrel Cage Type Motors, Principle of Operation, Flux and MMF Wave, No-Load Speed and Slip, Rotor Quantities Referred to Stator, Relationship Between Input Voltage and Current, Equivalent Circuit, Analysis of Equivalent Circuit.	6
		Torque Speed Characteristics, Starting, Maximum and Full Load Torque, Condition for Maximum Torque, Regions of Stable and Unstable Operations, Effect of rotor resistance and supply frequency on Speed Torque Characteristics, Losses, Efficiency, Performance Characteristics, The Circle Diagram, Starting of Slip Ring and Squirrel Cage Motors, High Starting Torque Motors. Speed Control: Various methods.	6
Module 4	**Single phase**	Single phase induction motor: Constructional features,	4

	induction motor	various types, Double revolving field theory, Determination of Equivalent circuit parameters, Determination of constants, Various starting type IM (Split phase, Shaded pole), Applications.	
Module 5	**Fractional kW Motors**	Hysteresis Motor, Servo Motor, Universal motor, BLDC motor	4

4. Text Books:

T1. A. S. Langsdorf, Theory of A. C. Machines, Tata McGraw Hill.
T2. Dr P S Bimbhra, Electrical Machinery
T3. Dr P S Bimbhra, Generalized Theory of Electrical Machines

5. Reference Books:

R1. I. L. Kosow, Electric Machinery & Transformers, PHI.
R2. E. Fitzgerald, C.M. Kingsley (Jr) and S. D. Umans, Electric Machinery, Tata McGraw Hill
R3. M.G Say, Electrical Machine

6. Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Ability to understand the construction of synchronous machine.	Design	Understand
CO2	Ability to determine alternator voltage regulation	Determine	Understand, Analyse
CO3	Ability to Synchronize an alternator with infinite bus	Understand	Understand, Apply
CO4	Ability to understand starting methodology and determine the variation of synchronous machine performance with excitation	Determine	Understand, Apply, Analyse
CO5	Ability to assess performance of an induction motor based on appropriate experimentation	Analysis	Analyse
CO6	Ability to start an induction and fractional motors by appropriate means & controlling its speed in effective way	Implement	Evaluate

7. Mapping of course outcomes to module / course contents.

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	3	3	3	-	-
2	3	3	-	3	-	-
3	-	-	-	-	3	3
4	-	-	-	-	3	3
5	-	-	-	-	3	3

8. Mapping of the Course outcomes to Program Outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	2	1	-	-	-	-	-	-	1
CO2	2	3	2	2	-	-	-	-	-	-	1
CO3	3	3	3	3	-	-	-	-	-	-	1
CO4	3	3	3	3	-	-	-	-	-	-	1
CO5	2	3	3	3	-	-	-	-	-	-	1
CO6	3	3	3	3	-	-	-	-	-	-	1

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	1
CO2	3	3	-	1
CO3	3	3	-	1
CO4	3	2	-	1
CO5	3	3	-	1
CO6	3	3	-	1

POWER SYSTEM-I

Course Code: EE -502

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1. **Course Pre-requisites:**
   1. Basic Electrical Engineering
   2. Network Theory
   3. Electromagnetic Field Theory

2. **Course Learning Objectives:**
   The course aims to provide students with a comprehensive understanding of the structure and evolution of power systems, covering both conventional and renewable methods of generation. It introduces the fundamental concepts of transmission line parameters, corona, insulators, and cables, along with their practical significance. Students will also learn to analyze the performance of short, medium, and long transmission lines using suitable models and constants. Additionally, the course develops knowledge of travelling wave phenomena and tariff principles, enabling learners to relate technical aspects with real-world power system planning and operation.

   Course Name: POWER SYSTEM-I
   Course Code: EE-502
   Hours per Week: 3
   Credits: 3

   Course Contents:

Module	Topics	36L
1.	**Basic Concepts:** Evolution of Power System and present-day Scenario. Structure of power system: Bulk power grid and Micro Grid. **Generation of Electric Power:** General layout of a typical coal fired power station, Hydroelectric power station, Nuclear power station, their components and working principles, comparison of different methods of power generation. Introduction to Solar & Wind energy system. **Indian Electricity Rule-1956:** General Introduction.	6
2.	**Overhead transmission line:** Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phase symmetrical and unsymmetrical configurations. Bundle conductors. Transposition. Concept of GMD and GMR. Influence of earth on conductor capacitance. **Overhead line construction:** Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag. Dampers. **Corona:** Principle of Corona formation, Critical disruptive voltage, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.	8
3.	**Insulators:** Types, Voltage distribution, String efficiency, Arching shield & rings, Methods of improving voltage distribution, Selection of insulation, Wood poles, Concrete poles, Supporting towers, Vibration of conductors, Effect of vibration on the transmission line.	5
4.	**Cables:** Types of cables, Cable construction, Dielectric stress, Most economical size of cable, Grading of cables, Limitations of grading, Cable capacitance, Charging current, Capacitances in a 3 core belted cable, Insulation resistance, Dielectric loss, Skin effect, Proximity effect, Current rating of cables.	4
5.	**Performance of lines:** Short, medium and long lines and their representation. ABCD constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams. Travelling Waves: Introduction, Characteristics impedance, Velocity of travelling waves, Reflection of waves, Refraction of waves, Open circuited line, Short circuited line, Junction of two dissimilar lines, Effect of cable on surge, Junction of several lines, Repeated reflections.	10
6.	**Tariff:** Guiding principle of Tariff, different types of tariff.	03

3. **Text Books:**
   T1: Electrical Power System, Subir Roy, Prentice Hall
   T2: Power System Engineering, Nagrath & Kothery, TMH

T3: Elements of power system analysis, C.L. Wodhwa, New Age International.
T4: Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors.

4. **References:**
R1: Electric Power transmission & Distribution, S.Sivanagaraju, S.Satyanarayana, Pearson Education.
R2: A Text book on Power system Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.
R3: Electric Power distribution system Engineering, 2nd Edition, T. Gonen, CRC Press.

5. **Course Outcomes:**

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	To understand the basic principle of generation of electricity from different sources.	Define, Explain	Remember, Understand
CO2	To find parameters and characteristics of overhead transmission lines and cables.	Analyze, Design	Analyze, Create
CO3	To find different parameters for the construction of overhead transmission line.	Evaluate, Develop	Evaluate, Create
CO4	To determine the performance of transmission lines and travelling waves.	Design, Implement	Create, Apply
CO5	To understand the principle tariff calculation.	Analyze, Solve	Analyze, Apply
CO6	To solve numerical problems on the topics studied.	Design, Implement	Evaluate, Create

6. **Mapping of course outcomes to module/course content:**

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	1	-	-
2	1	3	-	-	-	-
3	1	1	3	-	-	-
4	-	-	1	3	-	1
5	-	-	-	-	3	-
6	-	-	-	-	-	3

7. **Mapping of CO to PO:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	1	1	2	2	-	-	1	-	1
CO2	3	3	1	1	2	2	-	-	1	-	1
CO3	3	3	1	1	2	2	-	-	1	-	1
CO4	3	3	1	1	2	2	-	-	1	-	1
CO5	3	3	1	1	2	2	-	-	1	-	1
CO6	3	3	1	1	2	2	-	-	1	-	1

8. **Mapping to PSO:**

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2
CO2	3	3	1	1
CO3	3	-	1	1
CO4	3	-	2	1
CO5	3	2	-	2
CO6	3	2	-	1

Control Systems-I

Course Code: EE503

1. **Course Pre-requisite:**
   Mathematics
   Circuit Theory
   Electrical Machines

2. **Course Learning Objectives:**

   The primary learning objective of a "Control Systems" course is to equip students with the knowledge and skills to analyze, model, and design control systems for dynamic systems, including understanding concepts like feedback loops, stability analysis, transfer functions, and controller design, allowing them to optimize system performance based on desired specification.

3. **Course Name: Control Systems -1**
   Course Code: EE 503
   Hours per Week: 3
   Credits: 3

   Course Content:

Module	Topics	36L
1.	**Introduction:** Elementary concepts of control systems, Open and closed loop control systems with practical example. Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness.	02
2.	**Mathematical Models of Physical Systems:** Mathematical Models of Physical Systems: Modeling of electrical networks, Modeling of mechanical system elements; Concepts of poles and zeros, types& order of systems etc, block diagram algebra and reduction techniques, Signal flow graph.	06
3.	**Time Domain Analysis:** Introduction; Standard test signals – Impulse, Step and Ramp Inputs; Time-response of first and second order systems; Steady state errors and error-constants; Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Effects of Pole and Zeros on transient response.	08
4.	**Concepts of Stability:** Concept of stability – ZI and BIBO stability, Stability by pole location., Routh-Hurwitz criteria and applications. The Root Locus Technique: basic concept; Construction of Root Loci; Root Contours–Examples	06
5.	**Frequency Response Analysis:**	

	Frequency Response Analysis and Stability Studies in Frequency Domain: Frequency domain specifications, correlation between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability. Nichols chart, Concept of resonance frequency of peak magnification.	**08**
6.	**Control System performance measure:** Preliminary considerations of classical Design, Realization of Basic compensator, closed loop control using: P, P-I and P-I-D controllers. Examples. Tuning of PID controller by Z N method.	**04**
7.	**Practical Control Systems:** Components of a practical control system–sensors, controllers, actuators.	**02**

4. TextBooks:

T1. Norman S. Nise, "Control Systems Engineering," – Fifth Edition, Wiley India, 2009.
T2. M. Gopal, "Control Systems–Principles and Design,", Fourth Edition, McGraw Hill Education (India)–2012.
T3. I.J. Nagrath, M. Gopal, "Control Systems Engineering", Third Edition, New Age International–2000.
T4. B.C. Kuo, "Automatic Control Systems,"–Seventh Edition, Prentice Hall India–2000.
T5. Katsuhiko Ogata, "Modern Control Engineering,", Third Edition, Prentice Hall India–2000.

5. References:

R1: Textbook of Control System Engineering, Dr. K. Karthika Dr. Aaron Kevin Cameron Theoderaj, SIP Publisher.
R2: Handbook of Control Systems Engineering, Charles S. Singer, Oxford Book Company.
R3: A First Course in Control System Design, Iqbal Kamran, River Publishers

6. Course Out-comes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	To get the knowledge of basic objectives of control system design	Understand Remember	Remember
CO2	To derive input-out put relationship of systems based on their mathematical modeling governed by basic law of physics	Analyze	Apply, Analyze
CO3	To justify stability of systems based on their transfer functions, time domain and frequency domain specifications	Identify	Apply
CO4	To develop concepts on root pattern with variable gains and comment on the stability	Analyze	Apply, Analyze
CO5	To determine the stability of closed-loop system based on open loop frequency response	Implement	Analyze
CO6	To be able to design controllers ostomies design specifications both in time as well as frequency domain	Implement	Evaluate

7. Mapping of course out comes to module/course content:

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	2	3	-	-	-	-
3	2	-	3	-	-	-
4	2	-	3	-	-	-
5	2	-	3	3	-	-
6	2	2	-	-	2	3
7	2	3	-	-		2

8. Mapping of CO to PO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	-	-	1	-	-	-	-	1
CO2	3	3	3	2	2	1	-	-	-	-	1
CO3	3	3	3	3	2	2	-	-	-	-	1
CO4	3	3	3	3	2	1	-	-	-	-	1
CO5	3	3	3	3	2	1	-	-	-	1	1
CO6	3	3	3	2	2	2	-	1	-	-	1

9. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	1	2
CO3	3	2	1	2
CO4	3	2	1	1
CO5	3	2	1	2
CO6	3	3	1	2

POWER ELECTRONICS

Course Code: EE-504

1. Course Prerequisite:

1. Network Theory
2. Analog Electronics
3. Electromagnetic Field Theory
4. Digital Electronics

2. Course Learning Objectives:

This course is designed to introduce students to power electronic devices, converters, and their applications in electrical engineering. The course covers fundamental concepts of power electronics, operation of various power electronic devices, design and analysis of converters, and their industrial applications. Focus areas include thyristor operation, AC/DC converters, DC-DC converters, inverters, and resonant converters.

3. Course Name: Power Electronics

Course Code: EE-504
Hours per Week: 3
Credits: 3

Course Content:

Module	Topics	40L
1.	**Introduction**: Concept of power electronics and application of power electronics devices, ideal and practical characteristics of semiconductor switches, losses of switches, power diodes, power transistors, power MOSFETS, IGBT and GTO.	**04**
2.	**PNPN devices**: Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.	**05**

3.	**Phase controlled converters**: Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of free-wheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters.	**06**
4.	**DC-DC converters**: Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers.	**05**
5.	**Inverters**: Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control using PWM technique and harmonic reduction strategies. Introduction to current source inverter (CSI), types, advantage, disadvantage and application areas of CSI.	**10**
6.	**Resonant Pulse Converters**: Introduction, Series Resonant inverter, Parallel Resonant inverter, Zero-Current Switching Resonant converters, Zero-Voltage Switching Resonant converter, Two quadrant Zero-Voltage Switching Resonant converter, Resonant DC link inverter.	**05**
7.	**Applications**: Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS, static VAR controller	**05**

4. Text Books:

T1. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata McGraw-Hill Publishing Company Ltd. 2007
T2. Power Electronics, V.R. Moorthi, Oxford, 2005
T3. Power Electronics, M.H. Rashid, PHI, 3rd Edition
T4. Power Electronics, P.S. Bhimra, Khanna Publishers, 3rd Edition

5. Reference Books:

R1. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall
R2. Power Electronics, Mohan, Undeland & Riobbins, Wiley India
R3. Element of power Electronics, Phillip T Krein, Oxford, 2007
R4. Power Electronics systems, J.P. Agarwal, Pearson Education, 2006
R5. Power Electronics, M.S. Jamal Asgha, PHI, 2007
R6. Analysis of Thyristor power conditioned motor, S.K. Pillai, University Press
R7. Power Electronics: Principles and applications, J.M. Jacob, Thomson

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Define and explain the characteristics and operation of power electronic devices and switching components	Define, Explain	Remember, Understand
CO2	Analyze and design different types of power electronic converters and their control circuits	Analyze , Design	Analyze, Create
CO3	Evaluate the performance parameters of various power electronic converters and develop solutions for power factor improvement	Evaluate, Develop	Evaluate, Create
CO4	Design and implement different control strategies for DC-DC converters and inverters	Design, Implement	Create, Apply
CO5	Analyze and solve problems related to resonant pulse converters and their applications	Analyze, Solve	Analyze, Apply
CO6	Apply power electronic concepts to real-world applications in motor control, HVDC transmission, and power systems	Apply	Apply

7. Mapping of course outcomes to module/course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	3	2	-	-	-	-
3	2	3	3	-	-	-
4	-	3	2	3	-	-
5	-	3	2	3	-	-
6	-	2	-	2	3	-
7	-	2	2	2	2	3

8. Mapping of the Course outcomes to Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	2	2	1	1	-	1	1	2
CO2	3	3	3	2	3	1	1	1	2	2	2
CO3	3	3	3	3	3	2	1	1	2	2	2
CO4	3	3	3	2	3	2	1	2	2	2	2
CO5	3	3	2	3	3	1	1	1	1	2	2
CO6	3	2	2	2	2	3	2	1	2	2	3

9. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	1	2
CO3	3	2	2	2
CO4	3	3	1	2
CO5	3	2	1	2
CO6	3	3	3	2

EMBEDDED SYSTEMS

Course Code: EE-505

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1. **Course Pre-requisites:**
   1. Programming for problem solving
   2. Microprocessor & Microcontroller

2. **Course Learning Objectives:**
   The objectives of studying embedded systems are to understand the fundamental principles of designing and implementing embedded hardware and software. This includes gaining insight into how firmware and operating systems interact with hardware, ensuring efficient and reliable system performance. Students will explore resource management, real-time processing, and optimization techniques to design systems that meet specific functional and operational requirements. The goal is to equip learners with the skills needed to create robust embedded systems used in various applications across industries.

3. **Course Name:** EMBEDDED SYSTEMS
   Course Code: EE-505
   Hours per Week: 3
   Credits: 3
   Course Content:

Module	Topics	40L
1.	**Introduction to Embedded Systems:** Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	2
2.	**Typical Embedded System:** Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Interfacing techniques, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: On-board and External Communication Interfaces.	4

Module	Topics	40L
3.	**Advanced Embedded Microcontroller AVR:** Introduction to AVR microcontroller: Introduction to AVR ATMEGA microcontroller, pin layout, architecture, program memory, Data Direction register, Port Registers (PORTx), PWM registers(8-bit), ADC registers; Assembly and Embedded C programming; Timers/Counters, Interrupts, Serial Communication; LCD and Keyboard interfacing; ADC, DAC and Sensor interfacing; Relay, opto-isolator and stepper motor interfacing; PWM programming and DC motor control; SPI protocol and MAX7221 display interfacing; I2C protocol and DS1307 RTC interfacing.	17
4.	**Embedded Firmware:** Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	5
5.	**RTOS Based Embedded System Design:** Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.	7
6.	**Introduction to ARM microcontroller**: Architecture of ARM Embedded microcontroller, ARM instruction sets.	5

4. Text Books:

T1: The AVR Microcontroller and Embedded Systems, M.A. Mazidi, S. Naimi, S. Naimi, Prentice Hall.

T2: Introduction to Embedded Systems, Shibu K.V, McGraw Hill. 2017.

5. Reference books:

R1. Embedded Systems– Architecture, Programming and design, Raj Kamal, McGraw Hill Education, 2017

R2. Embedded System Design: A unified Hardware/ Software introduction, Tony Givargis and Frank Vahid, Wiley 2006

R3. Microcontrollers (Theory and Applications)– A. V. Deshmukh, TMH Education Private Limited, 2017

R4. Programming and Customizing the AVR Microcontroller, Dhananjay Gadre, McGraw Hill Education, 2014.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	To discuss the definition, purpose, application, classification, quality characteristics and attributes of Embedded Systems.	Identify, Select	Understand, Remember
CO2	To explain the internal structure of the Embedded system.	Identify, Select	Understand, Apply, Analyze
CO3	To interface IO devices and other peripherals with micro controllers in Embedded systems.	Identify, Select, Implement	Understand, Apply

CO4	To write programs for Microcontrollers in Embedded systems.	Analyze	Understand, Apply, Analyze
CO5	To apply the concept of Embedded firmware in design of Embedded systems.	Identify, Analyze	Analyze
CO6	To design RTOS based Embedded systems.	Implement	Evaluate

7. Mapping of course outcomes to module / course content:

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	2	3	-	-	-	-
3	2	1	3	-	-	-
4	1	1	3	2	-	-
5	1	2	3	3	3	3
6	-	2	2	-	-	-

8. Mapping of the Course outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	1	-	-	-	-	-	**2**
CO2	3	2	1	1	2	-	-	-	-	-	**2**
CO3	3	2	3	2	3	-	-	-	-	-	**2**
CO4	3	3	2	2	3	-	-	-	-	-	**3**
CO5	3	3	3	2	3	-	-	-	-	-	**3**
CO6	3	3	3	3	3	-	-	-	-	-	**3**

9. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	1	2
CO3	3	2	1	2
CO4	3	2	1	1
CO5	3	2	1	2
CO6	3	3	1	2

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Course Code: EE-506

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1. **Course Pre-requisites:**
   Programming for Problem Solving
   Mathematics-I, II, III

2. **Course Learning Objectives:**

   By the end of this course, students will be able to:

1. Understand the foundations of Artificial Intelligence, including intelligent agents, search algorithms, and knowledge representation.
2. Apply machine learning techniques for solving classification, regression, and clustering problems.
3. Develop models using supervised and unsupervised learning and evaluate their performance.
4. Understand neural networks and deep learning principles and their applications in engineering domains.
5. Explore practical applications of AI & ML in control systems, power systems, and electrical engineering problems.

3. **Course Name: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**
   Course Code: EE-506
   Hours per Week: 3
   Credits: 3
   Course Contents:

Module	Topics	36L
1.	**Introduction to AI and Problem Solving** What is AI? History, Applications in Electrical Engineering, Intelligent Agents: Types of agents, Environments, Problem Formulation: State space, Search problems, Search Strategies: Uninformed search (DFS, BFS), Informed search (Greedy, A*), Constraint Satisfaction Problems	**07**
2.	**Knowledge Representation & Reasoning** Knowledge Representation: Propositional and Predicate Logic, Inference Techniques: Forward & Backward chaining, Uncertainty Handling: Bayesian reasoning, Probability models, Introduction to Expert Systems	**06**
3.	**Machine Learning Fundamentals** ML Basics: Supervised vs. Unsupervised Learning, Supervised Learning: Regression (Linear & Logistic), Classification (Decision Trees, SVM, etc.), Unsupervised Learning: Clustering (K-Means, Hierarchical, etc.), Evaluation Metrics: Accuracy, Precision, Recall, F1-score, ROC, Feature Selection & Dimensionality Reduction (PCA), Case studies	**09**

Module	Topics	36L
4.	**Neural Networks & Deep Learning** Perceptron Model, Multilayer Perceptron (MLP), Backpropagation Algorithm, Activation Functions (Sigmoid, ReLU, Tanh), Introduction to Deep Learning: Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN)	**08**
5.	**AI & ML Applications** Case studies (fault monitoring, etc.)	**06**

4. Text Books:

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.

2. Tom Mitchell, *Machine Learning*, McGraw-Hill.

3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press.

4. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press.

5. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, O'Reilly.

5. References:

Research papers on AI/ML.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Explain fundamental concepts of AI, intelligent agents, and search strategies.	Explain	Remember, Understand
CO2	Apply knowledge representation and reasoning techniques for solving engineering problems.	Apply	Apply
CO3	Implement machine learning models for classification and clustering tasks.	Implement	Apply, Analyze
CO4	Analyze neural network architectures and their applications in EE.	Analyze	Analyze
CO5	Design and develop AI/ML solutions for real-world EE problems	Design	Evaluate, Create

6. Mapping of course outcomes to module / course content:

Module	CO1	CO2	CO3	CO4	CO5
1	3	-	-	-	-
2	-	3	-	-	-
3	-	-	3	-	-
4	-	-	-	3	-
5	-	-	-	-	3

7. Mapping of the Course outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	-	2	-	-	-	-	-	2
CO2	3	1	1	-	2	-	-	-	-	-	2
CO3	3	1	1	1	2	-	-	-	-	-	2
CO4	2	1	1	1	2	-	-	-	-	-	2
CO5	2	1	1	1	2	-	-	-	-	-	2

8. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-
CO2	3	3	-	-
CO3	3	3	-	-
CO4	3	3	-	-
CO5	3	3	-	-
CO6	3	3	-	-

Electrical Machine-II Laboratory
Course Code: EE-591

1. **Course Prerequisite:**
   1. Basic Electrical Engineering 2. Field Theory 3. Electric Machine I

2. **Course Learning Objectives:**
   The goal of the Electrical Machine -II Laboratory is to give students knowledge and practical experience for different motors using different experiments. The different characteristics of 3 phase, single phase Induction motor, alternator and synchronous motor are performed to gather knowledge on different machines. Performances and speed control there are regarded as important learning topics in this lab.

3. **Course Name: Electrical Machine II Laboratory**
   Course Code: EE-591
   Hours per Week: 2
   Credits: 1
   Course Content:

Exp. No.	Laboratory Experiments
1.	Study of equivalent circuit parameters and iron-loss with friction & windage loss of three phase Induction motor by no load and blocked rotor test.
2.	Different methods of starting of a 3 phase Cage Induction Motor & their comparison [DOL, Auto transformer &Star-Delta]
3.	Study of performance of wound rotor Induction motor under load.
4.	Speed control of 3 phase squirrel cage induction motor by changing voltage.
5.	Speed control of 3 phase slip ring Induction motor by rotor resistance control
6.	Load test on 3 phase wound rotor Induction motor to obtain the performance characteristics
7.	Load test on single phase Induction motor to obtain the performance characteristics.
8.	Determination of equivalent circuit parameters of a single-phase Induction motor.
9.	Determination of regulation of Synchronous machine by a. Potier reactance method. b. Synchronous Impedance method.
10.	V-curve of Synchronous motor
11	To determine the direct axis resistance [Xd] & quadrature reactance [Xq] of a 3-phase synchronous machine by slip test.
12.	Parallel operation of 3 phase Synchronous generators.

4. **Text Books:**

T1. Electrical Machine II: P.S Bimbhra (Khanna Publication)
T2. Electrical Machine : Ashfaq Hussain (Dhanpat Publication)

T3. Electrical Machine : J. B Gupta (Katson Publisher)
T4. Electrical Machine: Kothari & Nagrath (Mcgrawhill)

5. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Identify appropriate equipment and instruments for the experiment.	Identify	Understand,
CO2	Test the instrument for application to the experiment.	Testing	Application
CO3	Construct circuits with appropriate instruments and safety precautions	Construction	Understand, Apply
CO4	Validate different characteristics of single phase Induction motor, three phase Induction motor, Induction generator and methods of speed control of Induction motors and	Analysis	Understand, Analysis
CO5	Validate different characteristics of synchronous motor and parallel operation of the 3 phase Synchronous generator.	Analysis	Understand, Analysis

6. Mapping of course outcomes to module / course content:

Exp. No	CO1	CO2	CO3	CO4	CO5
1	3	1	-	-	-
2	1	2	3	-	-
3	1	2	3	-	-
4	1	2	3	-	-
5	1	2	-	3	-
6	1	2	-	-	3
7	1	2	-	-	3
8	1	2	-	3	-
9	1	2	-	3	-
10	1	2	-	3	-
11	1	2	-	3	-
12	1	2	-	3	-

7. Mapping of the Course outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	-	-	-	-	-	-	1
CO2	3	3	2	2	-	-	-	-	-	-	1
CO3	3	3	2	2	-	-	-	-	-	-	1
CO4	3	3	2	2	-	-	-	-	-	-	1
CO5	3	3	2	2	-	-	-	-	-	-	1

8. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	-	1	1
CO2	3	-	1	1
CO3	3	-	1	1
CO4	3	-	1	1
CO5	3	-	1	1

POWER SYSTEM-I LABORATORY

Course Code: EE-592

1. **Course Pre-requisites:**
   1. Basic Electrical Engineering
   2. Network Theory
   3. Power System-I

2. **Course Learning Objectives:**
   The course aims to help students understand the structure and operation of electric power systems, analyze generation, transmission, and distribution components, apply engineering principles for performance evaluation, interpret system diagrams, and assess reliability, stability, and efficiency considering economic and environmental aspects.

3. **Course Name: POWER SYSTEM-I LABORATORY**
   Course Code: EE-592
   Hours per Week: 2
   Credits: 1

   Course Contents:

Module	Topics	20L
1.	Determination of the generalized constants A.B, C, D of long transmission line and regulation of a 3-Φ transmission line model.	02
2.	Demonstration of different types of insulator.	02
3	Demonstration of different types of cables.	02
4.	Measurement of earth resistance by earth tester.	02
5.	Determination of dielectric strength of insulating oil.	02
6.	Determination of breakdown strength of solid insulating material	02
7.	Determination of parameter of 3-Φ transmission line model by power circle diagram .	02
8.	Study of 2-wire D. C distribution system by MULTISIM.	03
9.	Study of 3-wire D. C distribution system by MULTISIM.	03
10.	Determination of dielectric constant, tan delta, resistivity of transformer oil.	02

4. Text Books:

T1: Electrical Power System, Subir Roy, Prentice Hall
T2: Power System Engineering, Nagrath & Kothery, TMH

5. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Understand and analyze the electrical characteristics of transmission lines using ABCD parameters and power circle diagrams	Analyze, Calculate,	Remember, Understand
CO2	Identify and evaluate various cables, insulators and insulating materials based on their electrical properties and breakdown strengths.	Identify, Evaluate	Analyze, Create
CO3	Measure and assess earth resistance and grounding effectiveness using practical testing techniques.	Measure, Assess	Evaluate, Create
CO4	Determine the dielectric properties of transformer oil and solid insulating materials, including dielectric strength, resistivity, and loss tangent (tan δ).	Determine, Calculate	Create, Apply
CO5	Simulate and analyze D.C. distribution systems (2-wire and 3-wire) using circuit simulation tools like MULTISIM.	Simulate, Analyze	Analyze, Apply

6. Mapping of course outcomes to module/course content:

Module	CO1	CO2	CO3	CO4	CO5
1	3	-	-	1	-
2	3	3	-	-	-
3	-	-	3	-	-
4	-	-	-	3	-
5	-	3	-	3	-
6	3	-	-	-	-
7	-	-	-	-	3
8	-	-	-	-	3
9	-	-	-	3	-
10	-	-	-	-	3

7. Mapping of CO to PO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	1	1	2	2	-	-	1	-	1
CO2	3	3	1	1	2	2	-	-	1	-	1
CO3	3	3	1	1	2	2	-	-	1	-	1
CO4	3	3	1	1	2	2	-	-	1	-	1
CO5	3	3	1	1	2	2	-	-	1	-	1

8. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2
CO2	3	3	1	1
CO3	3	-	1	1
CO4	3	-	2	1
CO5	3	2	-	2

Control System Laboratory

Course Code: EE-593

1. **Course Prerequisite:**
   1. Control System
   2. Mathematics

2. **Course Learning Objectives:**
   The Control System Laboratory aims to provide students with practical knowledge and hands- on experience in analyzing, designing, and implementing control systems. The key learning objectives includes Understanding System Response, Stability Analysis, Control System Implementation, Simulation and Modeling, Practical Applications, Hands-on Hardware Experience, Design and Performance Evaluation.

3. **Course Name**: Control System Laboratory
   Course Code:EE593
   Hours per Week: 2
   Credits: 1
   Course Content:

Module	Content
1.	Familiarization with MATLAB control system tool box, MATLAB-Simulink tool box.
2.	Simulation of Step response for first order & Second order system with unity feedback with & calculation of control system specification, Time constant, % peak overshoot, settling time etc. using MATLAB.
3.	Determination of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB and Linear System Simulator. (Hardware Model)
4.	Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system tool box for a given system and stability by determining control system specification from the plot.
5.	Study of Real time Position and Speed Control of DC Servo Motor.
6.	Study of Real time tuning of PID controller.
7.	Microprocessor based Stepper Motor control.
8.	Study of control of a Magnetic Levitation system.
9.	Analysis of performance of Lead, Lag and Lead-Lag compensation circuits for a given system using simulation.

4. Text Books:

i. Norman S. Nise, "Control Systems Engineering,"–Fifth Edition, Wiley India–2009.

ii. M. Gopal, "Control Systems–Principles and Design," –Fourth Edition, McGraw Hill Education (India)–2012.

iii. I.J. Nagrath and M. Gopal, "Control Systems Engineering,"–Third Edition, New Age International– 2000.

iv. B.C. Kuo, "Automatic Control Systems,"–Seventh Edition, Prentice Hall India–2000. 5. Katsuhiko Ogata, "Modern Control Engineering,"–Third Edition, Prentice Hall India–2000.

5. Course Outcomes:

Course Outcomes	**Details/Statement**	**Action Verb**	**Knowledge Level**
CO1	Use MATLAB for identifying response of different systems with different inputs	Identify, Apply	Understand, Remember
CO2	Analyzing stability of the system following different methods using simulation.	Identify, Select	Understand, Apply, Analyze
CO3	Familiarize with practical control systems	Identify, Analyze	Understand, Apply
CO4	Tuning and implementation of controller	Analyze, Understand	Understand, Apply, Analyze
CO5	Familiarize with modern trend of control systems	Identify, Understand	Apply
CO6	Construct circuits with appropriate instruments and safety precautions. Work effectively in a team	Identify, Apply	Understanding, Apply

6. Mapping of course outcomes to module / course content:

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	3		-	-	-	-
3	3	-	-	-	-	-
4	2	3	-	-	-	-
5	2	-	3	-	-	1
6	2	-	2	3	-	1
7	1	-	2	-	3	1
8	2	-	1	-	3	1
9	2	-	1	3	-	2

7. Mapping of the Course outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	-	-	1	-	-	-	-	1
CO2	3	3	3	2	2	1	1	-	-	-	1
CO3	3	3	3	3	2	2	1	-	-	-	1
CO4	3	3	3	3	2	1	1	-	-	-	1
CO5	3	3	3	3	2	1	1	-	-	-	1
CO6	1	2	3	-	2	2	1	-	-	-	-

8. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	1	2
CO3	3	2	1	2
CO4	3	2	1	1
CO5	3	2	1	2
C06	1	1	2	2

Power Electronics Lab
Course Code: EE-594

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1. Course Prerequisite:

1. Network Theory Lab
2. Analog Electronics Lab
3. Digital Electronics Lab

2. Course Learning Objectives:

This course is designed to provide hands-on experience with power electronic devices, circuits, and systems through laboratory experiments. Students will learn to identify, test, and construct various power electronic circuits, validate their characteristics, and understand their practical applications in motor control and power systems. The course emphasizes both hardware implementation and software simulation of power electronic circuits.

3. Course Name: Power Electronics Lab
Course Code: EE-594
Hours per Week: 2
Credits: 1
Course Content:

Exp. No	Type: Hardware/Software	Topics
1	Hardware	Study of different triggering circuits of an SCR
2	Hardware	Study of firing circuits suitable for triggering SCR in a single phase full controlled bridge (R, RC, UJT)
3	Software	Study of performance of PWM bridge inverter using MOSFET as switch with R and R-L load
4	Software	Study of performance of single phase controlled converter with and without source inductance (simulation)
5	Hardware	Study of performance of single-phase half controlled symmetrical and asymmetrical bridge converter
6	Software	Study of performance of single-phase half controlled symmetrical and asymmetrical bridge converters
7	Hardware	Study of performance of step down chopper with R and R-L load
8	Software	Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation)
9	Software	Study of performance of three phase controlled converter with R & R-L load
10	Hardware	Study of the characteristics of a Triac
11	Hardware	Study of the characteristics of an SCR

12	Hardware	Study of the operation of a single phase full controlled bridge converter with R and R-L load
13	Software	Study of impact of switching frequency in DC-DC converter performance
14	Hardware	Study the speed control of universal motor to plot speed v/s α
15	Software	Study of Zero Voltage Switching Resonant converter and Zero Current Switching Resonant Converter and to plot its output waveforms

4. Text Books:

T1. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata McGraw-Hill Publishing Company Ltd. 2007
T2. Power Electronics, V.R. Moorthi, Oxford, 2005
T3. Power Electronics, M.H. Rashid, PHI, 3rd Edition
T4. Power Electronics, P.S. Bhimra, Khanna Publishers, 3rd Edition

5. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Identify appropriate equipment and instruments for the experiment	Identify	Remember
CO2	Test the instrument for application to the experiment	Test	Apply
CO3	Construct circuits with appropriate instruments and safety precautions	Construct	Apply
CO4	Validate characteristics of SCR, Triac, and performance of phase controlled converter, DC-DC converter, inverters, and resonant pulse converters	Validate	Analyze, Evaluate
CO5	Demonstrate the relation between the speed and firing angle of the Universal motor	Demonstrate	Understand, Analyze

6. Mapping of course outcomes to unit / course content

Exp. no	CO1	CO2	CO3	CO4	CO5
1-2	3	3	3	-	-
3-4	3	3	3	3	-
5-6	3	3	3	3	-
7-9	3	3	3	3	-
10-12	3	3	3	3	-
13-14	3	3	3	3	3
15	3	3	3	3	-

7. Mapping of the Course outcomes to Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	1	1	-	2	2	1
CO2	3	3	3	3	3	1	1	-	2	2	2
CO3	3	3	3	3	3	2	2	1	2	2	2
CO4	3	3	3	3	3	2	2	1	3	2	2
CO5	3	3	3	3	2	1	1	-	2	2	2

8. Mapping to PSO:

Course Outcomes	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	3	2
CO5	3	2	2	2

EMBEDDED SYSTEMS LAB
Course Code: EE-595

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1. **Course Pre-requisites:**
   1. Digital Electronics Lab
   2. Microprocessor and Microcontroller Lab

2. **Course Learning Objectives:**

   This course enables students to develop foundational skills in AVR microcontroller programming through hands-on interfacing experiments. Learners will configure GPIO for digital input/output operations, implement time delays using software and hardware timers, and generate PWM signals for brightness or speed control. The course covers analog signal acquisition using ADC, data communication using USART, and display interfacing with LCDs. Students will explore external interrupts, EEPROM data storage, and I2C/SPI communication with peripheral devices like RTCs, EEPROMs, and SD cards. Additionally, learners will interface wireless modules such as Bluetooth, enhancing their ability to design embedded systems with real-world applications.

3. **Course Name:** EMBEDDED SYSTEMS LAB
   Course Code: EE -595
   Hours per Week: 2
   Credits: 1
   Course Contents:

Exp. No./ Module	Topics
1.	**LED Blinking:** Introduce AVR GPIO programming by blinking an LED with a delay function.
2.	**Interfacing Switch and LED:** Understand AVR's digital input/output though control of LED state using a push button.
3.	**Timer-Based LED Blinking:** Blink LEDs using AVR's Timer0/Timer1 for delay generation.
4.	**PWM Generation using Timers:** Generate variable duty cycle PWM signals for varying the brightness of an LED or speed of a motor using AVR.
5.	**ADC Interface (Analog Sensor Reading):** Use AVR's internal ADC to read analog values from a potentiometer or temperature sensor (LM35).
6.	**USART Serial Communication:** Send/receive sensor data between AVR and PC via USART.
7.	**LCD (16x2) Interfacing:** Display text and sensor values on an LCD interfaced with an AVR.
8.	**External Interrupt Handling:** Use INT0/INT1 to trigger events such as toggling of LEDs from pushbutton.
9.	**EEPROM Read/Write:** Use AVR's internal EEPROM memory for storage and retrieval of sensor readings or configurations.

Exp. No./ Module	Topics
10.	**I2C Interface – RTC or EEPROM:** Interface I2C devices like DS1307 RTC or AT24C EEPROM with AVR for display time/date or read/write data to EEPROM.
11.	**SPI Interface – Serial Flash or SD Card:** Interface SD card or Flash using SPI with AVR for logging sensor data.
12.	**Bluetooth Interfacing:** Interface HC-04 bluetooth module with AVR.

4. Text Books:

T1. M.A. Mazidi, S. Naimi, S. Naimi, "*AVR Microcontroller and Embedded Systems: Using Assembly and C*", PHI, 2015.

5. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Write embedded C programs to control digital I/O peripherals using AVR GPIO.	Write	Apply
CO2	Demonstrate the use of timers and interrupts for delay generation and event handling.	Demonstrate	Apply
CO3	Generate PWM signals using AVR timers to control LED brightness or motor speed.	Generate	Apply
CO4	Interface analog sensors using ADC and display values using LCDs and serial communication.	Interface	Apply
CO5	Use EEPROM and communication protocols (I2C, SPI, USART) for data storage and transfer.	Use	Apply
CO6	Use Bluetooth for data transfer.	Use	Apply

6. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	3	-	-	-	-	-
3	-	3	-	-	-	-
4	-	3	3	-	-	-
5	-	-	-	3	-	-
6	-	-	-	3	-	-
7	-	-	-	3	-	-
8	-	3	-	-	-	-
9	-	-	-	-	3	-
10	-	-	-	-	3	-
11	-	-	-	-	3	-
12	-	-	-	-	-	3

7 Mapping of the Course outcomes to Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	1	2	1	3	-	1	1	2	-	2
CO2	3	2	2	2	3	-	1	1	2	-	2
CO3	3	2	3	2	3	1	1	1	2	-	2
CO4	3	2	3	3	3	2	1	1	3	-	2
CO5	3	2	3	2	3	1	2	2	3	1	2
CO6	3	2	2	2	3	1	2	2	3	1	3

8 Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	3	2
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	3	3
CO6	3	3	3	3

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON LABORATORY

Course Code: EE-596

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1. Course Pre-requisites:

1. Python Programming Laboratory

2. Course Learning Objectives:

1. Familiarize with Python programming and essential libraries for data analysis and AI/ML model development.
2. Implement basic AI algorithms such as search techniques and knowledge-based reasoning.
3. Apply supervised and unsupervised machine learning techniques to solve real-world data problems.
4. Develop and train neural network models for classification and regression tasks using modern frameworks like TensorFlow/Keras.
5. Analyze and interpret the performance of different ML models using evaluation metrics.
6. Work on mini-projects to apply AI & ML concepts to Electrical Engineering applications such as load forecasting, fault detection, and energy optimization.

3. Course Name: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON LABORATORY
Course Code:EE-596
Hours per Week: 2
Credits: 1

Course Contents:

Exp. No.	Topics
1.	Introduction to NumPy
2.	Basics of Pandas
3.	Search Algorithms: Implement BFS and DFS.
4.	Informed Search: Implement A* Algorithm for pathfinding.
5.	Knowledge Representation: Solve logic-based problems using Propositional Logic in Python.
6.	Supervised Learning (Regression): Linear Regression using Scikit-learn.
7.	Supervised Learning (Regression): Logistic Regression using Scikit-learn.
8.	Classification: Decision Tree and Naive Bayes classifiers.
9.	Clustering: K-Means Clustering on a sample dataset.
10.	Dimensionality Reduction: Implement PCA and visualize results.
11.	Neural Networks: Build a simple feed-forward neural network using TensorFlow/Keras.
12.	Deep Learning: Implement CNN for image classification (MNIST dataset).

4. Course Outcomes

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Demonstrate the use of Python libraries for AI & ML applications.	Demonstrate	Understand
CO2	Implement search algorithms and knowledge representation techniques.	Implement	Apply
CO3	Apply supervised learning techniques for regression and classification tasks.	Apply	Apply
CO4	Analyze clustering and dimensionality reduction methods on datasets.	Analyze	Analyze
CO5	Design and develop neural network-based models using TensorFlow/Keras.	Design, Develop	Evaluate, Create
CO6	Evaluate the performance of AI/ML models using suitable metrics.	Evaluate	Evaluate

5. Mapping of course outcomes to module / course content:

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	3	-	-	-	-	-
3	-	3	-	-	-	-
4	-	3	-	-	-	-
5	-	3	-	-	-	-
6	-	-	3	-	-	-
7	-	-	3	-	-	-
8	-	-	3	-	-	-
9	-	-	-	3	-	-
10	-	-	-	3	-	-
11	-	-	-	-	3	-
12	-	-	-	-	-	3

6. Mapping of the Course outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	-	-	-	-	-	1
CO2	3	2	2	2	3	-	-	-	-	-	1
CO3	3	2	2	2	3	-	-	-	-	-	1
CO4	3	2	2	2	3	-	-	-	-	-	1
CO5	3	2	2	2	3	-	-	-	-	-	1
CO6	3	2	2	2	3	-	-	-	-	-	1

7. Mapping to PSO:

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	3	2	-	-
CO3	3	2	-	-
CO4	3	2	-	-
CO5	3	2	-	-
CO6	3	2	-	-