K.K. Wagh Institute of Engineering Education and Research, Nashik

Department of Electrical Engineering

Final Year B.Tech
Electrical Engineering

Curriculum (2022 Pattern)

FINAL BTECH Electrical Engineering
SEM-VII

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TW	OR	TOTAL	TH	TU	PR	TOTAL
ELE224001	DCC*	Power System Operation and Control	3	-	-	-	60	40			**100**	3	-	-	**3**
ELE224002	DEC*	Program Elective Course IV	3	-	-	-	60	40	-	-	**100**	3	-	-	**3**
ELE224003	LHSM*	Massive Open Online Course*	2	-	-	-	-	50	-	-	**50**	2	-	-	**2**
ELE224004	PSI	Internship	-	-	24	-	-	-	300	200	**500**	-	-	12	**12**
Total			**8**	**00**	**24**	**-**	**120**	**130**	**300**	**200**	**750**	**8**	**-**	**12**	**20**

*** Considering an Internship of 6 months, these courses are to be offered in online mode.**

Dr. R. K. Munje
BOS Chairman
Electrical Engineering

Dr. K. N. Nandurkar
Director

SEM VIII

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks							Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TW	PR	OR	TOTAL	TH	TU	PR	TOTAL
ELE224011	DCC	Electrical Controlled Drives	3	-	-	20	60	20	-	-	-	**100**	3	-	-	**3**
ELE224012	DCC	Switch Gear and Protection	3	-	-	20	60	20	-	-	-	**100**	3	-	-	**3**
ELE224013	DCC	Electrical Controlled Drives Lab	-	-	2	-	-	-	25	25	-	**50**	-	-	1	**1**
ELE224014	DCC	Switch Gear and Protection Lab	-	-	2	-	-	-	25	-	25	**50**	-	-	1	**1**
ELE224015	DEC	Program Elective Course V	3	-	-	20	60	20	-	-	-	**100**	3	-	-	**3**
ELE224016	DEC	Program Elective Course VI	2	-	-	20	30	-	-	-	-	**50**	2	-	-	**2**
ELE224017	ASM	Research Methodology	3	-	-	20	60	20	-	-	-	**100**	3	-	-	**3**
ELE224018	LHSM	Massive Open Online Course	2	-	-	-	-	50	-	-	-	**50**	2	-	-	**2**
ELE224019	PSI	Project	-	-	8	-	-	-	100	-	50	**150**	-	-	4	**4**
Total			**16**	**0**	**12**	**100**	**270**	**130**	**150**	**25**	**75**	**750**	**16**	**0**	**6**	**22**

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Department Elective Courses

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
Program Elective Course IV (Sem-VII) (Students have to choose any one of the following)															
ELE224002A	DEC	Smart Grid	3	-	-	--	60	40	-	-	100	3	-	-	3
ELE224002B		Design of Power Electronic Converter	3	-	-	--	60	40	-	-	100	3	-	-	3
Program Elective Course V (Sem-VIII) (Students have to choose any one of the following)															
ELE224015A	DEC	Power Quality Assessment and Mitigation	3	-	-	20	60	20	-	-	100	3	-	-	3
ELE224015B		Microgrid and Control													
Program Elective Course VI (Sem-VIII) (Students have to choose any one of the following)															
ELE224016A	DEC	AI and ML Applications in Electrical Engineering	2	-	-	20	30	--	-	-	50	2	-	-	2
ELE224016B		Advanced Control System													

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*Open Elective (LHSM Category: Sem-I)

The student has to choose any one of the following courses as an open elective prescribed by NPTEL (Swayam Platform). The score obtained in the NPTEL course certificate will be converted into marks.

Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TW	OR	TOTAL	TH	TU	PR	TOTAL
Open Elective (Sem-VII) (Students have to choose any one of the following)															
ELE224003A	LHSM	Design, Technology and Innovation https://onlinecourses.nptel.ac.in/noc25 _de19/preview	2	--	--	--	--	50	--	--	50	2	--	--	--
ELE224003B		Entrepreneurship and IP Strategy https://onlinecourses.nptel.ac.in/noc25 _hs213/preview													
ELE224003C		Innovation, Business Models and Entrepreneurship https://onlinecourses.nptel.ac.in/noc25 _mg95/preview													

*Open Elective (LHSM category: Sem-II)

A list of available MOOCs will be declared at the start of the second semester.

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Final Year B.Tech.
Pattern:2022 Semester: VII (Electrical Engineering)
ELE224001: Power System Operation and Control

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 3 Hrs./Week	**TH: 3**	**End Sem Exam: 60Marks** **Continuous Comprehensive Evaluation: 40 Marks**

Prerequisite Courses: Power System Engineering, Power System Analysis

Course Objectives: The course objectives are to

1. Provide students with a strong foundation in the principles and practices of modern power system operation and control.
2. Enable students to analyze and optimize power system performance.
3. Equip students with knowledge of emerging trends in power systems.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Describe the structure, control strategies, and economic operation of modern power systems with various energy sources.	2-Understand
CO2	Analyze system stability and evaluate power exchange mechanisms between utilities	4-Analyze
CO3	Apply OPF techniques and interpret electricity market operations in restructured power systems.	3 – Apply 5 – Evaluate

COURSE CONTENTS

Unit I	**Basic Concepts**	**9 Hrs.**	**CO1, CO2**

Introduction to modern power systems: evolution, structure, power system control, operating states of a power system and control strategies, economic load dispatch, function and applications, price-based unit commitment problem, role of DSM in modifying load curves, various energy inputs for generation – conventional and non-conventional.

Unit II	**Transient and Voltage Stability**	**9 Hrs.**	**CO1, CO2**

Definition, Equal area criteria, Numerical integration methods, Transient stability analysis, factors affecting voltage instability and collapse, analysis and comparison of angle and voltage stability, analysis and comparison of voltage instability and collapse, control of voltage instability, Implications on power system dynamic performance.

Unit III	**Energy Control**	**9 Hrs.**	**CO1, CO2**

Interchange of power between interconnected utilities (numerical), economic interchange evaluation, interchange evaluation with unit commitment, types of interchange, capacity and diversity interchange, energy banking, emergency power interchange, inadvertent power exchange, power pools

Unit IV	**Optimal Power Flow (OPF)**	**9 Hrs.**	**CO2, CO3**

Introduction to OPF problem; formulation of OPF problem; OPF problem without inequality constraints; solution techniques for OPF.

Unit V	**Restructured power system**	**9 Hrs.**	**CO3**

Introduction, electricity markets and models, congestion management, energy pricing, integration of renewable energy, and global and Indian power markets.

Text Books
1. S. Sivanagaraju, G. Sreenivasan, "Power System Operation and Control," Pearson Education India, 2009. 2. I. J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4th Edition, Tata McGraw-Hill Publishing Co. Ltd. (Edition 2) 3. Kundur P. and Balu N. J., "Power System Stability and Control", EPRI Series, McGraw-Hill International Book Company
Reference Books
1. Wood A. J., Wollenberg B. F. and Sheblé G. B., "Power Generation, Operation and Control", 3rd Ed., John Wiley & Sons, Inc. 2. Zhong J., Power System Economic and Market Operations, CRC Press.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II)	10
2	Assignment 2 (Based on Units III, IV and V)	10
3.	LMS Tests (Best 5 sessions out of a Minimum of 10 sessions)	10
4.	Solving Case Study	10

Final Year B. Tech. Pattern: 2022 Semester: VII (Electrical Engineering) ELE224002A: Smart Grid		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 3 Hrs./Week	**TH-3**	**End Sem Exam: 60Marks** **Continuous Comprehensive Evaluation: 40 Marks**

Prerequisite Courses: Power Systems Analysis, Transformers and Induction Machines, Power Electronics, Communication Systems

Course Objectives: The objectives of the course are to

1. Introduce the concept, need, functions, and policy framework of Smart Grids with emphasis on the Indian scenario.
2. Provide knowledge of Smart Grid infrastructure, communication technologies, and cybersecurity.
3. Familiarize students with intelligent devices, substation automation, standard protocols, and monitoring systems.
4. Explore smart metering technologies, consumer-side automation, and their role in energy management.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Explain the Smart Grid concept, its functions, differences from conventional grids, and national policies, roadmap, and pilot projects in India.	2- Understand
CO2	Describe Smart Grid communication infrastructure, including HAN, NAN, WAN, ZigBee, Wi-Fi, NB-IoT, and cybersecurity aspects	2- Understand
CO3	Demonstrate the role of IEDs, PMUs, substation automation, IEC 61850, GIS, and smart sensors in Smart Grid systems.	3- Apply
CO4	Analyze smart metering technologies like AMI, AMR, net metering, OMS, and home/building automation systems.	4- Analyze

COURSE CONTENTS			COs mapped
Unit I	**Introduction to Smart Grid**	**9 hrs.**	**CO1**
Concept of Smart Grid, Need of Smart Grid, Functions of Smart Grid, Difference between Conventional and Smart Grid, Smart Grid Vision and Roadmap for India, Smart Grid National Policies, Drivers of Smart Grid in India, Opportunities and Barriers of Smart Grid, Smart Cities, Pilot Projects in India.			
Unit II	**Smart Grid Infrastructure and Communication**	**9 hrs.**	**CO2**
Functionalities and Key Components of Smart Grid, Communication Architecture of Smart Grid, Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN), ZigBee, Wi-Fi, Wi-Max, GPS, Wireless Mesh Network, LORaWAN, NB-IoT, SigFox, Basics of Cloud Computing, Cyber Security in Smart Grid.			
Unit III	**Intelligent Devices and Substation Automation**	**9 hrs.**	**CO3**
Intelligent Electronic Devices (IED), Phase Measurement Unit (PMU), Smart Substations, Substation and Feeder Automation, IEC 61850 Application for Monitoring, Protection and Control, Smart Sensors, Geographic Information System (GIS), IS 16444, Low-PAN RF Meter.			
Unit IV	**Smart Metering and Consumer Technologies**	**9 hrs.**	**CO4**
Introduction to Smart Meters, Prepaid Meters, Net Metering, Advanced Metering Infrastructure (AMI), Real Time Pricing, Automatic Meter Reading (AMR), Outage Management System (OMS), Smart			

Appliances, Home and Building Automation.			
Unit V	**Microgrid and Renewable Integration**	**9 hrs.**	**CO3, CO4**
Concept of Microgrid, Need and Applications of Microgrid, Microgrid Architecture, DC Microgrid, Hybrid Microgrid, Formation of Microgrid, Issues of Interconnection, Protection and Control of Microgrid, Smart Microgrid, Microgrid and Smart Grid Comparison, Renewable Energy Based Microgrid Systems, Integration of Renewable Energy Sources, Energy Storage Technologies and Applications, Flow Batteries, SMES, Super Capacitors, Compressed Air Energy Storage (CAES) and its Comparison, Plug-in Hybrid Electric Vehicles (PHEV), Vehicle to Grid (V2G), Power Quality and EMC in Smart Grid, Power Quality Issues of Grid Connected Renewable Energy Sources, Distributed Generation.			

Text Books

1. Gellings, Clark W "The Smart Grid: Enabling Energy Efficiency and Demand Response*",* CRC Press.
2. Momoh, James *"* Smart Grid: Fundamentals of Design and Analysis*"* Wiley-IEEE Press.
3. Ekanayake, Janaka, Jenkins, Nick, Liyanage, Kithsiri, Wu, Jianzhong, Yokoyama, Akihiko, "Smart Grid: Technology and Applications*",* Wiley-IEEE Press.
4. Wadhwa, C.L "Electrical Power System*",* New Age International Publishers.

Reference Books

1. Xiao, Yang, "Communication and Networking in Smart Grids*",* Wiley-IEEE Press.
2. Patel, M. R., "Integration of Renewable Energy Sources with Smart Grid*",* CRC Press.
3. Kothari, D.P., Nagrath, I.J., "Modern Power System Analysis", McGraw-Hill Education.
4. Ghosh, Uttam, Le, Dac-Nhuong, "Cyber-Physical Systems for Next-Generation *Networks*, CRC Press.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II)	10
2	Assignment 2 (Based on Units III, IV and V)	10
3.	LMS Tests (Best 5 sessions out of a Minimum of 10 sessions)	10
4.	Solving Case Study OR Teacher-Defined Tool	10

Final Year B. Tech (Electrical)
Pattern 2022 Semester: VII (Electrical Engineering)
ELE224002B: Design of Power Electronic Converters

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 3 Hrs./Week	TH-3	End Sem Exam: 60Marks Continuous Comprehensive Evaluation: 40 Marks

Prerequisite Courses: Power Electronics

Course Objectives: The objectives of the course are to
1. Make students aware of the different power electronics components' design methods
2. Empower students to design advanced power electronics converters for a given application

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand power electronic converter circuits with waveforms and equations	2-Undertsnad
CO2	Select appropriate power semiconductor devices for a particular application	3-Apply
CO3	Design a power electronic converter circuit with an appropriate protection circuit	6-Create
CO4	Design of Electromagnetic interference	6-Create

COURSE CONTENTS

Unit I	Analysis of power electronic converters	08 hrs	CO1, CO2

Introduction, Analysis of Buck Converter, Choosing L and C, Design Example of Buck Converter, Analysis of H Bridge, Bipolar PWM, Unipolar PWM, Bipolar Vs Unipolar PWM.

Unit II	Design of Power Semiconductor Devices	08 hrs	CO1, CO2, CO3

Different types of Power Diodes, Diode Characteristics, Diode Datasheets, Diode datasheet examples, Switching characteristics of MOSFET, MOSFET Datasheets –I, MOSFET Datasheets –II, MOSFET Datasheet Example, IGBT Datasheets –I, IGBT Datasheets –II, IGBT Datasheet Example,

Unit III	Design of Gate Drivers, Snubber	08 hrs	CO1, CO2, CO3

Introduction to Gate Drivers, Gate Driver Requirements, Optocouplers based Gate Drivers-I, Optocouplers based Gate Drivers –II, Pulse Transformer based Gate Drivers, Introduction to Snubbers, RC Snubber Analysis – II: Under damped Case, RC Snupper Analysis –III: Overdambed and Critically, Damped Case, RC Snubber Design –I, RC Snubber Design –II, RCD Snubbers –I, RCD Snubbers –II.

Unit IV	Design of Thermal, Magnetic, and Transformer	08 hrs	CO1, CO3, CO4

Thermal Modelling –I, Thermal Modelling –II, Thermal Modelling –III, choosing Heat Sinks, Magnetic Losses, Conductors, Magnetic Materials, Magnetic Core, Transformer Design, Example of Transformer Design.

Unit V	Design of Electromagnetic interference, and Familiarity and design of power electronic hardware	08 hrs	CO1, CO4

Introduction to EMI, EMI Measurements, EMI in Power electronics, CM and DM noise, design Solutions of EMI, EMI Filter –I, EMI Filter – II, Familiarity with Components –I, Familiarity with Components –II, PCB –I, PCB –II, PCB –III.

Text Books
1. Ned Mohan, T.M Undeland and W. P Robbin, "Power Electronics: converters, Application and design", John Wiley and Sons. Wiley India First Edition, 2006. 2. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004 3. P. S. Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003
Reference Books
1. Abraham I. Pressman, Keith Billings &Taylor Morey: Switching Power Supply Design, McGraw Hill International, Third Edition, 2009. 2. R.W. Erickson and Dragan Maksimovic: Fundamentals of Power Electronics, Springer, Second Edition, 2001. 3. Umanand, L., Power Electronics: Essentials and Applications, John Wiley India, First Edition, 2009
NPTEL Course: 1. Design of Power Electronics Converter" https://archive.nptel.ac.in/courses/117/103/117103148/#

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II)	10
2	Assignment 2 (Based on Units III, IV and V)	10
3.	LMS Tests (Best 5 sessions out of a Minimum of 10 sessions)	10
4.	Solving Case Study OR Teacher-Defined Tool	10

Final Year B. Tech. Pattern 2022 Semester: VII (Electrical Engineering) ELE224003: Massive Open Online Course		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 2 Hrs./Week	**TH- 2**	**Continuous Comprehensive Evaluation: 50 Marks**
Prerequisite Courses: Nil		

COURSE CONTENTS

Students have to select one of the following Online Courses available on the Swayam Platform and complete the course. Students have to submit the course completion certificate to the course teacher/coordinator.

Sr. No.	Name of the Course	Name of Course Teacher	Link
A	Design, Technology and Innovation	Prof. B. K. Chakravarthy, IIT Bombay	https://onlinecourses.nptel.ac.in/noc25_de19/preview
B	Entrepreneurship and IP Strategy	Prof. Gouri Gargate, IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc25_hs213/preview
C	Innovation, Business Models and Entrepreneurship	Prof. RajatAgrawal Prof. Vinay Sharma, IIT Roorkee	https://onlinecourses.nptel.ac.in/noc25_mg95/preview

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Grading of the online course will be taken as it is and will be rounded to 50 marks.	50

Note: COs will be defined separately for each selected course by the course teacher, and later, CO-PO-PSO Mapping will be decided, which will be included in the Course Handout.

Final Year B. Tech.
Pattern: 2022 Semester VII (Electrical Engineering)
ELE224004: Internship

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 24 Hours	**PR: 12**	**Term work: 300 Marks** **Oral: 200 Marks**

Prerequisite Courses:

Course Objectives: The objectives of the course are

1. To encourage and provide opportunities for the students to acquire professional learning experiences.
2. Provide exposure to handling and using various tools, measuring instruments, meters, and technologies used in industries.
3. Enable students to develop professional and employability skills and expand their professional network.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Describe the organizational structure, safety protocols, and key operational processes of the industry	2-Understand
CO2	Apply electrical engineering knowledge to operate, troubleshoot, or maintain equipment/systems used in the industry.	3-Apply
CO3	Analyze real-world engineering problems and suggest feasible solutions based on observed practices.	4-Analyze
CO4	Demonstrate professional skills such as communication, teamwork, punctuality, and ethical responsibility in an industrial setting.	3-Apply

Internship Guidelines for Students

A. Before Joining the Internship

1. Look for internships in the industries provided by the department.
2. The internship duration should be 16 weeks.
3. Ask for the internship request letter from the respective class coordinator. He/she will appoint a guide for you.
4. Monitoring and Mentoring of the internship activity will be done through your Guide. You are informed to report to your guide from time to time.

B. During Internship

1. Keep the internship record book with you.
2. Note down all the details date-wise in the internship record book. Take the signature of your industry mentor daily.
3. The internship record book will help you write your final internship report. Simultaneously, you can start writing internship reports.
4. Maintain an institutional culture while working in the industry.

C. After Internship

1. Submit the Internship Record book and Internship report. Both are in hard copy.
2. Submit all your details within 15 days of completion of the Internship.
3. After the internship, the presentation schedule will be displayed.
4. The internship course will be assumed to be completed only after the final presentation. The date of presentation will be declared at least 10-15 days before the actual date.

Sr. No.	Evaluation Parameter	Marks	Assessment By	Remarks
1	**Internship Record Book**	150 Marks	Internship Guide and Industry Guide	Maintain all the records as per the sample given to you. This should be handwritten and submitted in hard copy. It will be evaluated based on 1. Proper and timely documented entries 2. Adequacy and quality of information 3. Data, observations, and discussions recorded 4. Thought process and recording techniques used 5. Organization of the information
2	**Internship Report**	150 Marks	Internship Guide and Industry Guide	Submit your report as per the guidelines. It should have **1. Starting pages:** Certificates, declaration, abstract, table of contents, figures, tables, etc. **2. Chapter 1:** Introduction: A Brief about the company, industry or organization, objectives, motivation, and organization of the report **3. Chapter 2:** Problem Identification/Problem statement/objectives and scope/expected outcomes **4. Chapter 3:** Methodological details **5. Chapter 4:** Results / Analysis /inferences and conclusion **6. Chapter 5:** Suggestions/Recommendations for improvement to the industry, if any **7. End Pages:** Acknowledgement and references
3	**Review I Presentation (Online/ offline)**	Oral: 50	Internship Guide and Industry Guide	Evaluation will be done by both industry and department mentors, based on the presentation criteria given below 1. Internship Identification and Selection 2. The Problem Studied with objectives and expected outcomes 3. Consideration of environmental/ Social /Ethical/ Safety measures,/Legal aspects. 4. Methodology/System/Procedure Q&A 5. Block diagram, flowchart, algorithm, system description Q&A 6. Final results, discussions, suggestions, comments, etc. Q&A 7. Presentation and Communication 8. Application of the learning
4	**Review II Presentation (Offline)**	Oral: 50		
5	**Review III Presentation (Online/ Offline)**	Oral: 50		
6	**Review IV Final Presentation (Offline)**	Oral: 50		
	Total Marks	500		

Final Year B.Tech.
Pattern: 2022 Semester: VIII (Electrical Engineering)
ELE224011: Electrical Controlled Drives

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory:3 Hrs./Week	**TH:3**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses: Transformers and Induction Machines**, Synchronous and Special Purpose Machines, Power Electronics, Control System Engineering**

Course Objectives: The objectives of the course are to

1. Explain the structure and operation of electric drives and their components.
2. Enable students to analyze and apply control methods for DC and AC motors.
3. Evaluate and analyze power electronic circuits to regulate motor performance.
4. Empower students to evaluate energy-efficient and advanced control strategies.
5. Introduce various applications of drives in industries.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Explain the fundamental concepts, components, and control techniques of electric drives	2 - Understand
CO2	Apply advanced control strategies and modern techniques for energy-efficient and smart drive systems	3 - Apply
CO3	Analyze the performance and control strategies of DC and AC motor drives	4 - Analyze
CO4	Evaluate the performance of electric drives under different loads, controls, and operating conditions	5 - Evaluate
CO5	Evaluate power electronic converter circuits for various motor drive applications	5 - Evaluate

COURSE CONTENTS

Unit I	**Fundamentals of Electric Drives**	**09hrs**	**CO1, CO2, CO3**

Definition, classification, and applications of electric drives, Components of drive systems, Torque-speed characteristics, Load torque types, Multiquadrant operation, Drive selection criteria
Duty Cycles in Electric Drives – Continuous, intermittent, and variable duty cycles, **Basic Control of Electric Drives** – Open-loop and closed-loop control, feedback mechanisms, **Modern Trends in Electric Drives** – IoT-based monitoring, AI-driven control, **Case Studies on Industrial Applications** – Textile, steel, paper mills, and robotic drives

Unit II	**DC Drives – Characteristics & Control**	**09hrs**	**CO2, CO3, CO4, CO5**

Single-phase and three-phase fully controlled converter drives and the performance of converter-fed Separately excited DC Motor for speed control operations, 12-pulse converter drives.
Chopper-controlled drives for separately excited and series DC Motor operations. Closed-loop speed control of DC motor below and above base speed for starting, speed control and braking

Unit III	**Induction Motor Drives**	**09hrs**	**CO2, CO3, CO4, CO5**

Voltage Control Methods – AC voltage controllers for speed variation, **Variable Frequency Control (V/f Control)** – Principle, advantages, and disadvantages, **Vector Control (FOC) of Induction Motors** – Principle, implementation, applications, **Inverter-Fed Induction Motor Drives** – VSI, CSI, and PWM techniques, **Braking of Induction Motors** – Regenerative, dynamic, plugging braking techniques

Unit IV	**Synchronous & Special Motor Drives**	**09hrs**	**CO2, CO3, CO4, CO5**
Self-Controlled & Load-Commutated Synchronous Motor Drives, Permanent Magnet Synchronous Motor (PMSM) Drives, Brushless DC (BLDC) Motor Drives, Switched Reluctance Motor (SRM) Drives, Stepper motor drives, **Microcontroller-Based Drive Control –** DSP, FPGA, and embedded system control,			
Unit V	**Applications of Advanced Drives**	**09hrs**	**CO2, CO4, CO5**
Applications of advanced drives in industrial automation, electric vehicles, renewable energy systems, Aerospace and Defence, HVAC systems and industries like textile, steel, paper mills and robotic drives. Application of AI and IoT in drives for precise control and automation			

Text Books

1. G.K. Dubey – Fundamentals of Electrical Drives, Narosa Publishing.
2. B.K. Bose – Modern Power Electronics and AC Drives, Pearson Education.
3. R. Krishnan – Electric Motor Drives: Modeling, Analysis and Control, Pearson.

Reference Books

4. S.K. Pillai – A First Course on Electrical Drives, New Age International.
5. Vedam Subrahmanyam – Electric Drives: Concepts and Applications, TMH.
6. M.D. Singh & K.B. Khanchandani – Power Electronics, Tata McGraw-Hill.
7. N.K. De & P.K. Sen – Electric Drives, PHI Learning.

NPTEL Course:

2. Fundamentals of Electrical Drives" https://onlinecourses.nptel.ac.in/noc22_ee94/preview

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1 (Based on Units I and II) (Deadline: before Insem)	5
2	Assignment 2 (Based on Units III and IV) (Deadline: before Endsem)	5
3.	LMS (Best 5 sessions out of a Minimum of 10 sessions)	5
4.	Certificate course on Introduction to Motor Control MATLAB Onramp OR Class Test (Before End Sem on Units III, IV, V)	5

Final Year B.Tech.
Pattern: 2022 Semester: VIII (Electrical Engineering)
ELE224012: Switchgear and Protection

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 3 hrs/week	TH: 3	Continuous Comprehensive Evaluation: 20Marks InSem Exam: 20Marks EndSem Exam: 60Marks

Prerequisite Courses: Fundamentals of Electrical Engineering, Power System Analysis

Course Objectives: The objectives of the course are to

- Acquaint students with the construction and working principles of different types of CBs and Relays.
- Explain the different types of faults in the transformer, alternator, and 3-phase induction motor and the various protective schemes related to them.
- Impart knowledge about transmission line and bus bar protection schemes.
- Introduce recent trends and technologies in protection engineering.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand the operation and types of circuit breakers and arc interruption techniques.	2-Understand
CO2	Analyze protective relay characteristics and apply fault calculation techniques.	4-Analyze
CO3	Evaluate protection methods for transformers, motors, and generators.	5-Evaluate
CO4	Implement digital relay algorithms for modern power system protection	6-Create

COURSE CONTENTS

Unit I	Circuit Breaker	10	CO1, CO2, CO4

Introduction, fault clearing process, Electric arc formation, Current interruption in AC circuit breaker, high and low resistance principles, arc interruption theories, arc voltage, recovery voltage, derivation and definition of restriking voltage and RRRV, current chopping, interruption of capacitive current, resistance switching, Numerical on RRRV, current chopping and resistance switching, trip circuit, types of circuit breaker, ratings of circuit breaker, Working and constructional features of ACB, SF_6, VCB- advantages, disadvantages and applications. Auto reclosing, introduction to GIS

Unit II	Protective Relaying	10	CO1, CO2

Need for protective system, nature and causes of fault, types of faults, effects of faults, classification of relays, zones of protection, primary and backup protection, essential qualities of protective relaying. Principles of protection - over current, directional over current, differential, and distance. Induction type relay, torque equation in induction type relay, current and time setting in induction relay, Numericals on TSM, PSM and operating time of relay. IEEE and IEC standards and ANSI numbers for protective relays.

Unit III	Equipment Protection	10	CO2, CO3

I. **Power Transformer Protection:** Types of faults in transformer, Percentage differential protection, Restricted E/F protection, incipient faults, protection against overfluxing, protection against inrush current.
II. **3 Phase Induction Motor Protection:** Abnormal conditions and causes of failures, single phasing protection, overload protection, short circuit protection and protection against unbalanced conditions.
III. **Synchronous Generator (Alternator) Protection:** Various faults, abnormal operating conditions- stator faults, longitudinal and transverse percentage differential scheme. Rotor faults- abnormal

operating conditions, unbalanced loading, overspeeding, protection against loss of excitation using offset Mho relay, and loss of prime mover.

Unit IV	Bus Bar and Transmission Line Protection	8	CO2, CO3

I. Bus bar layout and protection- differential bus bar protection, selection of CTs, protection during high impedance faults.
II. Over current protection for feeders using directional and non-directional over current relays, Introduction to distance protection, impedance relay, reactance relay, mho relay and Quadrilateral Relays, three stepped distance protection, Effect of arc resistance, and power swing on performance of distance relay.

Unit V	Digital Relaying	7	CO2, CO4

Numerical Relays:- Introduction and block diagram of numerical relay, Sampling theorem, Anti–Aliasing Filter. Block diagram of PMU and its application. Introduction to PLCC, block diagram, advantages, and disadvantages. Introduction to Wide Area Measurement (WAM) system. Realization of numerical relaying algorithm (flowchart, block diagram). Setting calculations and parameterization

Text Books

4. S. Rao, 'Switchgear Protection and Power Systems', Khanna Publications
5. Y. G. Paithankar, S. R. Bhide, 'Fundamentals of Power System Protection', Prentice Hall of India
6. Badri Ram, D. N. Vishwakarma, 'Power System Protection and Switchgear', Tata McGraw-Hill Publishing Co. Ltd.
7. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, 'Protection and Switchgear', Oxford University Press

Reference Books

8. J. Lewis Blackburn, 'Protective Relaying – Principles and Applications', Marcel Dekker, Inc., New York
9. S. H. Horowitz and A. G. Phadke, 'Power System Relaying', John Wiley and Sons Ltd, 2008
10. P M Anderson, 'Power System Protection', IEE Press
11. A. G. Phadke, J. S. Thorp, 'Computer relaying for Power System', Research Studies Press Ltd, England. (John Willy and Sons Inc. New York)
12. Mason C.R., "Art and Science of Protective Relaying", Wiley Eastern Limited

NPTEL Course:

3. https://nptel.ac.in/courses/108107167 [Power System Protection and Switchgear, IIT Roorkee, Prof. Bhaveshkumar R. Bhalja]
4. https://nptel.ac.in/courses/108105167 [Power System Protection, IIT Kharagpur, Prof. Ashok Kumar Pradhan]
5. https://nptel.ac.in/courses/108101039 [Power System Protection, IIT Bombay, Prof. S.A. Soman]

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Assignment 1 (Based on Units I and II) (Deadline: before Insem)	5
2	Assignment 2 (Based on Units III, IV and V) (Deadline: before Endsem)	5
3.	LMS Tests (Best 5 sessions out of a Minimum of 10 sessions)	5
4.	Class Test (Before End Sem on Units III, IV, V)	5

Final Year B.Tech. Pattern:2022Semester:VIII(Electrical Engineering) ELE224013:Electrical Controlled Drives Lab		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 2 Hrs./Week	**PR:1**	**Term Work: 25 Marks** **Practical:25 Marks**

Prerequisite Courses: Transformers and Induction Machines**, Synchronous and Special Purpose Machines, Power Electronics, Control System Engineering**

Course Objectives: The objectives of the course are to

1. **Introduce** the operation and control of various electric drives, including DC, induction, BLDC, and PMSM motors using power electronic converters.
2. **Demonstrate** speed control and braking techniques through hardware-based and simulation-based experiments in groups of 4-5 students.
3. **Empower students to analyze and simulate** advanced control methods such as vector control and closed-loop drive systems using MATLAB/Simulink individually.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom'sLevel
CO1	**Control** the speed of DC and AC motors using converter and inverter-based circuits.	3-Apply
CO2	**Demonstrate** the implementation of electrical braking techniques for DC and induction motors in groups of 4-5 students	3- Apply
CO3	**Simulate** and analyze closed-loop control for Induction, BLDC, and PMSM drives individually	4- Analyze
CO4	**Interpret** experimental and simulation results to evaluate motor performance under different drive control strategies.	5-Evaluate

List of Laboratory Experiments

At least 8 experiments are to be performed out of the following list:

Sr. No.	Laboratory Experiments	COs Mapped
1	Speed control characteristics of a single-phase, fully converter-fed, separately excited D.C. motor	CO1,CO4
2	Speed control of DC motors using choppers.	CO1,CO4
3	Electrical braking of D.C. Shunt motor (Rheostatic, Plugging).	CO2
4	Four-quadrant operation of converter-fed DC drive.	CO1,CO4
5	Speed control of three-phase induction motors using V/f control	CO1,CO4
6	Electrical braking of 3-phase Induction Motor (DC Dynamic Braking, Plugging, and Regenerative Braking).	CO2
7	Study of speed control of BLDC drive.	CO1, CO4
8	Study of speed control of PMSM drive(V/f and FOC)	CO1,CO4
9	Simulation of Induction Motor Vector Control.	CO3, CO4
10	Simulation of closed-loop control of BLDC / PMSM drive.	CO3, CO4
11	Industrial Visit	CO1, CO2, CO3, CO4

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirements of the course.

Guidelines for Laboratory Conduction
1. The teacher will brief the given experiment to students for its procedure, observations, calculations, and outcome. 2. The apparatus and equipment required for the allotted experiment will be provided by the lab technician. 3. Students will perform the allotted experiment in a group (3-4 students in each group) under the supervision of faculty and a lab technician. 4. After performing the experiment, students will check their readings and calculations from the teacher. 5. After checking, they have to write the conclusion on the final results. 6. A minimum of 4 sets of the experiment should be made ready for the conduction of the experiment in a batch for hardware experiments.
Guidelines for Student's Lab Journal
The write-up should include a title, aim and apparatus, circuit or block diagram, waveforms, brief theory, procedure, observations, graphs, calculations, conclusion, and answers to the questions, if any.
Guidelines for Term Work Assessment
Each experiment from the lab journal is assessed for thirty marks based on three rubrics. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing, where each rubric carries ten marks.

Final Year B.Tech.
Pattern 2022 Semester: VIII (Electrical Engineering)
ELE224014: Switchgear and Protection Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical:2Hrs./week	**PR: 1**	**Term Work: 25Marks** **Oral: 25Marks**

Prerequisite Courses: Power System Engineering

Course Objectives: The objectives of the course are

1. Develop a deeper understanding of protection engineering.
2. Connect theoretical knowledge to real-time applications in switchgear and protection
3. Provide exposure to experimental skills like the design of protection systems using the latest technology.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Understand the operating principles and characteristics of various protection devices and switchgear equipment used in electrical power systems.	2-Understand
CO2	Analyze and interpret the working of different protection schemes, such as overcurrent, differential, and distance protection for transformers, alternators, and transmission lines in groups of 4-5 members	4-Analyze
CO3	Evaluate the performance of protective relays and circuit breakers using appropriate testing kits and simulation tools individually	5-Evaluate

List of Laboratory Experiments

Minimum of 8 Experiments to be performed from the following list.

Sr. No.	**Laboratory Experiments**	**COs mapped**
1	Study of switchgear testing kit	CO1, CO3
2	Protection of the Transmission line using Impedance relay	CO2,
3	Study and testing of the fuse, MCB	CO1,
4	Study and testing of contactors	CO1,
5	Study and testing of ACB	CO1,
6	Study and testing of MCCB	CO1,
7	Study and testing of thermal overload relay for Induction Motor protection.	CO1,
8	Study and plot the Characteristics of IDMT-type Induction over the current relay.	CO2, CO3
9	Study and parameterization of digital overcurrent relay.	CO2, CO3
10	Percentage differential protection of transformer (Merz Price Protection).	CO2
11	Protection of alternators.	CO2
12	Study and testing of Bus Bar protection.	CO2, CO3
13	Industrial Visit	CO1, CO2, CO3

Guidelines for Laboratory Experiment Conduction

1. The teacher will brief the given experiment to students for its procedure, observations, calculations, and outcome.

2. The apparatus and equipment required for the allotted experiment will be provided by the lab technician.
3. Students will perform the allotted experiment in a group (3-4 students in each group) under the supervision of faculty and a lab technician.
4. After performing the experiment, students will check their readings and calculations from the teacher.
5. After checking, they have to write the conclusion on the final results.
6. A minimum of 4 sets of the experiment should be made ready for the conduction of the experiment in a batch for hardware experiments.

Guidelines for Student's Laboratory Journal

The write-up should include a title, aim and apparatus, circuit or block diagram, waveforms, brief theory, procedure, observations, graphs, calculations, conclusion, and answers to the questions, if any.

Guidelines for Term Work Assessment

Each experiment from the lab journal is assessed for thirty marks based on three rubrics. Rubric R-1 for timely completion, R-2 for understanding, and R-3 for presentation/journal writing, where each rubric carries ten marks.

Final Year B. Tech.
Pattern: 2022 Semester: VIII (Electrical Engineering)
ELE224015A: Power Quality Assessment and Mitigation

Teaching Scheme	Credit Scheme	Examination Scheme:
Theory: 3 Hrs./Week	TH-3	Continuous Comprehensive Evaluation: 20Marks In-Sem Exam: 20Marks End-Sem Exam:60Marks

Prerequisite Courses: Power Systems, Electrical Machines, Power Electronics

Course Objectives: The objectives of the course are to

1. Develop an understanding of power quality attributes.
2. Make students describe problems associated with poor power quality.
3. Make students describe mitigation techniques for improving power quality.
4. Introduce various equipment for monitoring and assessment

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Understand various power quality issues, their terminology, and significance	2 – Understand
CO2	analyze voltage disturbances like flickers, sags, swells, harmonics and transients along with mitigation.	4 – Analyze
CO3	Explain power quality monitoring procedures and assess data using standards.	5 -Evaluate
CO4	Design a suitable power quality mitigation technique.	6-Create

COURSECONTENTS

Unit I	Introduction to Power Quality	(7 hrs)	COs Mapped - CO1

Importance of power quality, terms and definitions of power quality events as per IEEE std. 1159-2019. Symptoms of poor power quality. Definitions, Purpose and terminology of grounding. Recommended grounding practices for noise and power quality control.

Unit II	RMS Voltage variations, Flickers and Transient Over-Voltages	(8 hrs)	COs Mapped - CO2

RMS voltage variations in a power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and the impact of reactive power management. Various causes of voltage flicker and their effects. Short-term and long-term flickers. Ferro-resonance: Various means to reduce flickers. Flicker meter and monitoring. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages.

Unit III	Voltage Sag, Swell and Interruption	(10 hrs)	COs Mapped - CO2

Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag, Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of type of fault, fault location and fault level on voltage sag. Phase angle jumps. Types of sags (Type 1 to Type 7). Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Measurement of voltage sag half-cycle RMS, one-cycle RMS methods. Representation of the results of voltage sag analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT, etc., utility

solutions and end-user solutions			
Unit IV	**Harmonics and Mitigation**	**(10 hrs)**	**COs Mapped - CO3**
Definition and causes of harmonics, inter-harmonics, sub-harmonics; voltage vs. current distortion; Fourier analysis and harmonic indices (THD); sources of harmonics in residential, commercial, and industrial loads. Effects of harmonics and resonance (series and parallel); harmonic mitigation using K-rated transformers and filters (passive, active, tuned, broadband); IEEE 519-2014 and IEEE 1531 standards.			
Unit V	**Power Quality Monitoring & Assessment**	**(10 hrs)**	**COs Mapped - CO4**
Need for power quality monitoring. Initial site survey. Power quality instrumentation. Power quality analyzer specification requirement as per EN50160 Standard. Selection of power quality equipment for cost-effective power quality monitoring, Selection of monitoring location, events, intervals and period. Power Quality assessment, Power quality indices and standards for assessment of disturbances, waveform distortion.			

Text Books

Sr. No.	Title	Author(s)	Publisher
T1	Electrical Power System Quality	R.C. Dugan, M.F. McGranaghan, S. Santoso, H.W. Beaty	McGraw-Hill
T2	Power Quality	C. Sankaran	CRC Press
T3	Understanding Power Quality Problems: Voltage Sag and Interruptions	M.H.J. Bollen	IEEE Press
T4	Power System Quality Assessment	J. Arrillaga, M.R. Watson, S. Chan	John Wiley & Sons

Reference Books

Sr. No.	Title	Author(s)	Publisher
R1	Power System Harmonics: Computer Modeling and Analysis	Enrique Acha, Manuel Madrigal	John Wiley & Sons
R2	Power Quality in Power Systems and Electrical Machines	Ewald F. Fuchs, Mohammad A.S. Masoum	Elsevier
R3	Power System Harmonics	J. Arrillaga, M.R. Watson	John Wiley & Sons
R4	Electric Power Quality	G.J. Heydt	Stars in a Circle Publications
R5	IEEE Standards: 1159, 519,	IEEE Standards	IEEE

	1346, 1100		

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1(Based on Units I and II)(Deadline: before Insem)	5
2	Assignment 2 (Based on Units III and IV)(Deadline: before Endsem)	5
3.	LMS Tests (Best 5 out of a Minimum of 10)	5
4.	Class Test (Before End Sem on Units III, IV, V) OR Group activity-simulation topics and case study problems	5

Final Year B. Tech Pattern: 2022 Semester: VIII (Electrical Engineering) ELE224015B: Microgrid and Control		
Teaching Scheme	**Credit Scheme**	**Examination Scheme:**
Theory: 3Hrs./Week	**TH: 3**	**Continuous Comprehensive Evaluation: 20Marks** **In-Sem Exam: 20Marks** **End-Sem Exam:60Marks**

Prerequisite Courses: Power System Engineering, Power System Analysis, Power System Operation and Control

Course Objectives: The objectives of the course are to

1. Familiarize students with microgrid structures, operating modes, and challenges in integrating distributed energy resources.
2. Impart knowledge of modeling and controlling various microgrid components, including power electronic converters and storage systems.
3. Equip students with techniques to analyze and design control strategies for power sharing, synchronization, and stability under various operating conditions.
4. Develop skills in using modern tools for simulation, energy management, and protection analysis of microgrid systems.

Course Outcomes: On completion of the course, students will be able to –

	Course Outcomes	Bloom's Level
CO1	Explain the evolution, architecture, and components of microgrids and active distribution networks.	2-Understand
CO2	Analyze the integration and control of distributed energy resources within decentralized grid frameworks.	3-Analyze
CO3	Evaluate the protection, communication, and operational performance of Microgrids using analytical and simulation tools	5-Evaluate
CO4	Design intelligent control schemes for the stable operation of active networks under varying grid conditions.	6-Create

Unit no	Content		CO	BL
Unit 1	**Introduction to Microgrids and Active Networks**	**09Hrs**	**CO1**	**L2**
	Evolution from passive to active distribution networks, Components of microgrids: DERs, loads, PCC, interfaces, Types of microgrids (urban, rural, remote), Benefits: Reliability, sustainability, economics, Policy, planning, and operational considerations, IET and IEEE standards overview			
Unit 2	**Distributed Energy Resources and Network Integration**	**09Hrs**	**CO2**	**L3**
	Characteristics of RES: solar, wind, fuel cells, CHP, Power electronic interfaces: inverters, converters, Connection topologies and network planning, Case studies: EU and Indian distribution microgrids Technical issues: intermittency, harmonics, voltage fluctuations			
Unit 3	**Control and Energy Management in Microgrids**	**09Hrs**	**CO2, CO4**	**L3, L6**
	Hierarchical control levels, Voltage and frequency control under islanded/grid mode, Load forecasting and scheduling, Optimization of local generation vs grid import, Case studies on energy management systems (EMS)			
Unit 4	**Protection and Islanding Detection**	**09Hrs**	**CO3, CO4**	**L5, L6**

	Fault types in active networks, Islanding detection: passive and active methods, Protection schemes for grid-connected and islanded modes, Relaying techniques and protection coordination, Voltage ride-through and reconnection criteria			
Unit 05	**Communication, Simulation, and Monitoring**	**09Hrs**	**CO3**	**L5, L6**
	Role of ICT in microgrid control, Communication protocols (IEC 61850, DNP3, Modbus), SCADA and real-time monitoring systems, Simulation tools: MATLAB, ETAP, OpenDSS, Smart metering and consumer-side integration			

Textbook:

[1] S. Chowdhury, S. P. Chowdhury, & P. Crossley, *Microgrids and Active Distribution Networks*, IET Power Series, 2009.

Reference Book:

[1] Lasseter, R. H., &Paigi, P. *Microgrid: A Conceptual Solution*. IEEE Transactions, 2004.
[2] A. Keyhani et al., *Integration of Green and Renewable Energy in Electric Power Systems*, Wiley-IEEE Press, 2009.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment 1(Based on Units I and II)(Deadline: before Insem)	5
2	Assignment 2 (Based on Units III and IV)(Deadline: before Endsem)	5
3.	LMS Tests (Best 5 out of a Minimum of 10)	5
4.	Class Test (Before End Sem on Units III, IV, V) OR Group activity-simulation topics and case study problems	5

Final Year B. Tech.
Pattern: 2022 Semester: VIII (Electrical Engineering)
ELE224016A: AI and ML Application in Electrical Engineering

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 2 Hrs./Week	TH: 2	InSem Exam: 20 Marks End Sem Exam: 30 Marks

Prerequisite Courses: Basics of programming

Course Objectives: The course objectives are to

1. Enable students to understand the fundamentals of Artificial Intelligence and Machine Learning.
2. Develop skills in pattern recognition, neural networks, and soft computing techniques.
3. Develop skills to apply AI and ML for optimization, classification, and decision-making in electrical engineering.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Explain AI, ML, and DL concepts, learning types, and statistical reasoning to distinguish intelligent from traditional systems.	2 - Understand 4 -Analyze
CO2	Develop models using neural networks and soft computing to solve engineering problems with AI/ML tools.	3 - Apply
CO3	Apply AI/ML to optimize and automate electrical engineering tasks like forecasting and system monitoring.	3 - Apply 5 - Evaluate

COURSE CONTENTS

Unit I	Introduction to AI and ML	06hrs.	CO1, CO2

Basics of AI, ML, and DL; Types of learning: Supervised, Unsupervised, Reinforcement; AI vs traditional algorithms; Tools and platforms.

Unit II	Statistical Learning	06 hrs.	CO1, CO3

Statistical Reasoning: Probability and Daye's Theorem. Certainty factor and rule-based systems. Bayesian Networks, Dempster-Shafer theorem. Semantic nets and frames, Scripts. Examples of knowledge-based systems.

Unit III	Artificial Neural Networks	06hrs.	CO2, CO3

Artificial Neural Networks: Biological Neuron, Neural Net, use of neural nets, applications, Perception, idea of single layer and multilayer neural nets, back propagation, Hopfield nets, supervised and unsupervised learning.

Unit IV	Soft Computing Techniques	06 hrs.	CO2, CO3

Introduction, overview of particle swarm optimization, overview of differential evolution, and Overview of whale optimization.

Unit V	AI/ML Applications in Electrical Engineering	06 hrs.	CO1, CO3

Load forecasting using ML models; Fault detection and classification in power systems; Energy demand prediction and optimization; Condition monitoring of electrical equipment using AI; Renewable energy forecasting (solar, wind); Electric vehicle (EV) integration and scheduling using AI.

Text Books

1. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall
2. J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine

Learning), Create Space Independent Publishing Platform, First edition, 2016
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, “The Elements of Statistical Learning”, Second Edition. 2009.

Reference Books

1. Dan W Patterson, “Introduction to Artificial Intelligence & Expert Systems”, PHI,2010, 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed., 2011
2. Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw-Hill
3. Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson

Final Year B.Tech.
Pattern:2022 Semester: VIII (Electrical Engineering)
ELE224016B: Advanced Control System

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory: 2 hrs/week	TH: 2	InSem Exam: 20Marks EndSem Exam: 30Marks

Prerequisite Courses: Control System Engineering, Engineering Mathematics III, Electrical Network Analysis.

Course Objectives: The objectives of the course are to

1. Expose students to the concepts in control system design using the state-space technique, concepts in nonlinear control systems and concepts in digital control systems.
2. Impart knowledge on designing control systems using pole-placement methods and state observer techniques.
3. Introduce optimal and robust control design strategies, including Linear Quadratic Regulator (LQR), Kalman filtering, and H∞ control methods.
4. Familiarize students with digital, nonlinear, adaptive, and sliding mode control systems and their applications in modern automation and electrical systems.

Course Outcomes: On completion of the course, students will be able to–

CO	Course Outcomes	Bloom's Level
CO1	Define terms and terminologies in state-space, nonlinear control and digital control	2-Understand
CO2	Explain advanced control methods, including sliding mode control, robust control, and adaptive control, along with their applications	2-Understand
CO3	Determine the stability of a nonlinear system and a digital control system	3-Apply
CO4	Design state feedback controls and observers for the system.	3-Apply

COURSE CONTENTS

Unit I	State Space Analysis and Design	06hrs	CO1, CO4

State-Space Review, State equation and its solution, state transition matrix and its properties, computation of state transition matrix by Laplace transform and Cayley-Hamilton method,
Control system design using pole-placement using transformation matrix, direct substitution, and Ackermann's formula, State observers, and design of a full-order observer.

Unit II	State-Space Design	06hrs	CO1, CO4

State Observer- design of full order observer, Optimal Problems, Optimal control design (Linear Quadratic Regulator Design), Kalman filtering and estimation

Unit III	Nonlinear Control Systems	06hrs	CO1, CO3

Introduction to nonlinear systems, common nonlinearities, describing function method, describing functionof an ideal relay, stability analysis with describing function, introduction to Lyapunov stability analysis(basic concepts, definitions, and stability theorem)

Unit IV	Introduction to Digital Control Systems	06hrs	CO1, CO3

Basic block diagram of the digital control system, sampling and reconstruction, Shannon's Sampling Theorem, zero-order hold and its transfer function, First-order hold (no derivation), characteristic equation,mapping between the s-plane and z-plane, and stability analysis in the z-plane.			
Unit V	**Advanced Topics in Control Systems and Applications**	**06hrs**	**CO1, CO2**
Concept of sliding mode control, equivalent control, chattering, sliding mode control based on reaching law, Introduction to adaptive control, adaptive schemes, Introduction to robust control techniques (H∞ control basics), Distributed control system and applications to electrical systems			

TextBooks

1. Norman S. Nise, Control System Engineering, Sixth Edition, John Wiley and Sons, Inc., 2011
2. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Twelfth Edition, Pearson Education.
3. Benjamin C. Kuo, Digital Control System, Second Edition, Oxford University Press, 2003.
4. I. J. Nagarath, M. Gopal, Control System Engineering, Fourth Edition, New Age International (P) Limited, Publishers
5. A. Nagoor Kani, Advanced Control Theory, Third Edition, CBS Publishers and Distributors, 2020.

Reference Books

6. Katsuhiko Ogata, Modern Control Engineering, Fifth Edition, Prentice-Hall, 2010
7. M. Gopal, Digital Control and State Variable Methods, Tata McGraw-Hill.
8. K. Ogata, Discrete-Time Control System, Second Edition, PHI Pvt. Ltd. 2006
9. M. Gopal, Modern Control Systems Theory, Second Edition, New Age International (P) Limited, Publishers
10. Karl J. Åström, BjörnWittenmark, Adaptive Control, Second Edition, Dover Publications, Inc., New York

NPTEL Course:

11. https://nptel.ac.in/courses/108102043
12. https://nptel.ac.in/courses/108102113

Final Year B. Tech. Pattern: 2022/Semester: VIII (Electrical Engineering) ELE224017: Research Methodology		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 3 Hrs./Week	**Th-3**	**Continuous Comprehensive Evaluation: 20 Marks** **InSem Exam: 20 Marks** **EndSem Exam: 60 Marks**

Prerequisite Courses: IPR and Patents, Software for Research.

Course Objectives: The objectives of the course are to

1. Introduce the fundamentals of research and be able to identify and formulate research problems.
2. Develop skills for conducting a literature review and identifying research gaps.
3. Analyze and apply appropriate research designs, data collection methods, and data analysis techniques.
4. Develop awareness of research ethics and intellectual property rights (IPR).
5. Train students in writing and presenting research reports effectively.

Course Outcomes: On completion of the course, students will be able to–

Course Outcomes		Bloom's Level
CO1	Understand the fundamentals, types, and processes of research	2- Understand
CO2	Formulate research problems, objectives, and hypotheses	3- Apply
CO3	Use various research designs, data collection tools and techniques for data analysis	3 – Apply
CO4	Understand research ethics and intellectual property rights, and write research reports and oral Presentations	3 – Apply

COURSE CONTENTS			COs mapped
Unit I	**Introduction to Research**	**09 hrs.**	**CO1, CO2**
Definition and Objectives of Research, Types of Research: Basic, Applied, Descriptive, Analytical, Empirical, Research Approaches and Methodologies, Research Process Overview, Criteria of Good Research.			
Unit II	**Research Problem and Review of Literature**	**09 hrs.**	**CO1, CO2**
Identifying and Defining the Research Problem, Research Questions and Hypothesis Formation, Characteristics of a Good Hypothesis, Importance and Methods of Literature Review, Sources: Journals (Impact factor and Journal Indexing), Databases, Books, Reports, etc., Gap Identification Techniques, Identifying Research Gap.			
Unit III	**Research Design and Data Collection and Analysis**	**09 hrs.**	**CO1, CO3**
Research Design Types: Exploratory, Descriptive, Experimental, Validity and Reliability in Research Types of Data: Primary and Secondary, Methods of Data Collection: Surveys, Interviews, Observation, Tools for Data Collection: Questionnaire Design, Scaling Techniques, Data Preparation: Editing, Coding, Tabulation, Research Analysis using AI Tools. Data Analysis Techniques: Descriptive and Inferential Statistics.			
Unit IV	**Research Ethics and Intellectual Property Rights**	**09 hrs.**	**CO1, CO4**
Ethical Issues in Research, Plagiarism and its Consequences, Plagiarism checker/software (Turnitin), History and Types of Intellectual Property Rights, viz. Copyrights, Patents, and Trademarks. Citation Styles: APA, MLA, IEEE, Ethical Guidelines for Human and Animal Research.			
Unit V	**Report Writing and Presentation**	**09 hrs.**	**CO1, CO4**

Structure and Components of a Research Report, Writing Styles and Formatting, Abstract, Introduction, Methodology, Results, Discussion, Conclusion, Referencing and Bibliography, Preparing and Delivering Oral Presentations, Publishing in Journals and Conferences.

Text Books

1. Louis Cohen, Lawrence Manion, and Keith Morrison, Research Methods in Education, 7th Edition, Cambridge University Press, ISBN – 978-0415-58336-7
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition, APH Publishing Corporation.

Reference Books

1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age Int. (P) Ltd. 2004
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An Introduction to Research Methodology, RBSA Publishers, 2002.
3. Suresh Sinha, Anil K Dhiman, Research Methodology, ESS Publications, Vol. 2.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1.	Assignment 1 (Based on Units I and II) (Deadline: before Insem)	5
2.	Assignment 2 (Based on Units III and IV) (Deadline: before Endsem)	5
3.	LMS (Best 5 sessions out of a Minimum of 10 sessions)	5
4.	AI Tools Demonstration for Research and Oral Presentation	5

Final Year B. Tech. Pattern 2022 Semester: VIII (Electrical Engineering) ELE224018: Massive Open Online Course (LHSM)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 2 Hrs./Week	**TH- 2**	**Continuous Comprehensive Evaluation: 50 Marks**
Prerequisite Courses: Nil		
COURSE CONTENTS		
Students have to select one of the following Online Courses available on the Swayam Platform and complete the course. Students have to submit the course completion certificate to the course teacher/coordinator.		
The List of Courses will be declared at the beginning of the semester.		

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Grading of the online course will be taken as it is and will be rounded to 50 marks.	50

Note: CO will be defined separately for each selected course by the course teacher, and later, CO-PO-PSO Mapping will be decided, which will be included in the Course Handout. If the course is not available in the SEM II, the new course list will be published.

Final Year B. Tech. Pattern: 2022 Semester VIII (Electrical Engineering) ELE224019: Project		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 8 Hours	**PR: 4**	**Termwork: 100 Marks** **Oral: 50 Marks**
Prerequisite Courses:		

Course Objectives: The objectives of the course are to

1. Provide an opportunity to learn new software, interdisciplinary theory, concepts, technology, etc., not covered in earlier subjects
2. Empower students to use engineering knowledge and skills learned in previous courses to deliver a product that has passed through the design, analysis, testing, and evaluation
3. Encourage multidisciplinary project work through the integration of knowledge
4. Allow students to develop problem-solving, analysis, synthesis, and evaluation skills.
5. Encourage teamwork.
6. Improve students' communication skills by asking them to produce both a professional report and to give an oral presentation
7. Exposed to the project management skills and ethical practices in the project.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	Bloom's Level
CO1	Identify tools, techniques, methods, concepts, measuring devices, and instruments required for the project to define the methodology of the project	2-Understand
CO2	Justify the selection of electrical, electronic and mechanical components for the project prototyping	3-Apply
CO3	Select the appropriate testing method for system performance evaluation	4-Analyze
CO4	Interpret the results obtained by simulation and hardware implementation, and decide on further action or write a conclusion	4-Analyze
CO5	Write a project report and research paper on the project work	3-Apply

Sr. No.	Project Activity	Deadline (Semester II)	Parameters for Evaluation
1	Progress Review-1 Presentation	Up to the 5th Week	Problem Definition (5) Scope & Objectives (10) Literature Review (10) Methodology (10) Block Diagram / Architecture (10) Project Planning (5) **Total Marks (50)**
2	Progress Review-2 Presentation	Up to 10th Week	Requirement Specification (10) Literature Review (revised) (5) Detailed Design (10) Experimental Setup/Simulation (10) Performance Parameters (10) Partial Conclusion (5) **Total Marks (50)**
3	Progress Review-3 Presentation	Up to 14th Week	Tools and Techniques Used with justification (10) Implementation/ development (15) Testing and Evaluation (10)

			Results and Conclusion (15) **Total Marks (50)**
4	Project Documentation	Simultaneous Work	Review 1+ Review 2+ Review 3+ Final Project Report (50) = 200 Rounded rounded to 100

Guidelines to students:

1. Form a group of 3-4 students.
2. Select a project problem statement based on an industrial or societal issue and ideate on it.
3. Research on the project topic through existing theories, literature, technology, patents, etc.
4. Define objectives, scope, and outcomes of the project in 1st presentation
5. Maintain a notebook to keep records of all the meetings, discussions, notes, etc. This is to be done by the individual student.
6. Some parameters, mentioned in the above table, will be evaluated and assessed at the group level and some at an individual level.
7. Identify opportunities for self-learning and upgrading skills.
8. Actively participate in all the activities related to the project.
9. Document the project in the form of a hard-bound report at the end and submit it to the department.
10. Attempt to make a prototype, working model, and demonstration of the project to display during the final presentation.
11. Participate in project competitions, paper presentations, etc.
12. Maintain an institutional culture of authentic collaboration, self-motivation, peer learning, and personal responsibility.
13. Maintain a notebook to keep records of all the meetings, discussions, notes, etc. This is to be done by the individual student and submitted at the end to the supervisor or guide.
14. Some parameters, mentioned in the above table, will be evaluated and assessed at a group level and some at an individual level.