Institute of Engineering and Technology Lucknow

M. Tech.
(Power & Energy System)

Second Year Syllabus

Based on
CHOICE BASED CREDIT SYSTEM (CBCS) & NEP2020
(Effective from the session: 2023-24)

Department of Electrical Engineering
Institute of Engineering and Technology, Lucknow
(Constituent Institute of Dr. A.P.J. Abdul Kalam Technical University, Lucknow)

Semester - III												
S. No.	**Subject Code**	**Name of Subject**	**Periods**				**Evaluation Scheme**					
							Theory			**Practical**		**Subject Total**
			L	**T**	**P**	**Credit**	**CT**	**TA**	**ESE**	**TA**	**ESE**	
1	MAPE041-MAPE044	Departmental Elective-IV	4	0	0	4	20	10	70	-	-	**100**
2	MAPE351	Dissertation-I	0	0	20	10	-	-	-	100	200	**300**
3	MAPE352	Seminar-II	0	0	3	2	-	-	-	100	-	**100**
Total Contact Hours: 27						**16**						**500**

Semester - IV												
S. No.	**Subject Code**	**Name of Subject**	**Periods**				**Evaluation Scheme**					
							Theory			**Practical**		**Subject Total**
			L	**T**	**P**	**Credit**	**CT**	**TA**	**ESE**	**TA**	**ESE**	
1	MAPE451	Dissertation-II	0	0	32	16	-	-	-	150	350	**500**
Total Contact Hours: 32						**16**						**500**

Departmental Elective-IV (MAPE041-MAPE043)	
MAPE041	Modern Power System Protection
MAPE042	Advanced Electric Drives
MAPE043	Application of Artificial Intelligence in Power System

MAPE041 MODERN POWER SYSTEM PROTECTION L T P 4 0 0

Prerequisite: Power System

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Analyze the important operating principle and design of the digital protection relay for modern power system.	**4**
CO2	Differentiate the various subsystems of digital protection relaying architecture.	**4**
CO3	Explain the various types of Current Transformers and Potential Transformers and their construction and accuracy type, working principle and basic components of wide area measurement systems.	**2**
CO4	To monitor the concept of auto reclosing and all types of auto reclosing.	**4**
CO5	To analyze the concept of synchronizing phase measurement unit and concept of wide area measurement.	**4**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE041.CO1	2		3		
MAPE041.CO2	2		2	2	2
MAPE041.CO3	2		2	2	1
MAPE041.CO4	2			2	3
MAPE041.CO5	2		1	3	2

UNIT-I

INTRODUCTION TO DIGITAL PROTECTION RELAYS-1: Classification of protective relays, Electro-mechanical solid state and digital relays, adoptive relaying, tripping mechanism of relay, different relay algorithms, Comparison of digital relays with previous generation relays, Microprocessor Based Protective Relays: (Block diagram and flowchart approach only)

UNIT-II

INTRODUCTION TO DIGITAL PROTECTION RELAYS-2: Basic Components of Digital Relays with block diagram, Signal Conditioning Subsystems, Surge Protection Circuits, Anti-aliasing filter. Conversion Subsystem, The Sampling Theorem, Sample and Hold Circuit, Concept of analog to digital and digital to analog conversion, Idea of sliding window concept, introduction to intelligent electronic device (IED), Fourier analysis based half cycle and full cycle algorithm.

UNIT-III

MEASUREMENT FOR PROTECTION AND COORDINATION OF RELAYS IN AN INTERCONNECTED POWER SYSTEM NETWORK: Protection of an interconnected system, Flowchart of Primary/Backup relay pairs, Flowchart of Time Multiplier Setting. Examples based on existing power system network.
PROTECTIVE CURRENT & POTENTIAL TRANSFORMERS: Different Types, Accuracy, burden, Polarity and Transient Response.

UNIT-IV

AUTO-RECLOSING AND SYNCHRONIZING: Introduction, advantageous of auto-reclosing, classification of auto-reclosing, Sequence of events in single-shot auto-reclosing scheme, dead time, reclaim time, instantaneous trip lockout, intermediate lockout, breaker supervision function, Synchronism check, phasing voltage method, angular method, automatic synchronization.

UNIT-V

COMPLEX TRANSMISSION PROTECTION: Introduction, Single-Phase Switching of EHV Lines, Protection of Multi-terminal Lines, Protection of Mutually Coupled Lines.
WIDE AREA PROTECTION AND MEASUREMENT: Definition of wide-area protection, Architectures of wide-area protection, concept of synchronized sampling, Wide area phasor measurement technology.

Reference Books:

1. Badri Ram and D. N. Vishwakarma, “Power system protection and Switch gear “, TMH publication.
2. T.S. Madhava Rao, “Static relays”, TMH publication.
3. L. P. Singh, “Digital Protection- Protective Relaying from Electromechanical to Microprocessor”, New Age International.
4. Bhavesh Bhalja, R. P. Maheshwari, Nilesh G. Chothani, “Protection and Switchgear”, Oxford University Press.
5. Patra Basu & Choudhary, “Power System Protection”, Oxford & IBH.
6. P. M. Anderson, “Power System Protection”, IEEE PRESS The Institute of Electrical and Electronics Engineers, Inc, New York.

MAPE042 ADVANCED ELECTRIC DRIVES L T P 4 0 0

Prerequisite: Electric Drives

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Comprehend state of the art and review of AC and DC motors and converters.	**2**
CO2	Analyze the performance of dc drives and four quadrant operation.	**4**
CO3	Analyze the performance of AC drives and their control.	**4**
CO4	Design the special drives and compare the performance with the existing one.	**5**
CO5	Estimate & solve harmonics and power factor related problems in controlling AC and DC drives.	**5**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE042.CO1					
MAPE042.CO2					
MAPE042.CO3					
MAPE042.CO4					
MAPE042.CO5					

UNIT I

FUNDAMENTALS OF ELECTRIC DRIVE AND CONVERTERS: Overview of Drive: Drive Requirements & Specification, Drive Classification & Characteristics, Load Profile & Characteristics.

Overview of Converters: Rectifier, Chopper, Inverter, Cyclo-converter, and AC voltage regulators. Effects of power electronic equipment on load side & supply side.

UNIT II

DC DRIVES: DC Converter & Chopper fed DC drive, Reversing, Starting, Regenerative braking, Four-quadrant operation, and High power application.

UNIT III

AC DRIVE: Inverter & Cyclo-converter fed drive, Linear electrical motor concept, Synchronous motor drive & Induction Motor Drive (AC Chopper Drive/ AC-AC converter fed Drives).

UNIT IV

SPECIAL DRIVES: Switched reluctance& permanent magnet brushless DC Operation, Converters, Characteristics & Control, PLC based drives.
Servo drives & stepper motor- AC & DC Servomotor, Stepper motor, Control techniques, Controllers,Micro stepping.

UNIT V

Sensor less Vector and Direct-Torque Controlled Drives, AI-Based Drives, Fuzzy Logic in Electric Drive.

Reference Books:

1. Ned Mohan, T.M. Undeland, W.P. Robbins, "Power Electronics-Converters, Applications andDesign", John Wiley & Sons.
2. M H Rashid, "Power Electronics Handbook", Academic Press.
3. P.C. Sen, "D.C. drive", Pergamon Press.
4. B.K. Bose, "Power Electronics & AC drive", Prentice Hall.
5. Dubey G.K. "Power semi-Conductor controller drives", Prentice Hall.
6. Vedam Subramanyam, "Electrical Drives", McGraw Hill.
7. T.J.E. Miller, "Switched Reluctance & P.M. B.L. DC motor", Pergamon Press.

MAPE043 APPLICATION OF ARTIFICIAL INTELLIGENCE IN POWER SYSTEM **L T P 4 0 0**

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Describe fundamental understanding of the history of artificial intelligence (AI) and its foundations.	**2**
CO2	Describe fundamental understanding of applications of AI techniques to power system.	**2**
CO3	Describe the methodology of fuzzy logic to power system.	**2**
CO4	Describe the methodology of genetic algorithms to power system.	**2**
CO5	Demonstrate application of Artificial Intelligence techniques in power system.	**3**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE043.CO1					
MAPE043.CO2					
MAPE043.CO3					
MAPE043.CO4					
MAPE043.CO5					

UNIT-I

Artificial Intelligence: History and Applications Introduction, Intelligence, Communication, Learning, Artificial Intelligence, History, Early Works, Importance, Definitions, Programming Methods, Techniques, Growth of AI, AI and Industry, Current Trends in Applied AI.

UNIT-II

Artificial Neural Network: difference between human machine and intelligence, biological neural network, artificial neuron model, Concept of Perceptron, Feedback in Neural Network, Neural Network Architectures: Neural Learning, Application of Neural Network in Power System.

UNIT-III

Fuzzy Logic: Introduction, Foundation of Fuzzy Systems, Representing Fuzzy Elements, Basic Terms and Operations, Properties of Fuzzy Sets, Fuzzification, Arithmetic Operations of Fuzzy Numbers, Fuzzy Linguistic Descriptions, Fuzzy Relation Inferences, Fuzzy Implication and

Algorithms, Defuzzification Methods, Centre of Area Defuzzification, Centre of Sums Defuzzification.

UNIT-IV

Genetic Algorithms: Fundamentals, History, working principal, genetic modeling, encoding, fitness function, Genetic operators: reproduction, cross over, mutation, Similarities and differences between GAand traditional methods; Unconstrained and constrained optimization using Genetic Algorithm.

UNIT-V

Application of AI in Power Systems: Application of Neural Network and Expert Systems in Voltage Control, Application of ANN for security assessment, Schedule Maintenance of Electrical Power Transmission Networks using Genetic Algorithm, Intelligent Systems for Demand Forecasting.

Reference Books:

1. N. P. Padhy, “Artificial Intelligence and Intelligent Systems, OXFORD University Press.
2. Artificial Intelligence and Intelligent Systems, Oxford University Press
3. S. Rajasekaran and G. A. V. Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications”, PHI New Delhi.
4. Kalyanmoy Deb “Optimization for Engineering Design”, PHI publication.
5. Kevin Warwick, Arthur Ekwue, R. Agrawal “Artificial intelligence techniques in power systems”, IET.
6. K. Warwick, A. Ekwue and R. Aggarwal Artificial Intelligence Techniques in Power Systems, IEEE Power Engineering Series.

MAPE351 DISSERTATION-I L T P 0 0 3

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Identify key research and development topics in the field of chosen dissertation area.	
CO2	Identify, summarize, and critically evaluate relevant literature for further research.	
CO3	Identify research gaps based on literature survey and prepare effective action plan.	
CO4	Propose the appropriate modern tools and techniques for research.	
CO5	Identify the crisp research objective (at least three objectives)	

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE351.CO1	2		3	2	2
MAPE351.CO2	2	2	2	1	1
MAPE351.CO3	3	1	2	3	
MAPE351.CO4	1		2	3	3
MAPE351.CO5	2	3	3	1	1

Internal Evaluation

Impact analysis of area/sub area of work + Presentation strategy	Formulation of research problem, identification of objective	Review of literature	Material and research methodology	Results/ Comparison with existing methods/Publication	Answer to Queries	**Total**
15	**15**	**10**	**20**	**30**	**10**	**100**

External Evaluation

Impact analysis of area/sub area of work + Presentation strategy	Formulation of research problem, identification of objective	Review of literature	Material and research methodology	Results/ Comparison with existing methods/Publication	Answer to Queries	**Total**
25	**25**	**20**	**50**	**70**	**10**	**200**

MAPE352 SEMINAR-II L T P 0 0 3

	Course Outcome	*KL/ BL*
	Upon the completion of the course, the student will be able to:	
CO1	Demonstrate a sound technical knowledge after doing literature review on selected topic and explain factual knowledge of current areas of research.	
CO2	Develop and improve technical writing and presentation skills & demonstrate the knowledge, skills, and attitudes of a professional engineer	
CO3	Undertake problem identification, formulation, and solution.	
CO4	Be conversant with the latest developments in power and energy system and evaluate the impact of various technologies on environment	
CO5	To judge the value of different contributions & identify promising new directions.	

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5
MAPE352.CO1	3	2	3	3	1
MAPE352.CO2	1	3	2	2	1
MAPE352.CO3	3	2	2	2	3
MAPE352.CO4	2		3	2	3
MAPE352.CO5	1		2	1	3

Internal Evaluation

Review of literature	Subject Knowledge	Presentation • Speaking Skills • Audience Interaction • Visuals • Organization	Conclusions and Future Scope	Report	Answer to Queries	Total
15	15	40	10	10	10	**100**

MAPE451 DISSERTATION-II L T P 0 0 32

	Course Outcome	*KL/ BL*
	Upon the completion of the course, the student will be able to:	
CO1	Learn the application of proposed modern platforms for their research.	
CO2	Model, simulate/develop innovative hardware/develop new algorithms/ emulate/ HIL/ develop prototype for the selected topic.	
CO3	Analyze and interpret suitable data to enable the research question to be answered.	
CO4	Expertise in writing and oral presentation skills and also prepare peer reviewed publications for the journals and conferences.	
CO5	Apply the documentation process of carried out research in writing dissertation.	

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE451.CO1	2		2	3	1
MAPE451.CO2	1		3	3	2
MAPE451.CO3	3		2	3	2
MAPE451.CO4	1	3	2	2	
MAPE451.CO5		3	2	2	

Internal Evaluation

Impact analysis of area/sub area of work + Presentation strategy	Formulation of research problem, identification of objective	Review of literature	Material and research methodology	Results/ Comparison with existing methods/Publication	Answer to Queries	**Total**
20	**20**	**20**	**35**	**45**	**10**	**150**

External Evaluation

Impact analysis of area/sub area of work +	Formulation of research problem,	Review of literature	Material and research methodology	Results/ Comparison with existing methods/Publication	Answer to Queries	**Total**

Presentation strategy	identification of objective					
45	**45**	**45**	**90**	**110**	**15**	**350**