GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140911
Semester-IV
Subject Name: Economics for Engineers

Type of course:

Prerequisite: NA

Rationale: Engineering economics is a field that addresses the dynamic environment of economic calculations and principles through the prism of engineering. It is a fundamental skill that all successful engineering firms employ in order to retain competitive advantage and market share. The subject endeavors to provide them with the tools to optimize profits, minimize costs, analyze various scenarios, forecast fluctuations in business cycles, and more.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs
1	**1. Economic Decisions Making** – Overview, Problems, Role, Decision making process. **2. Engineering Costs & Estimation** – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits. Case Study - Price and Income Elasticity of Demand in the real world	**08**
2	**3. Cash Flow, Interest and Equivalence:** Cash Flow – Diagrams, Categories & Computation, Time Value of Money, Debt repayment, Nominal & Effective Interest.	**08**
3	**4. Cash Flow & Rate Of Return Analysis** – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks. Case Study – Tata Motors	**08**

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4	**5. Inflation And Price Change** – Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates. Case Study – Competition in the Advertise Segment in India	**08**
5	**6. Present Worth Analysis:** End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.	**08**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	**25**	**20**	**10**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. James L.Riggs,David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill
2. Donald Newnan, Ted Eschembach, Jerome Lavelle : Engineering Economics Analysis, OUP
3. John A. White, Kenneth E.Case,David B.Pratt : Principle of Engineering Economic Analysis, John Wiley
4. Sullivan and Wicks: Engineering Economy, Pearson
5. R.Paneer Seelvan: Engineering Economics, PHI
6. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe the principles of economics that govern the operation of any organization under diverse market conditions	30
CO-2	Comprehend macroeconomic principles and decision making in diverse business set up	30
CO-3	Explain the Inflation & Price Change as well as Present Worth Analysis	30
CO-4	Apply the principles of economics through various case studies	10

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Suggested Resource Material for Assignments/Tutorials

1. N.Gregory Mankiw, Principles of Economics, Thomson South Western , Pearson
2. H.L.Ahuja , Modern Economics , S.Chand & Company
3. C.Rangarajan and B.H.Dholakia, Principles of Macro Economics, The McGraw Hill
4. Dominick Salvatore, Managerial Economics: Principles and Worldwide Applications, Adapted by Ravikesh
5. Srivastava, Oxford University Press
6. List of Journals/Periodicals/Magazines/Newpapers: Economist, Indian Economic Review, Asian
7. Economic Review, American Economic Review, Economic and Political Weekly (EPW), Economic Times, Business Standard etc
8. Websites Recommended: www.finmin.nic.in , www.rbi.org.in , www.planningcommission.nic.in

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140912
Semester-IV
Subject Name: Electromagnetic Fields

Type of course: Basic Science Course

Prerequisite: NA

Rationale: Study of electromagnetic fields is basically concerned with study of charges at rest and in motion. Electromagnetic principles serve as basic fundamentals for detailed and in-depth study of electrical engineering and are indispensable for analysis of various electrical, electro-mechanical and electronic systems. This subject would cover the behavior of static and dynamic, electric and magnetic fields.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Review of Vector Analysis** Introduction, scalars and vectors, unit vector, vector addition and subtraction, position and distance vectors, dot product, cross product, scalar triple product, vector triple product, components of a vector, Cartesian co-ordinate system, Circular cylindrical co-ordinate system, Spherical co-ordinate system, transformation from one co-ordinate to other co-ordinate systems	**04**
2	**Static Electric Fields** Coulomb's law, Electric field intensity, Electric field due to point and line charges, Line surface and volume charge distributions, Gauss' law and its applications, Divergence theorem, Absolute Electric potential, Potential difference, Potential gradient, Calculation of potential difference for different configurations, Electric dipole, Electrostatic energy and energy density	**08**
3	**Conductors, Dielectrics and Capacitance** Current and current density, Ohm's law in point form, Continuity equation, Conductor-dielectric boundary condition, Dielectric-dielectric boundary condition, Polarization in dielectrics, Capacitance, Capacitance of two wire line	**06**
4	**Poisson's and Laplace's equations** Poisson's equation, Laplace's equation, Uniqueness theorem, Solution of Poisson's and Laplace's equation, Application of Poisson's and Laplace's equations	**04**
5	**Steady Magnetic Fields** Biot Savart's law, Ampere's law, Curl operation, Stoke's theorem, Magnetic flux and magnetic flux density, Scalar and vector magnetic potentials, Steady magnetic field produced by current carrying conductors	**08**

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6	**Magnetic forces, materials and inductance** Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and Permeability, Magnetic boundary conditions, Magnetic circuit, Inductance and mutual inductances	**06**
7	**Time varying fields and Maxwell's equations** Faraday's law, Transformer and motional electromotive forces, Displacement current, Maxwell's equations in integral and point form, Time varying potentials	**06**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**20**	**10**	**10**	**00**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. W. H. Hayt, J. A. Buck, "Engineering Electromagnetics", McGraw Hill Education
2. M.N.O. Sadiku, S.V. Kulkarni, "Principles of Electromagnetics", 6th edition, Oxford University Press
3. A Pramanik, "Electromagnetism- Theory and Applications" PHI Learning Pvt. Ltd. ,New Delhi, 2009
4. A. Pramanik, "Electromagnetism-Problems with Solutions, PHI, 2012
5. S.P. Seth, "Elements of Electromagnetic fields", Dhanpat Rai & Co, 2013

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Apply vector calculus to electric and potential fields due to various charge distributions	30
CO-2	Compute potential, Electric fields, Electric flux density, Capacitance using Poisson's and Laplace's equations	25
CO-3	Derive forces and torques in magnetic fields, forces due to current carrying conductors and their inter-relationship with magnetic field	35
CO-4	Analyze Maxwell's equations in different forms (point & integral) and	10

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	apply them to diverse engineering problems	

Suggested Resource Material for Assignments/Tutorials/Experiments

Suggested learning material and Assignments/Tutorials are available on the following links:

- https://nptel.ac.in/downloads/108104087/ by Prof. Pradeep Kumar, IIT, Kanpur
- https://nptel.ac.in/downloads/115101005/ by Prof. D.K. Ghosh, IIT , Bombay
- https://nptel.ac.in/downloads/115104088/ by Prof. Manoj K. Harbola, IIT, Kanpur
- Transcripts and video lectures of Prof. Harishankar Ramachandran, IIT, Madras https://nptel.ac.in/courses/108106073/
- Matlab experiments manual by Dr. M. H. Bakr http://www.ece.mcmaster.ca/faculty/talia/EM_2FH3_downloads/assignments/Matlab_Manual_2FH3_Bakr.pdf

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140913
Semester – IV
Subject Name: Electrical Machine – I

Type of course: Professional Core Course

Prerequisite: NA

Rationale: Electrical power sector is the backbone of industries, agriculture, irrigation, urban development and almost all the segments of society. Electricity is the primary requirement for the growth of ICT. In view of this, the static and rotating electrical equipments play a vital role for the society. This subject deals with basic principles of electromechanical energy conversion, DC machines and Transformers.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Magnetic fields and magnetic circuits:** Review of magnetic circuits - MMF, flux, reluctance, inductance; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air. Review of Ampere's law and Biot Savart law.	**06**
2	**Principles of Electromechanical Energy Conversion:** B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element.	**06**
3	**DC Machines:** Review of construction and working of a DC machine, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, Commutation, Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction. Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, voltage build-up in a shunt generator, critical field resistance and critical speed.	**15**

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	V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control methods. Losses and Efficiency in DC machines. Swinburn's test, Hopkinson's test, Field test, Retardation test, Separation of losses of a DC shunt machine.	
4	**Transformers:** Review of construction and working principle of single-phase and three-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency. Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, types of connection and their comparative features, Vector groups, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.	**15**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**20**	**10**	**10**	**00**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy) Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. I J Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
3. J B Gupta, "Theory and Performance of Electrical Machines", Katson Publication, 2009.
4. B L Theraja, "Electrical Technology – Part II", S Chand Publications, 2011
5. A E Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
6. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
7. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe the principles of magnetic circuit and electromechanical energy conversion	30

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CO-2	Comprehend the construction, working, testing, speed control and applications of DC machines and transformers	50
CO-3	Analyze the performance of DC machines and transformers	10
CO-4	Evaluate the operating parameters of machines under various load conditions	10

List of Experiments:

- To obtain Magnetizing Characteristics, Internal & External Characteristic of Self Excited DC Shunt Generator. Also obtain the critical field resistance of the machine from magnetizing Characteristics.
- To conduct direct load test on a D.C. compound generator with a) Shunt field alone b) Cumulative and differential compounding for short and long shunt connections.
- To obtain Speed-Torque characteristics of DC Series Motor and DC Shunt Motor.
- To determine the efficiency of two similar shunt machines by regenerative method. (Hopkinson's Test.)
- To perform field test on identical D.C. series machines.
- To determine the various losses in a D.C. machine and separation of its core losses.
- To perform direct load test on a D.C. shunt motor and plot variation of (a) Input current (b) Speed(c) Torque (d) Efficiency versus output power.
- To separate hysteresis and eddy current losses of a single phase transformer at rated voltage, frequency by conducting no load tests at different frequencies keeping V/f constant.
- To operate two single phase transformers of different KVA ratings in parallel and plot the variation of currents shared by each transformer versus load current.
- To conduct Sumpner test on two identical single phase transformers and determine their efficiency at various loads.
- To make Scott connection of two single phase transformer and to verify the three phase to two phase conversion.
- To conduct open circuit and short circuit test on a three phase transformer and determine the equivalent circuit parameters.
- To perform Swinburn's test on DC shunt motor to find out its efficiency
- Speed control of DC Shunt Motor using a) Armature control and b) field control methods.

Major Equipments:

The necessary no. of machines, panels, meters, accessories and instruments etc… to be provided to conduct the above experiments in a group of maximum 4 students. Charts and cut section models of various machines should be provided for better understanding.

List of Open Source Software/learning website:

- http://www.scilab.org/
- http://www.gnu.org/software/octave/
- http://www.vlab.co.in
- http://www.femm.info

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140914

Semester – IV
Subject Name: Power System – I

Type of course: Engineering – Professional Core Course

Prerequisite: Fundamental knowledge of Electrical Engineering

Rationale: The course is aimed to provide exposure about methods of electricity generation, various AC supply systems, transmission lines and their parameters, underground cables and their parameters, substation equipments, neutral grounding and sources of over-voltages and protection against them

Teaching and Examination Scheme:

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Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	**Conventional Generation, Load Curves and Tariffs:** Generation scenario in India and Gujarat Steam power station, Schematic arrangement of steam power station, Equipments of steam power station, Hydroelectric power station, Schematic arrangement of hydro-electric power station, Constituents of hydro-electric plants, Nuclear power station, Schematic arrangement of nuclear power station, Nuclear reactor, Gas turbine power plant, Schematic arrangement of gas turbine power plant, comparison of various power plants. Load curves, Important terms and factors, Load duration curve, Examples. Tariff, Desirable characteristics of tariff, Types of tariff, Examples.	08	08
2.	**Introduction to Wind and Solar Power Generation:** The wind power plant – Introduction, wind turbine classes, Wind Turbine Components (Rotor, Nacelle, Tower, Electric Substation, Foundations)	08	10

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	Wind Energy Conversion – Rotation principle, Forces on a rotor blade, Factors affecting performance of rotor (Aerodynamic efficiency, tip speed, tip seep ratio etc.), Thrust and torque on rotor, Power curve. Topologies and operation characteristics of SCIG based wind turbine power plant. Working Principal and operation characteristic of WRIG based wind turbine power plant. Concentrated Solar Power (CSP) plant Operation and its working, Photovoltaic Conversion – Introduction, Description and principle of working, performance characteristics of a solar cell, types of solar cell, photovoltaic system applications, Stand-alone PV system configurations, Grid-connected PV systems.		
3.	**Electrical Supply Systems:** Electric supply system, Typical ac power supply scheme, Advantages of high transmission voltage, Overhead v/s underground systems, Requirements of a distribution system, Connection schemes of distribution system. AC Distribution – Methods of solving AC distribution problems, Four wires star connected unbalanced load,Examples.	05	07
4.	**Power Factor and Power Factor Improvement of Load:** **Power factor, Power factor triangle, Causes of low power factor, Disadvantages of low power factor, Power factor improvement, Power factor improvement equipment, Calculations of power factor correction, Most economical power factor, Examples.**	05	08
5.	**Mechanical Features and Design of Overhead Transmission Line:** Main components of overhead lines, Conductor materials, Line supports, Insulators, Types of insulators, String efficiency, Methods of improving string efficiency, Examples, Sag in overhead lines, Calculation of sag, Examples.	08	15
6.	**Transmission Line Parameters:** Line resistance, Inductance of single conductor, Inductance of single phase lines, Flux linkages in terms of self and mutual inductances, Inductance of 3-phase transmission lines – Symmetrical spacing, asymmetrical spacing and transposed lines, Inductance of composite conductors, Inductance of 3-phase double circuit lines, Examples. Line capacitance, Capacitance of single phase lines, Capacitance of three phase lines, Effect of bundling, Capacitance of three phase double circuit	14	24

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	lines, Effect of earth on the capacitance, Examples.		
7.	**Underground Cables:** Underground cables, construction of cables, Insulating materials of cables, Classification of cables, Cables for 3-phase service, Insulation resistance of a single core cable, Capacitance of a single core cable, Dielectric stress in single core cable, Most economical conductor size in cable, Grading of cables, Capacitance grading, Inter-sheath grading, Capacitance of 3-core cables, Measurement of core to core and core to earth capacitances, Examples.	07	12
8.	**Substations:** Classification of substations, Transformer substation, Pole mounted substation, Underground substation, Symbols for equipments in substations, Equipments in a transformer substation, Bus-bar arrangements in substations, Terminal and through substations, Key diagrams of 66/11 kV substation and 11/400 kV indoor substation.	04	08
9.	**Neutral Grounding:** System with ungrounded neutral, Neutral grounding, Advantages of neutral grounding, Methods of neutral grounding – Solid grounding, Resistance grounding, Reactance grounding, Resonant grounding, Voltage transformer earthing, Grounding transformer.	05	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	25	25	20	15	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Principles of Power System: V. K. Mehta, Rohit Mehta, S. Chand Publications
2. Wind Power Technology: Earnest Joshua, PHI Learning Pvt. Ltd.
3. Solar Energy: S. P. Sukhatme, McGraw Hill Education India Pvt. Ltd.
4. Power System Analysis: Hadi Saadat, McGraw Hill Education India Pvt. Ltd.
5. Electrical Power systems: C. L .Wadhwa, New Age International Publishers
6. Electrical Power Systems: Dr. S. L. Uppal, Prof. S. Rao, Khanna Publications

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7. Elements of Power Systems Analysis: W. D. Stevenson Jr., 4th Edition, McGraw Hill Education.
8. Power System Analysis : John J. Grainger, William D. Stevenson Jr., McGraw Hill Education
9. Modern Power system Analysis by I J Nagrath, D P Kothari, McGraw Hill Education

Course Outcome (Theory):

After learning the course, the students should be able to:

Sr. No.	CO Statement	Marks % Weightage
1.	Compare various means of electricity generation and evaluate load curves, tariff structures and power factor and load power factor improvement.	26
2.	Carry out mechanical design of overhead line.	15
3.	Compute resistance, inductance and capacitance of overhead lines and underground cables.	36
4.	Acquire knowledge about electrical supply system, substation equipments & layout and methods of neutral grounding.	23

Course Outcome (Laboratory):

After performing practical in this course, the students should be able to:

1. Become conversant about generation scenario and power plants in Gujarat and India.
2. Develop programs for computations of design and performance parameters of power system transmission line and grounding.
3. Analyze unbalanced and balanced loading on the three phase supply systems, compute neutral current and examine its effect on its operation.

List of Experiments:

Suggested list of practicals but not limited to:

1. Survey of generation scenario and power plants of Gujarat.
2. Survey of different type of power plants of India to observe the power and energy supplied by them daily, their rates of energy, daily schedule etc.
3. Plot VI and PV characteristics of solar cell/panel.
4. Simulation of three phase system with three phase balanced load with neutral grounded
5. Simulation of three phase system with three phase load, effect of unbalanced load on the voltages of phases with and without neutral grounded.
6. Write a program to calculate string efficiency of string of insulating discs for voltage levels upto

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400 kV.

7. Write a program for calculating line inductance for different conductor configurations and dimensions.
8. Write a program for calculating line capacitance for different configurations and design of line.
9. Write a program for calculating sag of transmission line under different loading conditions.
10. Prepare layout of substation for a given bus arrangement and given voltage rating with all necessary equipments.
11. Write a program for calculating voltage drop in a radial AC feeder.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140915
Semester – IV
Subject Name: Power Electronics

Type of course: Engineering – Professional Core Course

Prerequisite: Fundamental knowledge of Electrical Engineering and Analog Electronics**.**

Rationale: The power electronic devices and converters employing power electronics devices are now widely used in domestic applications as well as in industrial applications like Electrical Drives, Power Systems, Renewable Energy based power generation, heating applications etc. The course is aimed to provide exposure about the commonly used power electronic devices and the power electronic converters**.**

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Power switching devices Diode, Thyristor, MOSFET, IGBT; Static characteristics of these devices; Operation of power devices as switches and switching losses, Single-quadrant switches, two-quadrant and bidirectional switches; Firing circuit for thyristors; Gate drive circuits for MOSFET and IGBT.	06
2	DC-DC converters - Switching Voltage Regulators Linear voltage regulator, Concept of switching voltage regulators and advantages, Operation and Principle of Basic DC-DC converter topologies like Buck, Boost and Buck-Boost converter, Various control techniques for output voltage control, Mathematical analysis for these converters for steady state, Concept of CCM and DCM and factors affecting them, Closed loop control for voltage regulation, Isolated converters: Forward converter and Flyback converter; Multi-quadrant operation of DC-DC converters; Applications	12
3	DC-AC converters – Inverters Classification of Inverters, Half-bridge and full-bridge single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage, three-phase sinusoidal modulation, Three phase bridge inverter – 180◦ and 120◦ conduction mode, SPWM control, Third harmonic injection, SVPWM, Output voltage and frequency control, Harmonic spectrum, Harmonics and its effects, Applications	12
4	AC-DC Converters Concept of phase control using half-wave single phase ac-dc converter, Single phase and	11

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	three phase half wave and full wave, 1-phase and 3- phase half controlled and fully controlled converters, Analysis with R & RL load, Performance parameters for converters, Operation in continuous and dis-continuous mode, Reactive power considerations, Operation in conversion and inversion mode, Effect of source inductance, Power factor improvement techniques, Dual Converters, Applications	
5	AC Voltage Controller Triac characteristic and operating modes, Triac as Single-phase AC voltage controller, Principle of Phase Control, On-off Control, Mathematical analysis related to single-phase AC voltage controller, Three-phase AC voltage controller configurations: Operations, Waveforms, Analysis;	7
6	Miscellaneous Frequency Control: Introduction to cycloconverter and matrix converter; basic power circuit and their operating principle (2 Hrs) Datasheet interpretation, Ratings of the devices and Selection of switches (2 Hrs) Overvoltage, overcurrent and short-circuit protection; Electromagnetic interference and its remedies; Snubber circuit and its design (3 Hrs)	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**30**	**10**	**10**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
2. N. Mohan, T. M. Undeland, W.M. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Edition, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. P.S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 2012..
5. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140915

Course Outcomes: At the end of this course, students will be able to clarify

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the differences between signal level and power level devices.	15
CO-2	To understand the construction of power converters.	25
CO-3	To analyse the operation of power converters.	30
CO-4	To understand the applications of power converters	30

List of Experiments: The following are suggested list of experiments.

1. Static and dynamic characteristic of SCR, MOSFET and IGBT
2. R, RC and UJT triggering of SCR
3. To analyse the performance of single phase and three-phase full bridge thyristor rectifier for R and RL load.
4. Duty ratio control for regulating the output voltage of DC-DC Buck/Boost/Buck-Boost converter
5. Modeling and simulation of closed-loop control of DC-DC Buck/Boost/Buck-Boost converter.
6. To study the effect of inductance, switching frequency, duty cycle, load current on the output ripple voltage of a step-down chopper (using simulation platform like MATLAB/Simulink)
7. Performance of 1-phase bridge inverter with R and R-L load
8. Study of harmonic spectrum of output voltage for unipolar and bipolar PWM controlled half-bridge and full bridge converter.
9. Performance of 3-phase bridge inverter operating with 120° and 180° conduction mode.
10. Simulation of SVPWM and and to study its effectiveness over SPWM
11. Output AC voltage control of SCR based 1-phase ac voltage controller using ON-OFF and phase-control principle
12. Output AC voltage control of SCR based 3-phase ac voltage controller using ON-OFF and phase-control principle
13. To study the performance of single-phase fully controlled and semi-controlled converter for R and R-L load
14. To study the performance of three-phase fully controlled and semi-controlled converter for R and R-L load

Major Equipment:

Power semiconductor devices, power electronic converter kits, CRO/DSO, choke coil, load bank, voltage and current probes, Simulation software like Scilab, MATLAB, PSIM etc. along with necessary toolbox.

List of Open Source Software/learning website:

GTUQuestionPapers.com

ocw.mit.edu/courses/electrical.../6-334-power-electronics-spring-2007
Courses available through NPTEL - website: https://nptel.ac.in

GTUQuestionPapers.com