Institute of Engineering and Technology, Lucknow

EVALUATION SCHEME & SYLLABUS

FOR

B.TECH. IV YEAR

ELECTRICAL ENGINEERING

BASED ON

(AICTE MODEL CURRICULUM & NEP2020)

[Effective from the Session: 2025-26]

ELECTRICAL ENGINEERING

EVALUATION SCHEME - B. TECH 4th YEAR 2025-26

			SEMESTER- VII										
Sr. No.	**Course Code**	**Course Title**	**Type of Course**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credits**
				L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	IHU701	Project Management & Entrepreneurship	HSMC	3	0	0	20	10	30	--	70	--	100	3
2	IEE070-IEE079	Program Elective Course-IV	PEC Regular Class Room Teaching/ MOOCs	3	0	0	20	10	30	--	70	--	100	3
3	IOE070-IOE079	Open Elective-II	OEC	3	0	0	20	10	30	--	70	--	100	3
4	IOE080-I0E89	Open Elective-III	OEC	3	0	0	20	10	30	--	70	--	100	3
5	IEE751	Project	PL	0	0	8	--	--	--	100	--	0	100	4
6	IEE752	Internship Assessment/ Mini Project/ Start-up & Entrepreneurship Assessment*	PL	0	0	2	0	0	0	100	0	0	100	2
7		MOOCs (for Honours. Degree)/Minor Degree												
		TOTAL		**12**	**0**	**10**							**600**	**18**

*The Internship Assessment/Mini Project or (5-6 weeks) conducted during summer break after VIth semester and will be assessed during VIIth semester.

List of Program Elective - IV

IEE070: Embedded Systems
IEE071: Energy Conservation and Auditing
IEE072: HVDC & AC Transmission
IEE073: High Voltage Engineering
IEE074: Power Quality and FACTS
IEE075: Electric drives
IEE076: Power System dynamics and Control
IEE077: Power System Protection
IEE078: Deregulated Power System
IEE079: Utilization of Electrical Energy & Electric Traction

ELECTRICAL ENGINEERING

EVALUATION SCHEME - B. TECH 4th YEAR 2025-26

SEMESTER- VIII

Sr. No.	Course Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	IEE851	Project/Industrial Project	0	0	24	--	--	--	150	--	350	500	12
2		MOOCs (for Hons. Degree)/ Minor Degree											
		Total	**0**	**0**	**24**							**500**	**12**

PROGRAM ELECTIVE – IV

(IEE070-IEE079)

[L T P: 3 0 0]

IEE070: EMBEDDED SYSTEMS

Pre-requisites of course: Digital Electronics, C Programming, Microprocessors / Microcontrollers

COs	Couse Outcome Statement	Knowledge Level, KL
CO1	Explain the fundamentals, design metrics, and application domains of embedded systems.	K2
CO2	Understand the architecture, memory, I/O devices, and communication interfaces of embedded hardware.	K2
CO3	Develop embedded programs using C, device drivers, and apply RTOS concepts in system design.	K5
CO4	Evaluate system design approaches, hardware–software partitioning, and use appropriate debugging/testing tools.	K5
CO5	Design and present embedded system applications in real-life domains considering innovation and sustainability.	K6

CO-PO Mapping Matrix/Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
IEE070.C1	2		2	2									1	
IEE070.C2	2		2	2									1	
IEE070.C3	2	2	2	2									1	
IEE070.C4	2			2									1	
IEE070.C5	3		1	2									1	

Syllabus	Contact Hours
Unit-1: Introduction to Embedded Systems	**8**
Definition and characteristics of embedded systems; application areas and examples; hardware–software co-design; design challenges – performance, power, cost, reliability; real-time requirements.	
Unit-2: Embedded Hardware	**8**
Microcontrollers and microprocessors basics; processor architecture (ARM/RISC concepts); memory – ROM, RAM, Flash, EEPROM; I/O devices; sensors and actuators; ADC/DAC; communication interfaces – UART, SPI, I2C, CAN, USB.	
Unit-3: Embedded Software	**8**
Embedded C programming; cross-compilers, assemblers, and linkers; firmware development; device drivers; interrupts and exceptions; real-time operating systems (RTOS) – tasks, scheduling, inter-task communication.	
Unit-4: System Design and Development Tools	**8**
Embedded system design cycle; hardware–software partitioning; debugging and testing tools – simulators, emulators, logic analyzers; development platforms and IDEs; case study of an embedded application.	
Unit-5: Applications of Embedded Systems	**8**
Consumer electronics; automotive systems; industrial automation; medical electronics; defense applications; IoT and wireless sensor networks; smart devices and energy-efficient systems; case study.	

Reference/Text Books

1. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufmann.
2. Kamal R., Embedded Systems – Architecture, Programming and Design, Tata McGraw-Hill, 2008.
3. Vahid F. & Givargis T., Embedded System Design, Wiley India, 2008.
4. Maxfield C. M., The Design Warrior's Guide to FPGAs, Newnes, 2006.
5. Berger A. S., Embedded System Design, CMP Books, 2001.
6. Labrosse J. J., Embedded Systems Building Blocks, CMP Books, 1999.
7. Barr M., Programming Embedded Systems in C and C++, O'Reilly, 1999.

IEE071: ENERGY CONSERVATION AND AUDITING

Pre-requisites of course: Basic Electrical Engineering, Power System-I & II

Course Outcomes Statement:

COs	CO Statement	*KL/BL*
CO1	Describe the energy landscape, including classification, policies, conservation methods, and the importance of renewable energy sources in ensuring sustainable development.	**KL2**
CO2	Explain a comprehensive energy management strategy, including key elements and responsibilities, and evaluate energy efficiency programs and systems.	**KL2**
CO3	Describe various types of energy audits to maximize system efficiency and optimize energy requirements, utilizing appropriate instruments and techniques.	**KL2**
CO4	Describe strategies for energy conservation and efficiency in electrical utilities, including power factor management, DSM, and the application of energy-saving techniques in various systems.	**KL2**
CO5	Explain the historical evolution and current framework of national energy policies, understanding their impact on energy markets and climate change concerns, and the role of key stakeholders.	**KL2**

				CO-PO Mapping Matrix/Course Articulation Matrix									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE071.C1	3					1						1	1	1
IEE071.C2	3					1						1	1	1
IEE071.C3	3	2			2	2						1	1	1
IEE071.C4	3	2				2						1	1	1
IEE071.C5	3					1						3	1	1

Syllabus	Contact Hours
Unit-1: Energy Scenario Energy sources-Primary and Secondary, Commercial and Non-commercial, Energy scenario in India and Global scenario, Energy Security, Energy and GDP, Energy Intensity, Energy conservation and its importance, Energy Conservation Act 2001 and related policies, The Electricity (Amendment) Bill, 2022, Schemes of Bureau of Energy Efficiency (BEE), Energy Conservation and Building Code (ECBC), Role of Non- conventional and Renewable Energy.	**8**
Unit-2: Energy Management and Integrated Resource Planning Definition and Objectives of Energy management, Energy management strategy, Key elements, Responsibilities and duties of Energy Manager, Energy efficiency Programs, Energy Monitoring and Targeting System, Importance of SCADA, Analysis techniques, Cumulative sum of differences (CUSUM), Energy Management Information Systems (EMIS)	**8**
Unit-3: Energy Audit Definition, need of energy Audit, Types of Energy Audit, Maximizing system efficiency, Optimizing the input energy requirements, fuel and energy substitution, Energy Audit instruments and metering, thermography, Smart metering, Case studies on energy auditing in residential, Industrial, and Commercial Sectors.	**8**

Unit-4: Energy Efficiency in Electrical Utilities Electrical billing, Electricity (Rights of consumers) Rules, power factor management, distribution and transformer losses, losses due to unbalance and due to harmonics, Demand Side Management, DemandResponse, Role of tariff in DSM and in Energy management, ToU/ToD tariff, Power factor tariff, Integrated Resource Planning and Energy Management Energy conservation in Lighting systems, HVAC, Electric Motors, Pump and Pumping systems	**8**
Unit-5: National Energy Policy Historical context and evolution of energy policies, Current energy mix and consumption patterns, Key stakeholders: Government, private sector, and international organizations, Key components of the new energy policy, Objectives and targets: 2022 Renewable Energy Goals, National Solar Mission, Legislative and regulatory framework, Role of policy in shaping energy markets, Climate change concerns.	**8**

Reference/Text Books

1. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRCPress
2. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press
3. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A WileyInterscience publication 4. Heating and Cooling of Buildings -Design for Efficiency, J. Krieder and A. Rabl, McGraw Hill Publication, 1994.
5. Draft National Energy Policy-NITI Ayog, Government of India, 2017

Websites

1. Ministry of New and Renewable Energy (MNRE)- https://mnre.gov.in/
2. NITI Aayog- https://www.niti.gov.in/
3. International Renewable Energy Agency (IRENA)- https://www.irena.org/

IEE072: HVDC & AC TRANSMISSION

Pre-requisites of the course: Power System-I & II

COs	Course Outcome Statement	Knowledge Level (KL)
CO1	Describe the comparison of EHVAC and HVDC transmission while understanding various issues related to transmission.	**K1**
CO2	Calculate and study the corona loss and its impacts. Cite examples of the causes of switching overvoltage, Ferro-resonance.	**K3**
CO3	Explain the generation and measurement circuits for impulse, high DC & AC voltages. While considering the design parameters evaluate the effect on the performance of the EHV lines.	**K2**
CO4	Classify the DC links and choice of converter configuration to investigate the impact of inductance on operation of converters and identify different control schemes as well as starting and stopping methods of DC links.	**K4**
CO5	Describe the converter faults, protections including MTDC types and applications.	**K2**

CO-PO Mapping Matrix/Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IEE072.C1	1	2	3	3	1	3	3	0	3	3	2	1
IEE072.C2	2	2	2	2	2	0	0	3	3	2	2	2
IEE072.C3	3	2	0	0	1	0	3	0	3	3	0	3
IEE072.C4	2	3	1	0	2	3	3	0	2	3	2	2
IEE072.C5	3	1	0	2	0	3	3	2	3	3	2	2

UNIT-I: EHV transmission, standard transmission voltage, comparison of EHV AC & DC transmission systems and their applications & limitations, surface voltage gradients in conductor, distribution of voltage gradients on sub-conductors, mechanical considerations of transmission lines, modern trends in EHV AC and DC transmission, UHVAC transmission system.

UNIT-II: EHV AC Transmission: Corona loss formulas, corona current, audible noise – generation and characteristics corona pulses their generation and properties, radio interference (RI) effects, over voltage due to switching, ferro-resonance, reduction of switching surges on EHV system, principle of half wave transmission.

UNIT-III: Extra High Voltage Testing: Characteristics and generation of impulse voltage, generation of high AC and DC voltages, measurement of high voltage by sphere gaps and potential dividers.

Consideration for Design of EHV Lines: Design factors under steady state limits, EHV line insulation design based upon transient over voltages. Effects of pollution on performance of EHV lines.

UNIT-IV: EHV DC Transmission – I: Types of dc links, converter station, choice of converter configuration and pulse number, effect of source inductance on operation of converters, working principle and characteristics of a 6 pulse converter with two & three valve conduction mode, three valve conduction mode and three and four valve conduction mode, Principle of DC link control, converter

controls characteristics, firing angle control, current and excitation angle control, power control, starting and stopping of DC link.

UNIT-V: EHV DC Transmission – II: Converter faults, protection against over currents and over voltages, smoothing reactors, generation of harmonics, AC and DC filters, Multi Terminal DC systems (MTDC): Types, control, protection and applications.

Text Books:

1. R. D. Begamudre, "Extra High Voltage AC Transmission Engineering" Wiley Eastern.
2. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Reactions" New AgeInternational.
3. J. Arrillaga, "High Voltage Direct Current Transmission" IFFE Power Engineering Series 6, PeterPeregrinus Ltd, London.
4. M. S. Naidu & V. Kamaraju, "High Voltage Engineering" Tata Mc Graw Hill.

ReferenceBooks:

5. M. H. Rashid,"PowerElectronics: Circuits, Devices and Applications" Prentice Hall of India.
6. S. Rao, "EHV AC and HVDC Transmission Engineering and Practice" Khanna Publisher.
7. "EPRI, Transmission Line Reference Book, 345 KV and above" Electric Power Research Institute. PaloAlto, California, 1982.

IEE073: HIGH VOLTAGE ENGINEERING

Pre-requisites of course: Power System-I and II

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO1	Describe conduction and breakdown phenomenon in gases, liquid dielectrics and solid dielectrics.	K1
CO2	Explain generation of high voltages and currents	K2
CO3	Explain measurement techniques for high voltages and currents	K2
CO4	Describe overvoltage phenomenon and insulation coordination in electric power systems.	K2
	Describe non-destructive testing of materials and electric apparatus andhigh-voltage testing of electric apparatus	K2

CO-PO Mapping Matrix/Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IEE073.C1	2											
IEE073.C2	3	2	2									
IEE073.C3	3	3	2									
IEE073.C4	3	3										
IEE073.C5	3		3									

UNIT-I: Conduction and Breakdown in Gases:

Gases as Insulating Media, Collision Process, Ionization Processes, Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Experimental Determination of Coefficients α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges.

Conduction and Breakdown in Liquid Dielectrics:

Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids.

Breakdown in Solid Dielectrics:

Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.

UNIT-II: Generation of High Voltages and Currents:

Generation of high direct current voltages, generation of high alternating voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

UNIT –III: Measurement of High Voltages and Currents:

Measurement of high direct current voltages, measurement of high alternating and impulse voltages, measurement of high direct, alternating and impulse currents, Cathode Ray Oscillographs for impulse voltage and current measurements.

UNIT-IV: Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems

National Causes for Overvoltages - Lightning Phenomenon, Overvoltage due to Switching Surges, System Faults and Other Abnormal, Principles of Insulation Coordination on High Voltage and Extra High Voltage Power Systems.

UNIT-V: Non-Destructive Testing of Materials and Electrical Apparatus

Measurement of dielectric constant and loss factor, partial discharge measurements

High Voltage Testing: Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, testing of transformers, testing of surge arresters, radio interference measurements.

Text Books:

1. M. S. Naidu and V. Kamaraju, “High Voltage Engineering, Tata Mc-Graw Hill.
2. C. L. Wadhwa, “High Voltage Engineering”, Wiley Eastern Ltd.

Reference Books:

1. E. Kuffel and W. S. Zacngal, High Voltage Engineering”, Pergamon Press.
2. M. P. Chaurasia , “High Voltage Engineering”, Khanna Publishers
3. R. S. Jha, “High Voltage Engineering”, DhanpatRai& sons
4. M. Khalifa,’ High Voltage Engineering Theory and Practice,’ Marcel Dekker.
5. Subir Ray,’ An Introduction to High Voltage Engineering’ Prentice Hall of India

IEE074: POWER QUALITY AND FACTS

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Classify the power quality issues in electrical distribution network	**CO1**	**K2**
Describe the sources and mitigation methods of power quality issues.	**CO2**	**K2**
Describe working principle of various power-quality-conditioners.	**CO3**	**K2**
Describe concepts of FACTS and classification of FACTS Controllers	**CO4**	**K2**
Explain the working and application of shunt, series, and combined FACT Controllers.	**CO5**	**K2**

				CO-PO Mapping Matrix/Course Articulation Matrix									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE074.C1	2	2		1									1	1
IEE074.C2	2	2		1									1	1
IEE074.C3	2	2		1	1								1	1
IEE074.C4	2	3		1									1	1
IEE074.C5	2	3		1	1								1	1

Syllabus	Contact Hours
Unit-I: Introduction to Power Quality	**08**
Impacts of Power Quality Problems on End Users, Power Quality Standards, Power Quality Monitoring, POWER QUALITY TERMS AND DEFINITIONS: Transients, Short Duration Voltage Variations, Long Duration Voltage variations, Voltage Imbalance, Waveform Distortion, Voltage Fluctuations, Power Frequency Variations, Power Acceptability Curves.	
Unit-2: Sources and Mitigation of Power Quality Issues	**08**
POWER QUALITY PROBLEMS: Poor Load Power Factor, Loads Containing Harmonics, Notching in Load Voltage, DC Offset in Loads, Unbalanced Loads, Disturbance in Supply Voltage POWER QUALITY SOLUTIONS: Reduce Effects on Sensitive Equipment, Reduce or Eliminate Cause, Reduce or Eliminate Transfer Medium, Install Power Conditioning Equipment	
Unit-3: Power Quality Conditioners	**08**
Surge Suppressors, Noise Filters, Isolation Transformers, Line-Voltage Regulators, MotorGenerator Sets, Magnetic Synthesizers, Custom Power Devices, Uninterruptible Power Supply (UPS), Harmonic Filters, Selection of Appropriate Power Conditioning Equipment, Grounding and Wiring Solutions	
Unit-4: Introduction to FACTS	**08**
Transmission Interconnections, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers -Shunt Connected Controllers, Series Connected Controllers, Combined Shunt and Series Connected controllers.	
Unit-5: FACTS Controllers	**08**
Impedance based Controllers: Principle of operation TCR, Principle of operation of FCTCR(SVC) and TCSC. Voltage Source Converter (VSC) base Controllers: Basic concept of VSC, Principle of operation VSC type shunt compensator (STATCOM), series compensator (SSSC), and combined Controller (UPFC). Comparison of FACTS Controllers with Custom Power Devices.	

Reference/Text Books

1. Roger C Dugan, McGrahan, Santoso&Beaty, “Electrical Power System Quality” McGraw Hill
2. Arindam Ghosh & Gerard Ledwich, “Power Quality Enhancement Using Custom Power Devices” Kluwer Academic Publishers
3. C. Sankaran, “Power Quality” CRC Press.
4. S. Sivanagaraju& S. Satyanarayana, “Electric Power Transmission and Distribution” Pearson Education
5. Narain G. Hingorani& Laszlo Gyugyi “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems” Wiley
6. Ghosh, Arindam, and Gerard Ledwich. Power quality enhancement using custom power devices.
7. Springer science & business media, 2012.
8. Kennedy, Barry W. "Power quality primer." (No Title) (2000).

IEE075: ELECTRIC DRIVES

Pre-requisites of the course: Power Electronics, Electrical Machines-I & II

Course Outcome		**Knowledge Level**
Upon the completion of the course, the student will be able to:		
CO1	Describe the operation of electric drives and its classification.	**K1**
CO2	Explain the electric drive stability and selection of motor power rating.	**K2**
CO3	Illustrate electric braking and its dynamics.	**K3**
CO4	Describe the types of DC drives and its control.	**K2**
CO5	Describe the types of AC drives and its control.	**K2**

CO-PO Mapping Matrix/Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IEE075.C1	3				3				1			2
IEE075.C2	3				3				1			2
IEE075.C3	3	3	3		3				1			2
IEE075.C4	3				3				1			2
IEE075.C5	3				3				1			2

Detailed Syllabus	**Contact Hours**
Unit-1: Fundamentals of Electric Drive	**8**
Introduction: Introduction to electric drives, Block diagram, advantages of electric drives, Dynamics of motor load system, fundamental equations, and types of load, classification of load torque, four-quadrant operation of drives. Steady state stability. Introduction to closed loop control of drives.	
Unit-2: Dynamics of Electric Drive	**12**
Dynamics of motor-load combination, Steady state stability of Electric Drive, Transient stability of electric Drive ,DC motor drives- constant torque and constant power operation, separately excited dc motor drives using controlled rectifiers, single phase semi converter and single phase fully controlled converter drives. Closed loop control of separately excited dc motor drive. DC series motor drive for traction application	
Unit-3: Four Quadrant Operation Of DC Drives	**12**
Introduction to Four Quadrant Operation , Motoring operation, Electric Breaking –Plugging, Dynamic and Regenerative Breaking operation, Four Quadrant operation of DC motors by dual converters , Closed loop operation of DC motors (Block Diagram Only) Chopper controlled DC drives, Analysis of single quadrant chopper drives, Cyclo converters for drive applications –different types – basic principle.	
Unit-4: Power Electronic Control of DC and AC Drives	**8**
Single phase and three phase-controlled converter fed separately excited dc motor drives (continuous	

conduction only), dual converter fed separately excited dc motor drive, rectifier control of dc series motor. Supply harmonics, power factor and ripples in motor current Chopper control of separately excited dc motor and dc series motor. Three phase induction motor speed control, Stator voltage control, stator frequency control , Stator voltage and frequency control (v/f), Rotor chopper speed control , slip power recovery control schemes , sub synchronous and super synchronous speed variations.	
Unit-5: Control of DC motors by Single and Three Phase Converters	**8**
Introduction to Thyristor controlled Drives, Single Phase semi and Fully controlled connected to D.C Separately excited and DC series motors , continuous Current Operation, Output Voltage and Current waveform , Speed and Torque expression , Speed ,Torque Characterises, Three Phase semi and fully controlled converters connected to DC separately excited and DC series motors , output voltage, and Current waveform , Speed and Torque Expression, Speed , Torque Characterises	

Textbooks:

1. G.K. Dubey, "Fundamentals of Electric Drives", Narosa publishing House.
2. S.K.Pillai, "A First Course on Electric Drives", New Age International.
3. Bimal K. Bose "Modern power electronics and AC drives" Pearson Education, Asia 2003
4. Dubey G. K. "Power semiconductor control drives" Prentice Hall, Englewood Cliffs, New Jersey, 1989

Reference Books:

1. M. Chilkin, "Electric Drives",Mir Publishers, Moscow.
2. Mohammed A. El-Sharkawi, "Fundamentals of Electric Drives", Thomson Asia, Pvt. Ltd. Singapore.
3. N.K. De and Prashant K.Sen, "Electric Drives", Prentice Hall of India Ltd.
4. V. Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill.
5. Dewan S.B. , G. R. Slemon, A. Strauvhen, "Power semiconductor drives", John Wiley and sons
6. Dr. P. S. Bimbra "Power electronics", Khanna publishers
7. J. M. D. Murphy "Thyristor control of AC drives"
8. N. K. De, P. K. Sen "Electric drives" Prentice Hall of India 2002

IEE076: POWER SYSTEM DYNAMICS AND CONTROL

Pre Requisite- Electrical Machines-II, Power System-I, Power System-II, Control Systems

Course Outcomes Statement:

CO Statement	COS	*KL/BL*
Describe the fundamental dynamic behavior and controls of power systems to perform basic stability analysis	**CO1**	**K2**
Obtain the model of the synchronous machine for stability analysis.	**CO2**	**K3**
Obtain the models of the excitation system and power system loads for stability analysis	**CO3**	**K3**
Illustrate the basic control loops of alternator and analyze the load frequency control system	**CO4**	**K3**
Explain the concept of reactive power in the power system and methods for voltage control in the power system	**CO5**	**K3**

K1 – Remember K2 – Understand K3 – Apply K4 – Analyze K5 – Evaluate K6 - Create

				CO-PO Mapping Matrix/Course Articulation Matrix									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE076.C1	3	2	1	1			1				1		2	1
IEE076.C2	3	2	1	1									2	1
IEE076.C3	3	2	1	1									2	1
IEE076.C4	3	2	1	1	1								2	1
IEE076.C5	3	1	1	1									2	1

Syllabus	Contact Hours
Unit-1: Basic Concepts	**8**
Introduction to Power System Control, Operating states of power system and control strategies, Design and operating criteria for stability, basic phenomena of power system stability- review, classification of power system stability.	
Unit-2: Modeling of Synchronous Machine for stability studies	**8**
Synchronous machine, Park's Transformation-analysis of steady state performance, per unit quantities-Equivalent circuits of synchronous machine determination of parameters of equivalent circuits.	
Unit-3:Modelling-Excitation System, Load	**8**
Types of excitation system, -Block diagrams, Modelling of excitation system components and complete excitation system Basic load modelling concepts- static load model, dynamic load model	
Unit-4: Power System Control-I	**8**
Basic control loops of alternator, Active power and frequency control, speed governing system, load frequency control, performance of the primary LFC	
Unit-5: Power System Control-II	**8**
Reactive power and voltage control, Methods of voltage control, Shunt reactors, Shunt capacitors, series capacitors, synchronous condensers, Basic introduction to Static VAR system (SVS) and FACTS controllers.	

TEXT BOOKS:

1. Power System Stability & Control, By- P.Kundur, Tata Mcgraw hill
2. K. R. PADIYAR," Power system dynamics "- B.S. Publications.

3. P.M. Anderson and A. A. Fouad, “Power system control and stability”, IEEE Press

REFERENCE BOOKS:

1. R. Ramanujam, “Power Systems Dynamics”- PHI Publications.
2. Power System Stability & Control, By- P.Kundur, Tata Mcgraw hill

IEE077: POWER SYSTEM PROTECTION

Pre-requisites of the course: Power System-I, Power System-II

Course Outcome: Upon the completion of the course, the student will be able to:

CO STATEMENT	CO	KL/BL
Describe the evolution, comparison, qualities of different protective schemes.	**CO1**	**K2**
Calculate essential relay parameters and explain their types and application.	**CO2**	**K3**
Apply protection scheme for major components of power system.	**CO3**	**K3**
Describe the circuit breaker operation, testing and types.	**CO4**	**K2**
Explain the electronic relay, numerical relay-based protection schemes, WAMS.	**CO5**	**K2**

CO-PO Mapping Matrix/Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
IEE077.C1	3	1		1								1	1	1
IEE077.C2	3	1		1								1	1	1
IEE077.C3	3	2	1	2								1	1	1
IEE077.C4	3	1		1								1	1	1
IEE077.C5	3	1		1	1	1						1	1	1

Unit-I: Protection Scheme

Need for Protective systems, Evolution of protective relays, Zones of protection, Primary and Back -up Protection, Essential qualities of Protection, Classification of Protective schemes, Automatic reclosing, current transformer for Protection, potential transformer, summation transformer

Unit-II: Relays:

Electromagnetic, attracted and induction type relays, thermal relay, gas actuated relay, design considerations of electromagnetic relay, relay application and characteristics, over current relays, directional relays, distance relays, differential relay Static Relays: Comparison with electromagnetic relay, classification and their description.

Unit-III: Protection of Components

Types & detection of faults and their effects, alternator protection scheme (stator, rotor, reverse power protection etc.) - Power transformer protection (external and internal faults protection), generator transformer unit protection scheme, bus bar protection - Transmission line protection (current/time grading, distance), Pilot relaying schemes, power line carrier protection.

Unit-IV: Circuit Breaking

Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, resistance switching, capacitive current interruption, short line interruption, circuit breaker ratings. Testing of Circuit Breaker: Classification, testing station and equipment, testing procedure, direct and indirect testing, selection of circuit breakers. constructional features and operation of Bulk Oil, Minimum Oil, Air Blast, SF6, Vacuum and d. c. circuit breakers.

UNIT V- Modern Trends in Protection

Electronic relays - static relays functional circuits, comparators, Numerical relays, numerical relay based protection schemes, Gas insulated substation/switchgear, Basics of Substation automation system, Basics of Phasor Measurement Units and Wide-Area Measurement Systems (WAMS) for special protection systems.

Text Books:

1. S. S. Rao, “Switchgear and Protection”, Khanna Publishers.

2. B. Ravindranath and M. Chander, “Power system Protection and Switchgear,” Wiley Eastern Ltd.

3. B. Ram and D. N. Vishwakarma, “Power System Protection and Switchgear”, Mc. Graw Hill

4. Y.G.Paithankar S.R. Bhide, “Fundamentals of Power System Protection”, PHI

5. P.M. Anderson, “Power System Protection”, Wiley Interscience, IEEE Press.

IEE078: DEREGULATED POWER SYSTEM

Pre-requisites of the course: Power System-I & II

Course Outcome		Knowledge Level
Upon the completion of the course, the student will be able to:		
CO1	Describe the deregulation, unbundling of electric utilities and its benefits.	**K1**
CO2	Explain the operational planning activities of independent system operator in pool & bilateral markets and describe competitive bidding.	**K2**
CO3	Explain the open access of transmission line and management of security & congestion in deregulation.	**K2**
CO4	Describe the different types of Electric traction, system of track electrification and its related mechanics	**K2**
CO5	Illustrate the Reliability Analysis of Generation, transmission and distribution and the regulation of the market.	**K3**

CO-PO Mapping Matrix/Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IEE078.C1	2	1		2								
IEE078.C2	2	1										
IEE078.C3	3	1										
IEE078.C4	3	2	2	2								
IEE078.C5	2	2	1	2								

UNIT-I: Deregulation, Reconfiguring Power systems, unbundling of electric utilities, Background to deregulation and the current situation around the world, benefits from a competitive electricity market after effects of deregulation

UNIT-II: Role of the independent system operator, Operational-planning activities of ISO: ISO in Pool markets, ISO in Bilateral markets, Operational-planning activities of a GENCO: Genco in Pool and Bilateral markets, market participation issues, competitive bidding.

UNIT-III: Power wheeling, Transmission open access, pricing of power transactions, security management in deregulated environment, and congestion management in deregulation

UNIT-IV: General description of some ancillary services, ancillary services management in various countries, and reactive power management in some deregulated electricity markets.

UNIT-V: RELIABILITY ANALYSIS*:* Interruption criterion, stochastic components, component models, Calculation methods, Network model: stochastic networks, series and parallel connections, minimum cut sets, reliability cost. Generation, transmission and distribution reliability, Reliability and deregulation: conflict, reliability analysis, effects on the actual reliability, regulation of the market.

Text Books:

1. K. Bhattacharya, MHT Bollen and J.C Doolder, “Operation of Restructured Power Systems”, Kluwer Academic Publishers, USA, 2001.
2. Lei Lee Lai, “Power System restructuring and deregulation”, John Wiley and Sons, UK. 2001.
3. Fred I Denny and David E. Dismukes, “Power System Operations and Electricity Markets”, CRC Press, LLC, 2002.

IEE079: UTILIZATION OF ELECTRICAL ENERGY & ELECTRIC TRACTION

Pre-requisites of the course: Basic Electrical Engineering, Electrical Machines-I & II

Course Outcome		Knowledge Level
Upon the completion of the course, the student will be able to:		
CO1	Classify the electric motors for different traction applications.	**K2**
CO2	Explain the methods of electric heating, types of Electric welding and laws of electrolysis.	**K2**
CO3	Explain the laws of illumination and explain the principle of refrigeration and air-conditioning.	**K2**
CO4	Describe the different types of Electric traction, system of track electrification.	**K2**
CO5	Describe the traction mechanics.	**K2**

CO-PO Mapping Matrix/Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
IEE079.C1	3	2				2	1						1	1
IEE079.C2	3	2				2	1						1	1
IEE079.C3	3	2		1		2							1	1
IEE079.C4	3	2				2							1	1
IEE079.C5	3	2				2	1						1	1

Unit-I: Electric Drives: Advantages of electric drives, Characteristics of different mechanical loads, Types of motors used in electric drive, Methods of power transfer by direct coupling by using devices like belt drive, gears, pulley drives etc., Examples of selection of motors for different types of domestic loads, Selection of drive for applications such as general workshop, textile mill, paper mill, steel mill, printing press, crane, lift etc. Application of flywheel. Specifications of commonly used motors e.g. squirrel cage, slip ring induction motors, AC series motors, FKW motor.

Unit-II: Electric Heating: Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating and Dielectric heating.
Electric Welding: Electric Arc Welding, Electric Resistance Welding, electric welding equipment, comparison between A.C. and D.C. Welding
Electrolyte Process: Principles of electro deposition, Laws of electrolysis, and applications of electrolysis.

Unit-III: Illumination: Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light, Laws of illumination, requirements of good lighting Design of indoor lighting and outdoor lighting systems. General ideas about street lighting, flood lighting, monument lighting and decorative lighting, light characteristics etc., LED Lighting.
Refrigeration and Air Conditioning: Description of Electrical circuit used in refrigerator, air conditioner and water cooler.

Unit-IV: Electric Traction – I: Types of electric traction, Review of existing electric traction systems in India, Systems of track electrification, Special features of traction motor, methods of electric braking-plugging, rheostatic braking and regenerative braking.

Unit-V: Electric Traction – II: Traction mechanics- types of services, speed time curve and its simplification, average and schedule speeds Tractive effort, specific energy consumption, mechanics of train movement, coefficient of adhesion.

Reference Books:

1. Generation and Utilization of Electrical Energy by S. Sivanagaruju, Pearson
2. Art and Science of Utilization of Electrical Energy by H.Partap, Dhanpat Rai & Sons
3. Utilization of Electrical Energy by J. B. Gupta, Kataria Publications
4. AText Book of Electrical Power by Dr. S. L. Uppal, Khanna Publications
5. Modern Electric Traction by H.Partap, Dhanpat Rai & Sons
6. Utilization of Electrical Energy by O. S. Taylor, Pitman Publications
7. Generation, Distribution and Utilization if Electrical Power by C. L.Wadhwa, Wiley Eastern

IEE751: PROJECT

Couse Objective: The course aims to equip students with the ability to plan and develop project, assess their social and environmental relevance, implement innovative technical solutions, collect and analyze data effectively, and communicate project outcomes through clear and impactful oral presentations.

COs of Project (IEE751)

COs	After completing this course students will be able:	Cognitive Level
CO1	Project Planning & Proposal development -- To **formulate**, **design**, and **justify** clear, feasible project objectives and proposals by **analysing** and **synthesizing** relevant literature and background information.	Create
CO2	Social relevance of project – To **analyze** the impact of developed solutions in societal and environmental contexts, **demonstrate** the knowledge of, and need for sustainable development.	Analyze
CO3	Technical Implementation & Innovation-- To **implement** complex technical solutions and **apply** innovative problem-solving skills in their project execution.	Apply
CO4	Data Collection & Analytical Skill -- To **collect** accurate data proficiently and **performing** thorough and correct analysis to **evaluate** and **interpret** data for meaningful insights and conclusions.	Evaluate
CO5	Oral Presentation & Communication Skill-- To **deliver** clear and organized oral presentations and **respond** confidently to questions to demonstrate effective communication skills.	Apply

Rubrics for B. Tech Project (IEE751)

Group No.	Student's Name	Roll no.	Project Planning & Proposal development (25)	Social relevance of project (20)	Technical Implementation & Innovation(25)	Data Collection & Analytical Skill (15)	Oral Presentation & Communication Skill (15)	Total (100)

* If total mark is not 100, then all the marks in rubrics parameter would be scaled accordingly.

			Performance Criteria		
Student's Performance	Project Planning & Proposal development (25)	Social relevance of project (20)	Technical Implementation & Innovation(25)	Data Collection & Analytical Skill (15)	Oral Presentation & Communication Skill (15)
Below Average	15 - 16	10 - 12	15 - 16	08 - 09	08 - 09
Average	17 -19	13 -15	17 -19	10 -11	10 -11
Good	20 - 23	16 - 18	20 - 23	12- 13	12- 13
Outstanding	24 - 25	19 - 20	24 - 25	14 - 15	14 - 15

IEE752: INTERNSHIP ASSESSMENT/ MINI PROJECT/START-UP & ENTREPRENEURSHIP ASSESSMENT

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able:		
CO1	Project Planning & Proposal development -- To **formulate** and **justify** clear, feasible project objectives and proposals by **analysing** and **synthesizing** relevant literature and background information.	**Evaluate**
CO2	Social relevance of project – To **analyze** the impact of developed solutions in societal and environmental contexts, **demonstrate** the knowledge of, and need for sustainable development.	**Analyze**
CO3	Data Collection & Analytical Skill -- To **collect** accurate data proficiently and **performing** thorough and correct analysis to **evaluate** and **interpret** data for meaningful insights and conclusions.	**Evaluate**
CO4	Outcome (Development of Solution & modern tool) -- Assess the outcome of the internship/mini project/industrial training/Internship/Seminar in form of some, project proposal, term paper, programming codes or app development based on the study.	**Evaluate**
CO5	Oral Presentation & Communication Skill— To **deliver** clear and organized oral presentations and **respond** confidently to questions to demonstrate effective communication skills.	**Apply**

KL-Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1– Remember, K_2 –Understand, K_3–Apply, K_4– Analyse, K_5– Evaluate, K_6– Create.

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE752.C1	3								2			2	1	1
IEE752.C2		3			2		2		2	3			1	1
IEE752.C3		2		3	2	2	2	3	2	3	3	2	1	1
IEE752.C4			3		2	2	2		2		2		1	1
IEE752.C5								3	3	3	2	3	1	1

Group No.	Student's Name	Roll no.	Project Planning & Proposal development (25)	Social relevance of project (20)	Technical Implementation & Innovation(25)	Data Collection & Analytical Skill (15)	Oral Presentation & Communication Skill (15)	Total (100)

* If total mark is not 100, then all the marks in rubrics parameter would be scaled accordingly.

			Performance Criteria		
Student's Performance	Project Planning & Proposal development (25)	Social relevance of project (20)	Technical Implementation & Innovation(25)	Data Collection & Analytical Skill (15)	Oral Presentation & Communication Skill (15)
Below Average	15 - 16	10 - 12	15 - 16	08 - 09	08 - 09
Average	17 -19	13 -15	17 -19	10 -11	10 -11
Good	20 - 23	16 - 18	20 - 23	12- 13	12- 13
Outstanding	24 - 25	19 - 20	24 - 25	14 - 15	14 - 15