Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

New Scheme of Examination as per AICTE Flexible Curricula

VII Semester **Bachelor of Technology (B.Tech.) [Electrical and Electronics Engineering]** ***(w.e.f. July, 2020)***

S.No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
				Theory			Practical						
				End Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem	Term work / Lab Work & Sessional		L	T	P	
1.	EX-701	DC	Power System Protection	70	20	10	30	20	150	2	1	2	4
2.	EX-702	DE	Departmental Elective	70	20	10	-	-	100	3	1	-	4
3.	EX-703	OE	Open Elective	70	20	10	-	-	100	3	0	0	3
4.	EX-704	D Lab	Electrical CAD Lab	-	--	-	30	20	50	-	-	6	3
5.	EX-705	O/E lab	Energy Audit Lab	-	-	-	30	20	50	-	-	6	3
6.	EX-706	P	Major Project-I	-	-	-	100	50	150	-	-	8	4
7.	EX-607		Evaluation of Internship -III	-	-	-	-	100	100	-	-	6	3
8.	Additional Credits[#]	*[#]Additional credits can be earned through successful completion of credit based MOOC's Courses available on SWAYAM platform (MHRD) at respective UG level.*											
			Total	210	60	30	190	210	700	8	2	28	24

Departmental Electives	Open Electives
EX-702 (A) Power Electronics Application to Power System	EX-703(A) Hybrid & Electrical Vehicles
EX-702 (B) HVDC & FACTS	EX-703(B) Energy Audit & Management
EX-702(C)High Voltage Engineering	EX-703(C) Digital Signal Processing

1 Hr Lecture	1 Hr Tutorial	2 Hr Practical
1 Credit	**1 Credit**	**1 Credit**

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Electrical & Electronics Engineering, VII-Semester

EX-701 Power System Protection

UNIT-I Fault Analysis

Faults in power systems, single line diagram, equivalent impedance diagram, per unit reactances. Analysis (using matrices) of power systems by symmetrical components under:

(a) Three phase short circuit.
(b) Line to line fault.
(c) Line to ground fault.
(d) Double line to ground fault.

Sequence networks and their inter connections for different types of faults, effects of fault impedance. Current Limiting Reactors: Applications, types, construction and location of current limiting reactors, short circuit calculation using reactors.

UNIT-II Relays

General considerations, sensing of faults, construction of electro-magnetic attraction and induction types relays, Buchholz and negative sequence relay, concept of reset, pick up, inverse time and definite time characteristics, over current , over voltage, directional, differential and distance relays on R-X diagram. Static Relays: Introduction, advantage and limitation of static relays, static over current, directional, distance and differential relays.

UNIT-III Protection

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 Switchgear

Theory of current interruption- energy balance and recovery rate theory, arc quenching, recovery and restriking voltages. Types of circuit breakers. bulk oil and minimum oil, air break and air blast, sulphurhexafluride (SF6) and vacuum circuit breakers. Rating selection and testing of circuit breakers/operating mechanisms. LT switchgear, HRC fuses, types construction and applications.

UNIT-V Modern Trends In Protection

Electronic relays, static relays functional circuits: comparators, level detectors, logic and training circuits, microprocessor and computer based protection schemes, software development for protection, security & reliability.

List of Experiments(EXPANDABLE):

1. Determination of drop out factor of an instantaneous over current relay.
2. Determination of operating characteristic of IDMT relay.
3. Determination of operating characteristic of differential relay.
4. Study and operation of gas actuated protective relay.
5. Study and operation of static over current relay.
6. Determination of transmission line parameters using MATLAB.
7. Analysis of power system faults (Symmetrical & Asymmetrical) using MATLAB.
8. Study of SF6 circuit breaker
9. Protectional simulation study of generator, Transformer, Feeder & Motor protection.

REFERENCE BOOKS

- Van A. R & Warrington C., " Protective Relays : Their Theory and Practice", Vol 1 &2, Chapman and Hall.
- Paithankar Y. O.," Transmission Network Protection: Theory and Practice", Marcel Deicker, Inc.
- GEC Measurements," Protective Relays : Application Guide", GEC Measurements.
- Masson R.J., Art & Science of Protective Relaying.
- J & P Switchgear handbook Ravindra Nath B., and Chandar M., Power systems protection and switchgear
- Rao Sunil S, Switchgear and protection.
- Crane P.H.C., Switchgear Principle.
- The Elementary Council, "Power System Protection", Vol. 1,2 &3, Peter PeregrinusLtd.
- Badriram& Vishwakarma, Power System Protection.
- Ravindranath&Chander, Power System Protection & Switchgear.

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Electrical & Electronics Engineering, VII-Semester

Departmental Elective EX- 702 (A) Power Electronics Application to Power System

UNIT-I Steady state and dynamic problems in AC systems: Flexible AC transmission systems (FACTS), Principles of series and shunt compensation, Description of static var compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC),

UNIT-II Modelling and Analysis of FACTS controllers: Control strategies to improve system stability, Power Quality problems in distribution systems

UNIT-III Harmonics: Harmonics creating loads, modelling, harmonic propagation, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters, Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker, Mitigation of power quality problems using power electronic conditioners, IEEE standards, HVDC Converters and their characteristics, Control of the converters (CC and CEA), Parallel and series operation of converters.

UNIT-IV Active Power Controllers: Dynamic static synchronous controllers, D – STATCOM, Dynamic static synchronous series controllers, dynamic voltage restorer, AC/AC voltage regulators.

UNIT-V Energy Storage Systems: Introduction, structure of power storage devices, pumped – storage hydroelectricity, compressed air energy storage system, flywheels, battery storage, hydrogen storage, super conducting magnet energy storage, super capacitors, applications of energy storage devices.

REFERENCE BOOKS

1. N.G. Hingorani& Laszlo Gyugyi , Understanding FACTS , IEEE Press, 2000.
2. E. F. Fuchs & Mohammad A.S. Masoum, Power Quality in Power Systems and Electrical Machines, Elsevier Academic Press 2008.
3. K.R. Padiyar, FACTS controllers in power transmission and distribution, New Age International publishers, New Delhi, 2007.
4. K.R. Padiyar, HVDC Power Transmission Systems, New Age International publishers, New Delhi, 1999.

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Electrical & Electronics Engineering, VII-Semester

Departmental Elective EX- 702 (B) HVDC & FACTS

UNIT-I Facts concepts: Reactive power control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.

UNIT-II Static shunt and series compensators: Shunt compensation – objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators – SVC, STATCOM, SVC and STATCOM comparison. Series compensation – objectives of series compensation, thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes.

UNIT-III Combined compensators:Unified power flow controller (UPFC) – Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters.

UNIT-IV HVDC transmission:HVDC Transmission system: Introduction, comparison of AC and DC systems, applications of DC transmission, types of DClinks, Layout of HVDC Converter station and various equipments. HVDC Converters, analysis of bridge converters with and without overlap, inverter operation, equivalent circuit representation of rectifier and inverter configurations

UNIT-V Control of HVDC system:Principles of control, desired features of control, converter control characteristics, power reversal, Ignition angle control, current and extinction angle control. Harmonics introduction, generation, ac filters and dc filters. Introduction to multiterminal DC systems and applications, comparison of series and parallel MTDC systems, Voltage Source Converter based HVDC systems

REFERENCE BOOKS

- Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.
- Mohan Mathur R. and Rajiv K.Varma , 'Thyristor – based FACTS controllers for Electrical
- Transmission systems', IEEE press, Wiley Inter science , 2002.
- Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007.
- Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 2002.
- Jos Arrillaga, 'High voltage Direct Current Transmission' IET Power and Energy Series 29

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Electrical & Electronics Engineering, VII-Semester

Departmental Elective EX- 702 (C) High Voltage Engineering

Unit-I Introduction:-

Introduction to HV technology, advantages of transmitting electrical power at high voltages, need for generating high voltages in laboratory. Important applications of high voltage.

Unit-II Breakdown phenomena:-

Classification of HV insulating media, Properties of important HV insulating media. Gaseous dielectrics: Ionizations: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory, Limitations of Townsend's theory. Streamer's theory breakdown in non uniform fields. Corona discharges. Paschen's law and its significance. Time lags of Breakdown. Breakdown in solid dielectrics: Intrinsic Breakdown, avalanche breakdown, thermal breakdown, and electro mechanic breakdown. Breakdown of liquids dielectric dielectrics: Suspended particle theory, electronic Breakdown, cavity breakdown (bubble's theory), electro convection breakdown.

Unit-III Generation of HV AC DC and Impulse Voltage and current:-

HV AC-HV transformer; Need for cascade connection and working of transformers units connected in cascade, Series resonant circuit principle of operation and advantages. Tesla coil. HV DC- voltage doubler circuit, cock croft- Walton type high voltage DC set, Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for Output impulse voltage, Multistage impulse generator Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Triggering gap and oscillograph time sweep circuits. Generation of switching impulse voltage. Generation of high impulse current.

Unit-IV Measurement of high voltages:-

Electrostatic voltmeter-principle, construction and limitation. Generating voltmeter-Principle, construction. Series resistance micro ammeter for HV DC measurements. Standard sphere gap measurements of HV AC, HV DC, and impulse voltages; Factors affecting the measurements. Potential dividers-resistance dividers capacitance dividers mixed RC potential dividers. Surge current measurement.

Unit-V High voltage tests on electrical apparatus:-

Definitions of technologies, tests on isolators, circuit breakers, cables insulators and transformers.

Reference books:

1. E. Kuffel and W.S. Zaengl, “High voltage engineering fundamentals”, 2nd edition, Elsevier, press, 2005.

2. M.S.Naidu and Kamaraju, “High Voltage Engineering”, 3rd edition, THM, 2007.

3. L. L. Alston, “High Voltage technology”, BSB Publication, 2007..

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New Scheme Based On AICTE Flexible Curricula

Electrical & Electronics Engineering, VII-Semester

Open Elective EX- 703 (A) Hybrid &Electrical Vehicles

UNIT 1:- Introduction Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT 2:- Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Trains Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control Of Switch Reluctance Motor drives, drive system efficiency. drive-train topologies, fuel efficiency analysis.

UNIT 3:- Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

UNIT 4:- Energy Management Strategies Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text / References:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
4. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

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Electrical & Electronics Engineering, VII-Semester

Open Elective EX- 703 (B) Energy Audit & Management

Unit-I

Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

Unit-II

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

Unit-III

Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.

Unit-IV

Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets.

Unit-V

Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing ESCO concept.

Text Books:

1. Witte L.C. , Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere

Publ., Washington, 1988.

2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.

3. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.

4. Energy Manager Training Manual , Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004

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Electrical & Electronics Engineering, VII-Semester

Open Elective EX- 703 (C) Digital Signal Processin

Unit 1: Discrete-time signals and systems

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation ofdiscrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theoremand Nyquist rate.

Unit 2: Z-transform

z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of Z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Unit 3: Discrete Fourier Transform

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, FastFourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Unit 4: Design of Digital filters

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth,Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band stop and High-pass filters. Effect of finiteregister length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-ratesignal processing.

Unit5: Applications of Digital Signal Processing

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, LinearMean-Square Estimation, Wiener Filter.

Text/Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.

2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.

3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications",Prentice Hall, 1997.

4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.

5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.

6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

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Electrical & Electronics Engineering, VII-Semester

EX-704 Electrical CAD Lab

LIST OF EXPERIMENT (PROGRAM)

1. **Computer Program for Optimal Design of dc machine.**
2. **Computer Program in for Complete Design of core type power Transformer.**
3. **Computer Program for Complete Design of salient pole Alternator.**
4. **Computer Program for Optimal Design of cage rotor.**
5. **Computer Program for Optimal Design of slip ring induction motor.**

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Electrical & Electronics Engineering, VII-Semester

EX-705 Energy Audit Lab

List of Experiments

1) To study the need of energy conservation and audit.
2) To study the uses and technical specification of all relevant energy auditing instruments.
3) To perform experiment to collect data of all energy auditing instruments with respect to their inputs and also analyze the collected data.
4) To perform experiment for comparative analysis of all luminaries (Incandescent lamp, Florescent lamp(FL), Compact FL and LED) using energy auditing instruments.
5) To study of different lighting systems, such as commercial, factory, flood and decorative etc.
6) To study applications of solar energy with respect to photovoltaic and thermal.
7) To study performance assessment of motors for energy conservation using auditing.
8) To study the different techniques for power factor improvement and its benefits.
9) To study the criteria and types of energy efficient motors.
10) To study the comparative analysis between standard and energy efficient motors.
11) Case study of net metering as a future technique to optimize electrical energy utilization.
12) Case study of energy audit of your departmental building.

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Electrical & Electronics Engineering, VII-Semester

EX-706 Major Project-I

GUIDELINES

The objectives of the course 'Major Project-I' are To provide students with a comprehensive experience for applying the knowledge gained so far by studying various courses. To develop an inquiring aptitude and build confidence among students by working on solutions of small industrial problems. To give students an opportunity to do something creative and to assimilate real life work situation in institution.

To adapt students for latest developments and to handle independently new situations.

To develop good expressions power and presentation abilities in students.

The focus of the Major Project is on preparing a working system or some design or understanding of a complex system using system analysis tools and submit it the same in the form of a write-up i.e. detail project report. The student should select some real life problems for their project and maintain proper documentation of different stages of project such as need analysis, market analysis, concept evaluation, requirement specification, objectives, work plan, analysis, design, implementation and test plan. Each student is required to prepare a project report and present the same at the final examination with a demonstration of the working system (if any).

The faculty and student should work according to following schedule:

i) Each student undertakes substantial and individual project in an approved area of the subject and supervisedby a member of staff.

ii) The student must submit outline and action plan for the project execution (time schedule) and the same be approved by the concerned faculty.

iii) At all the steps of the project, students must submit a written report of the same.