GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160923
Semester – VI
Electrical Materials

Type of course: Engineering – Open Elective Course

Prerequisite: Physics (3110018) and Basic Electrical Engineering (3110005).

Rationale:

The course is aimed to provide exposure to the various electrical materials which are used in electrical engineering and their applications in designing electrical equipments and it gives the fundamental knowledge of various material used in electrical engineering. This course provides the essential knowledge in the selection of conducting, dielectric, insulating, magnetic, semiconductor and superconductor materials during design of electrical engineering equipments.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total HRS	% Weightage
01	**Conductors** Classification: High conductivity, high resistivity materials, fundamental requirements of high conductivity materials and high resistivity materials, mobility of electron in metals, factors affecting conductivity and resistivity of electrical material, thermoelectric Effect: Seeback effect, Peltier effect, commonly used high conducting materials: copper, aluminum, bronze brass properties and characteristics, constantan, platinum and nichrome properties, characteristics and applications, material used for AC and DC machines	09	20
02	**Dielectric Materials and Insulators** Properties of gaseous, liquid and solid dielectric, dielectric as a field medium, electric conduction in gaseous, liquid and solid dielectric, breakdown in dielectric materials, mechanical and electrical properties of dielectric materials, effect of temperature on dielectric materials, polarization, loss angle and dielectric loss, petroleum based insulating oils, transformer oil, capacitor oils and its properties, classification of insulation (Solid) and application in AC and DC machines, solid electrical insulating materials, fibrous, paper boards, yarns, cloth tapes, sleeving wood, impregnation, plastics, filling and bounding materials, fibrous, film, mica, rubber, mica based materials, ceramic materials.	09	20

03	**Magnetic Materials** Basic terms, classification of magnetic material: diamagnetic, paramagnetic, ferromagnetic, anti- ferromagnetic and amorphous material, hysteresis loop, magnetic susceptibility. coercive force, curie temperature, magneto-striction, factors affecting permeability and hysteresis loss, common magnetic materials: soft and hard magnetic materials, electric steel, sheet steel, cold rolled grain-oriented silicon steel, hot rolled grain-oriented silicon steel.	08	20
04	**Semi-Conductors and Superconductors** General concepts, energy bands, types of semiconductors: intrinsic Semi-conductors, extrinsic Semi-conductors, compound semiconductor, amorphous semiconductor, hall effect, drift, mobility, diffusion in Semiconductors, semi-conductors and their applications. **Superconductors:** Superconductivity, properties of superconductors, critical field, Meissner effect, type-I and type-II Superconductors.	08	20
05	**Special purpose materials** Nickel iron alloys, high frequency materials, permanent magnet materials, feebly magnetic materials, ageing of a permanent magnet, effect of impurities, Losses in Magnetic materials, Refractory Materials, Structural Materials, Radioactive Materials, Galvanization and Impregnation of materials.	08	20

Text Books:

1. Electrical Engineering Materials: A.J. Dekker, PHI Publication.
2. An Introduction to Electrical Engineering Materials: C. S. Indulkar and S. Thiruvengadam, S. Chand & Co., India.

Reference Books:

1. Material Science for Electrical & Electronics Engineers: Ian P. Hones, Oxford University Press.
2. Electrical Properties of Materials: L. Solymar and D. Walsh, Oxford University Press-New Delhi.
3. A Course in Electrical Engineering Materials: T K Basak, New Age Science Publications.
4. A Course in Electrical Engineering Materials: R K Rajput, Laxmi Publications.
5. A Course in Electrical Engineering Materials: S. P. Seth and P. V. Gupta, Dhanpat Rai & Sons.
6. Electrical and Electronic Engineering Materials: S.K. Bhattacharya, Khanna Publishers, New Delhi.
7. Electrical Engineering Materials: T.T.T.I Chennai, Tata MacGraw Hill.

Suggested Specification table with marks(Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	25	20	15	10	5

Legends: R: Remembrance; U: Understanding, A: Application, N: Analyze, 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.

Course Outcome (Theory):

After learning the course the students should be able to:

Sr. No.	CO Statement	Marks % Weightage
01	Recall different material and its properties which are used in electrical equipments as conductor and its properties in electrical equipments.	20
02	Elucidate various types of dielectric materials, special purpose materials and their properties in various conditions.	40
03	Evaluate types of magnetic materials and its behavior.	20
04	Analyze semi-conductor and superconducting material used in electrical engineering and different effect associated with the materials.	20

List of Open Source Software/learning website:

https://nptel.ac.in/courses/108/108/108108116/

https://nptel.ac.in/courses/113/104/113104096/

https://nptel.ac.in/courses/108/108/108108112/

https://nptel.ac.in/courses/115/103/115103108/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170001
Semester –VII
Subject Name: Summer Internship

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
0	0	0	2	0	0	80	20	100

The duration of internship will be two weeks. It will be after completion of 6th Semester and before the commencement of Semester VII.

Following options can be opted by the students:

1. Offline internship in industry - Student is supposed to produce joining letter and relieving letter once the internship is over in case of Offline internship in any industry.
2. Online internships – with organizations /institutions those are approved /supported / recommended by the All India Council of Technical Education for Internship (like Internshala etc)
3. A Mini Project- to be carried out on some suitable topic related to respective branch. It can be small fabrication / experimental results/ simulations/ application development / Design and / or Analysis of System(s) etc. depending on the branch of the student. Preferably a single student should carry out a mini-project.

Report Submission and Evaluation Guidelines:

- Student has to prepare a detailed report and submit the report to his/her college. A copy of report can be kept in the departments for record.
- Each student must be assigned a faculty as a mentor from the college and an Industry Expert as External Guide or Industry Mentor.
- The evaluation will be of 20 marks for I component and 80 marks for V Component. I Component (20 marks) will be evaluated by the Faculty Mentor or Internal guide of the students and V Component (80 marks) will also be carried as Internal Faculty (Department/ Institute faculty) but this V Component will be evaluated by faculty member of the department / institute and nominated / appointed by the Internship Committee formed by the institute.
- The presentation by student for Internship/ Mini project should in the presence of all students is desirable.
- Student should produce successful completion certificate in case of summer internship in industry.
- The details of type of Internship carried out by student will be uploaded on the GTU PMMS portal from the available option(s) like Offline Internship, Online Internship OR Mini project and the Summer Internship report will be uploaded on the PMMS portal.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170001

Course Outcomes:

Upon completion of this course students are able to:

1. Get exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Get possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job(s).
3. Gain experience in writing Technical reports / projects and presentation of it.
4. Learn and gain exposure to the engineer's responsibilities and ethics.
5. Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

General Guidelines for Summer Internship

Step 1: Request Letter/ Email from the Institute should go to industry to allot multiple slots of 2 weeks during summer vacation as Summer Internship period for the students. Students request letter/profile/ interest areas may be submitted to industries for their willingness for providing the internship.

Step 2: Industry will confirm the internship slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the internship themselves the confirmation letter will be submitted by the students in the office Institute through respective department. Based on the number of slots agreed to by the Industry, institute will allocate the students to the Industry.

Step 3: Students, after joining the Training at the concerned Industry / Organization, has to submit the Joining Report/ Letters / Email.

Step 4: Students are undergoing for Summer Internship at the concerned Industry / Organization. In between Faculty Member(s) has to evaluate(s) the performance of students once by visiting the Industry/Organization and Evaluation Report of the students needs to be submit in department office with the consent of Industry persons/ Trainers.

Step 5: Students will submit a training report after completion of internship.

Step 6: Training Certificate to be obtained from industry.

Step 7: List of students who have completed their internship successfully will be issued/maintained by Training and Placement Cell of the Institute.

Evaluation Rubrics

List of Documents to be prepared for Submission:

- Detail report duly signed and approved by the internal/external mentor
- Presentation softcopy approved by the internal/external mentor
- CD – Scan copy of report and presentation

Student Details												
Enrollment Number												
Student Name												
Branch												
Code and Name of the Institute												
Mentor Details	Name: Designation: Mobile No:											
Mode of Internship Carried Out	Online / Offline											
Title of the Project/ Internship carried out												
Nature of Work Carried Out	Small fabrication / experimental results/ simulations/ Application development / Design and / or Analysis of System(s) etc… Other please Specify_____											

[Company Institute letterhead]

No: Date

TO WHOM IT MAY CONCERN

This is to certify that, Mr./Mrs. _____ Enrollment No_____ Student of _____, has successfully completed a two week Internship in the field of _____ during the period of _____

During the period of his/her internship program with us, He/She had been exposed to different processes and was found sincere and hardworking.

Authorised Signature Mentor Signature

Institute Head

Evaluation Rubrics

Enrollment No: _____ **Branch:_____**

Name of the Students: _____

Date of Evaluation: _____

Internal Evaluation – 20 Marks PA(I) (To be carried out by the mentor in consultation with Industry) Minimum Passing Marks: 10					
Parameter	Excellent	Very Good	Good	Not up the level of Satisfaction	Obtained Marks
Mark range	10	09-08	07-05	Below 5	
Student regularity during the Internship period and proactiveness/responsiveness towards the given tasks **10 marks**					
Quality of the prepared report **10 marks**					
Total Marks Obtained Out of 20 PA(I)					

External Evaluation – 80 Marks ESE(V) Minimum Passing Marks: 40						
Parameter	Excellent	Very Good	Good	Average	Not up the level of Satisfaction	Obtained Marks
Mark range	20-17	16-15	14-12	11-10	Below 10	
Adequacy and Quality of the Work carried Out (**20 Marks)**						
Tools and Techniques Used and to achieve the objectives of the work (**20 Marks)**						
Work Plan and Execution and Outcome achieved (**20 Marks)**						
Quality of the report and presesentation Skill **(20 Marks)**						
Total Marks Obtained Out of 80 ESE(V)						

External Examiner Name:_____ **External Examiner Name:_____**

Signature:_____ **Signature:_____**

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170906
Semester – VII
Subject Name: Advanced Power Electronics

Type of course: Professional Elective Course

Prerequisite: Power Electronics (3140915)

Rationale:

The course is aimed to provide exposure of some power electronic converters that are utilized by the industries and utilities and are not taught in the basic courses on Power Electronics-I and Power Electronics-II.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Switching Voltage Regulators** Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters, Flyback and Forward Converter (2 -3Hrs); Other converter configurations like Half bridge, Full bridge configurations, Push-pull converter, C'uk converter, Sepic Converter; Design criteria for SMPS; Multi-output switch mode regulator; Design of Inductor and high frequency transformer	**10**
2	**Resonant Converters** Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero-voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies	**7**
3	**Multi-level converters** Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations, Applications, Introduction to Carrier based PWM technique and SVPWM for Multilevel converters	**7**
4	**Multipulse Converters** Concept of multi-pulse, Configurations for m-pulse (m=12,18,24 ….) converters, Different phase shifting transformer (Y-Δ1, Y-Δ2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications	**6**
5	**HVDC Transmission** Introduction, Operation of 12-pulse converter as receiving and sending terminals of HVDC system, Equipment required for HVDC System and their	**5**

	significance, Comparison of AC and DC transmission, Control of HVDC transmission	
6	**FACTS devices** Importance of reactive power compensation, Flow of power in AC system and conventional control mechanisms, Definition of Flexible ac Transmission Systems (FACTS) and brief description, possible benefits from FACTS, Thyristor- Controlled Reactor (TCR), Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), Thyristor-Switched capacitor and Reactor, Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSCTCR), STATCOM configuration and operating principle, Static characteristics of SVC and STATCOM Comparison of SVC and STATCOM, Principle of series compensation, Introduction to Static Synchronous Series Compensator, Advantages and limitation of SSSC, Introduction to UPFC and operating principle	**10**

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
15	**30**	**30**	**15**	**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. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2009.
3. Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.
4. Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996.
5. Muhammad H. Rashid , "Power Electronics Handbook", Elsevier, 3rd ed., 2011.
6. P.C.Sen, "Modern Power Electronics ", S. Chand and Co. Ltd., New Delhi, 2000.
7. Vijay K. Sood, "HVDC and FACTS Controllers Applications of Static Converters in Power Systems", Kluwer Academic Publishers, Boston, 2004.
8. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009
9. Recent Literature

Course Outcomes:

After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weig4tage
CO-1	Evaluate different dc-dc voltage regulators	24
CO-2	Simulate and analyze resonant converters	16
CO-3	Evaluate various multi-level inverter configurations and Select appropriate phase shifting converter for a multi-pulse converter	27
CO-4	Describe and simulate HVDC transmission system	09
CO-5	Compare various FACTS devices for VAR compensation	24

List of Experiments:

Lab experiments shall be based on the course content and few experiments shall involve the analyzing and designing skills besides the basic understanding of the subject. A list provided here is to indicate the type of experiments that can be included.

1. Evaluate the performance and operating modes of SLR/PLR dc-dc converter with the change in switching frequency.
2. Simulate/Design a circuit for a Buck Converter with ZVS/ZCS to regulate the output voltage Vo with a given input voltage Vin.
3. Carrier based Sine PWM control of a CHB multilevel inverter and study of harmonic spectrum.
4. Study the operation and performance of half-bridge, full-bridge, push-pull converters etc.
5. Study the operation and performance of fourth order converters like C'uk or Sepic converters
6. Evaluate the performance of STATCOM/SVC as a shunt compensator.
7. Study of harmonic spectrum for 12 and 18 pulse converters.

Major Equipment:

Simulation software like MATLAB, PSIM, Scilab, Power Electronic Converters, CRO/DSO, meters, Current/Voltage Probes, Isolation transformer etc. as demanded by the course.

List of Open Source Software/learning website:

1. MIT OPEN COURSEWARE by Massachusetts Institute of Technology
   - website: ocw.mit.edu
2. Courses available through NPTEL.
   - website : nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170908

Semester – VII
Subject Name: Switchgear and Protection

Type of course: Professional Core Course

Prerequisite: Power System – I
Power System – II

Rationale: An electrical power system consists of generators, transformers, and transmission and distribution lines. In the case of an event of a fault, an automatic protective scheme comprising of circuit breakers and protective relays isolate the faulty section protecting the healthy part of the system. The safety of equipment and human beings is the major concern for every protection scheme. Moreover, students must develop skills for operating various controls and switchgear in the power system. They are also required to carry out remedial measures for faults/abnormalities in machines/equipment in the power system using appropriate diagnostic instruments/devices. This course attempts to develop these skills in students and hence it is a core course for all electrical engineers.

Teaching and Examination Scheme:

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

Sr. No.	Content	Total Hrs
1	**Fundamentals of Power System Protection:** Introduction to Protective Relaying, Function of the Protective Relaying, Faults and Abnormal Operating Conditions, Desirable Qualities and Terms of Protective Relaying, System Transducers, Basic Tripping Mechanism of a relay, Types and operating principles of various protective relays, Simple Differential Protection, Zone of Protection and Actual Behavior of Simple Differential Protection, Percentage Differential Protection, Earth Leakage Protection [1, 3, 4].	**06**
2	**Overcurrent Protection of the Transmission Line:** Introduction, Thermal Relays, Over Current Relays, Types of Relay Characteristics, Application of Definite Time & IDMT O.C. Relays for Protection of Feeder, Relay Coordination, Directional Over Current Relay, Limitations of O.C. Relays [1].	**05**
3	**Distance Protection of Transmission Line:** Introduction to Distance Protection, Types of Distance Relay, Impedance, Reactance, MHO Relay, Performance of Distance Relay During Normal Load and Power Swing, Effect of Arc Resistance on Reach of Distance Relays, Comparison of Distance Relays, Distance Protection of Transmission line, Reasons for Inaccuracy of Distance Relay	**07**

	Reach, Three Step Protection, Trip contact configuration, 3-step protection of double end fed lines [1].	
4	**Transformer Protection:** Faults and Abnormal Conditions in Transformer, Non-electrical Protection, Overcurrent Protection, Earth Fault Protection, Inter-turn Protection, Differential Protection [4].	**06**
5	**Bus-zone Protection:** Non-Unit Protection by Back-up Relays, Differential Protection of Busbars, External and Internal Fault, Protection of Three-phase Busbars [1,4]	**05**
6	**Generator Protection:** Various faults & abnormal operation conditions in a Generator, Stator & rotor faults, Transverse differential protection of a Generator, Unbalanced loading, Over speeding, Loss of excitation, Loss of prime mover [1].	**06**
7	**Induction Motor Protection:** Various faults & abnormal operation conditions in an Induction Motor, Starting of induction motor, Protection of small & large induction motor [2].	**06**
8	**Current and Voltage Transformer:** Construction of Current Transformers, Difference Between CT Cores Used for Measurement and those Used for Protective Relays, Calculation of CT Accuracy, Factors to be Considered while Selecting a CT, Construction of Potential Transformer, Specifications of Voltage Transformer, Capacitor Voltage Transformer.	**05**
9	**Circuit Breaker:** Classification of switchgear and fields of application and relative merits. Theories of current interruption, Energy balance and recovery rate theories, Air Circuit Breaker(ACB), Air Blast Circuit Breaker (ABCB), Practical systems of arc quenching in oil circuit breakers, Construction and operation of bulk oil, Minimum Oil Circuit Breakers, Recent trends in H.V. Circuit Breakers, Sulphur Hexafluoride Circuit Breaker (SF6), Vacuum Circuit Breaker (VCB), Rating of Circuit Breakers, Testing of Circuit Breakers, Miniature Circuit Breakers, Earth Leakage Circuit Breakers [3].	**07**
10	**Modern Trends in Power System Protection** Introduction to static and digital relays, Introduction to adaptive relays. [6]	**03**

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

Distribution of Theory Marks

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170908

R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**30**	**15**	**10**	**5**

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 the above table.

Reference Books:

1. Fundamentals of Power System Protection –Y. G. Parithankar & S. R. Bhide, 2nd edition, PHI
2. Power System Protection and Switchgear by Badari Ram , D.N Viswakarma, TMH Publications
3. Power system protection and switchgear by Oza, Nair, Mehta, Makwana
4. Protection and switchgear, by Bhavesh Bhalja, R.P.Maheshwari, Nilesh hotani,1st edition, 2011, Oxford Publication
5. Power System Protection and Switchgear –B. Ravindranath and M. Chander
6. Power System Protection & Switchgear by B. Ram, McGraw Hill
7. Power System Protection- Static Relays by T.S.M. Rao Tata McGraw Hill
8. Art and Science of Protective Relaying –Russel Masson

Course Outcomes:

S. No	CO STATEMENT	Bloom's taxonomy level	Marks % weightage
CO1	Acquire the knowledge of various abnormal conditions that could occur in electrical system and protective relays	**Remember L1 , Understand L2, Evaluate L5,**	**15%**
CO2	Knowledge of various conventional relays, their design and latest developments	**Remember L1 , Understand L2, Evaluate L5,**	**25%**
CO3	Ability to understand and design various protective devices in power system for protecting equipment and personnel.	**Remember L1 , Understand L2, Evaluate L5 Create L6**	**40%**
CO4	Knowledge of various types of instrument transformers, circuit breakers with their design and constructional details.	**Remember L1 , Understand L2, Evaluate L5 Create L6**	**20%**

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CO' s	Program Outcomes (PO's)

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170908

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	2	1			1			1	1
CO2	3	1	3	2	2	1						2
CO3	1	3	3	2							1	
CO4	2	2	1	1							1	1

1: Slight (Low) **2: Moderate (Medium)** **3: Substantial (High)** **: None**

Suggestive List of Experiments:

1. To check performance/ study of a 3-Phase Differential Relay.
2. To check performance/ study of an over current Relay.
3. To check performance/ study of the Numerical Protection of induction motor.
4. To obtain the operating characteristics of an IDMT relay.
5. To study the operating characteristics of directional over current relay.
6. To check performance/ study of the operating characteristics of the transformer percentage differential relay.
7. To study the magnetic inrush current in a transformer and its protection.
8. To study radial feeder protection using two overcurrent and one Earth fault relay.
9. To obtain and study the magnetization characteristic of CT.
10. To study the protection schemes for different abnormal conditions in an alternator.
11. To study Buchholz relay for transformer protection.
12. To study generalized block diagram of Numerical Relay

Design based Problems (DP)/ Open Ended Problem:

1. The students can be asked to collect the data of a small power system network. Then the student is asked to design a complete protection scheme of the component of the power system like a feeder, a transmission line, transformer, and a generator. The design should include the selection of circuit breaker rating and the relay settings wherever applicable.

2. Students can study and verify various settings of a generator.

3. Students simulates various system and explore how to source impedance and fault location affect the performance of protective relays.

4. With appropriate simulation explain the selectivity of a protective relay.

5. Study and verify factors that will affect CT accuracy and corrective measures.

Major Equipments:

Electromechanical Relay, Static / Numerical Relay, Testing Panels, CT, PT, Timers, Circuit Breakers.

List of Software/learning website:

- MATLAB
- PSCAD
- EMTP
- NPTEL https://nptel.ac.in/courses/108/101/108101039/
- SWAYAM https://onlinecourses.nptel.ac.in/noc20_ee80/preview

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170909
Semester – VII
Subject Name: AC Machine Design

Type of course: Professional Elective Course

Prerequisite:

Rationale:

Electrical machines serve as the backbone for the electrical power sector. The knowledge of electrical machines design is essential for manufacturing as well as the pre-installation performance analysis. The design is also essential for the practicing engineers in the research and development field. This subject deals with design of electrical machines including basics of computer aided design.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Introduction** Major considerations in electrical machine design, Electrical engineering materials, Space factor, Choice of specific electrical and magnetic loadings, Thermal considerations, Heat flow, Temperature rise, Rating of machines.	05
2	**Design of transformers** Sizing of a transformer, Main dimensions, kVA output for single- and three-phase transformers, Window space factor, Overall dimensions, Operating characteristics, Voltage regulation, No load current, Temperature rise in transformers, Design of cooling tank, Methods for cooling of transformers.	10
3	**Design of induction motors** Sizing of an induction motor, Main dimensions, Length of air gap, Rules for selecting rotor slots of squirrel cage machines, Design of rotor bars & slots, Design of end rings, Design of wound rotor, Magnetic leakage calculations, Leakage reactance of poly phase machines, Magnetizing current, Short circuit current, Circle diagram, Operating characteristics.	10
4	**Design of synchronous machines** Sizing of a synchronous machine, Main dimensions, Design of salient pole machines, Short circuit ratio and its significance, Shape of pole face, Armature design, Armature parameters, Estimation of air gap length, Design of rotor, Design of damper winding, Determination of full load field mmf, Design of field winding, Design of turbo alternators.	10
5	**Computer aided design** Need for CAD analysis, Synthesis and hybrid methods, Design optimization methods, Variables, Constraints and objective function, Problem formulation. Introduction to FEM based machine design. Introduction to **c**omplex structures of modern machines- Permanent Magnet Synchronous Machines, Brushless DC Machines and Switched	10

	Reluctance Machines.	

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
15	20	30	25	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. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 2010
2. R. K. Agarwal, "Principles of Electrical Machine Design", S. K. Kataria and Sons, 2009
3. M.G. Say, "Theory & Performance & Design of A.C. Machines", CBS Publishers, 2005
4. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
5. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2015.
6. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

Course Outcomes:

After completing the course, students will be able to;

Sr. No.	CO statement	Marks % weightage
CO-1	Select appropriate design parameters according to applications and rating of electrical machines	20
CO-2	Design the AC machines as per the given specifications	40
CO-3	Evaluate the performance parameters of electrical machines using design parameters	20
CO-4	Formulate the optimum design problem and solve it with computer aided tools	20

List of Experiments:

This is a suggestive list only:

1. Electrical machine design problems should be given for practice to the students. At least 8-10 design problems with different ratings should be practiced by the students
2. Computer aided design problems 1-2 should be practiced by the students

3. 3D visualization of various electrical machine components should be demonstrated to students during lab sessions using open source softwares.

Major Equipment:

Charts and cut section models of various electrical machines, CAD softwares like ANSYS etc..

List of Open Source Software/learning website:

- E-materials available at the website of NPTEL- http://nptel.ac.in/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170916
Semester – VII
Subject Name: Advanced Electric Drives

Type of course: Professional Elective Course

Prerequisite: Power Electronics

Rationale: Electric motor is inevitable part of industries. High precision Control of this electric motors for various industrial applications are needed. Electric drive using power electronic converters with suitable control strategy can control the speed and torque of electric motor precisely. The course is aimed to provide exposure about the commonly used power electronic converters for electric drive applications and various control strategies used for the purpose of motion control.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Power Converters for AC drives** PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.	**10**
2	**Induction motor drives** Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).	**10**
3	**Synchronous motor drives** Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.	**07**
4	**Permanent magnet motor drives** Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.	**06**
5	**Switched reluctance motor drives** Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.	**06**
6	**DSP based motion control** Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.	**06**

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
15	**30**	**30**	**15**	**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. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P.C. Krause, O. Wasynczuk and S.D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

Course Outcomes:

After completing the course, students will be able to;

Sr. No.	CO statement	Marks % weightage
CO-1	Select appropriate power electronic converters for drive applications.	25
CO-2	Analyze the vector control strategies for ac motor drives.	25
CO-3	Select appropriate control strategies for electric drives.	25
CO-4	Evaluate performance of electric drives under different control strategies.	25

List of Experiments:

This is a suggestive list only:

2. PWM inverter fed three phase induction motor control using PSPICE/MATLAB/PSIM software
3. VSI fed induction motor drive analysis using MATLAB/PSPICE/PSIM software
4. Study of V/f control operation of three phase induction motor
5. Study of vector controlled three phase induction motor drive.
6. Study of permanent magnet synchronous motor drive fed by PWM inverter using simulation software.
7. Study of BLDC motor drive fed by PWM inverter using simulation software.
8. Study of SRM motor drive fed by PWM inverter using simulation software.
9. Regenerative/ Dynamic breaking operation for AC motor using simulation software

10. PC/PLC based AC/DC motor control operation

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:

- E-materials available at the website of NPTEL- http://nptel.ac.in/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3170917

HIGH VOLTAGE ENGINEERING

B.E. 7th SEMESTER

Type of course: Professional Core Course (Electrical)

Prerequisite: Not applicable

Rationale: Electrical power transmission is trending towards higher and higher voltages. Under such scenario, the conceptual understanding related to insulation, testing the HV devices is must for every electrical engineer. The subject deals with HV test generating devices, measurement devices, over voltages including lightning and non-destructive testing as well.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1.	Electrostatic fields and field stress control: Electrical field distribution and breakdown strength of insulating materials - fields in homogeneous, isotropic materials - fields in multi-dielectric, isotropic materials.	02
2.	Numerical analysis of electrical fields in high voltage equipment: numerical methods - Charge simulation method (CSM), Finite Difference Method (FDM), Finite Element Method (FEM), The boundary-element method, Comparative summary, Formulation of the finite-element equations in two and three dimensions - Forming the functional equation, The energy functional illustrated, Numerical representation.	04
3.	Electrical breakdown in gases: Gases as insulating media - ionization and decay processes, Townsend first ionization coefficient, photo ionization, ionization by interaction of metastable with atoms, thermal ionization, deionization by recombination, deionization by attachment–negative ion formation, examples - cathode processes – secondary effects, photoelectric emission, electron emission by positive ion and excited atom impact, thermionic emission, field emission, Townsend second ionization coefficient, secondary electron emission by photon impact, examples - transition from non-self-sustained discharges to breakdown, the Townsend mechanism, examples - the streamer or 'kanal' mechanism of spark, examples - the sparking voltage–Paschen's law, penning effect.	05
4.	Breakdown in liquid and solid dielectrics: Liquid as insulators, breakdown in liquids - electronic breakdown, suspended solid particle mechanism, cavity breakdown, examples - static electrification in power transformers,	07

	transformer oil filtration, transformer oil test, alternative liquid insulations like vegetable oils, esters and silicon oils - breakdown in solids, intrinsic breakdown, streamer breakdown, electromechanical breakdown, edge breakdown and treeing, thermal breakdown, erosion breakdown, tracking - breakdown of solid dielectrics in practice, partial discharges in solid insulation.	
5.	Generation of high voltages: Generation of high direct voltages, half and full wave rectifier circuits, voltage multiplier circuits, Van de Graff generators, electrostatic generators, examples - generation of alternating voltages, testing transformers, cascaded transformers, resonant transformers, examples - impulse voltages, Standard lightning and switching surge and associated parameters and their corrections, design and construction of impulse voltage generator circuits, Marx circuit, operation, examples - impulse current generator.	07
6.	Measurement of high voltages: High direct voltage measurement, peak voltage measurements by spark gaps, sphere gaps, reference measuring systems, uniform field gaps, rod gaps, factors affecting sphere gap measurements, examples - electrostatic voltmeters - ammeter in series with high ohmic resistors and high ohmic resistor voltage dividers - generating voltmeters and field sensors - the measurement of peak voltages, the Chubb–Fortescue method, high- voltage capacitors for measuring circuits - voltage dividing systems and impulse voltage measurements. Numericals	06
7.	Over voltages, and insulation coordination: The lightning mechanism, energy in lightning, nature of danger - examples - insulation coordination, insulation level, statistical approach to insulation coordination, correlation between insulation and protection levels.	04
8.	Non-destructive test techniques: Insulation: Measurement of d.c. resistivity - dielectric loss and capacitance measurements, the Schering bridge, current comparator bridges, Tan Delta measurement, Partial-discharge (PD) measurements - the basic PD test circuit, Dissolved gas analysis - Key gas method, Duval's triangle. Machine winding: Frequency Response Analysis Method (FRA)- Introduction, Sweep Frequency Response Analysis (SFRA), procedure, methods of interpretation of signature.	05
9.	High voltage testing: Testing of insulators and bushings, testing of isolators and circuit breakers Testing of cables, testing of transformers - testing of surge diverters	05

Note:

1. 10%-20% weightage should be given to the Examples and Short/Multiple choice questions.
2. The institutes which does not have proper High Voltage Laboratory are advised to visit nearby High Voltage laboratory

Suggested Specification table with Marks (Theory):

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

Legends:R:Remembrance;U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Createa ndabove Levels (Revised Bloom'sTaxonomy)

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. Kuffel,E.,ZaenglW.S.,KuffelJ.,"HighVoltageEngineering:Fundamentals"Butterworth-Heinmann (A division of Reed Educational & Profession Publishing Limited), 2nd Edition, 2000.
2. Naidu M. S. and Kamaraju V., "High Voltage Engineering", fourth Edition, Tata McGraw- Hill Publishing Company Limited, New Delhi,2009.
3. Rakosh Das Begamudre, "High Voltage Engineering, Problems and Solutions", New Age International Publishers, New Delhi,2010.
4. Dieter Kind, Kurt Feser, "High Voltage Test Techniques", Reed educational and professional publishing ltd. (Indian edition), NewDelhi-2001
5. M. Khalifa, "High Voltage Engineering-Theory and Practice", Marcel Dekker, Inc. New York and Basel,1990.
6. Hugh M. Ryan, "High Voltage Engineering and Testing", 2nd edition, The Institution of Electrical Engineers, London, United Kingdom,2001.
7. Wadhwa C.L., "High Voltage Engineering", third edition, New Age publishers, New Delhi,2010.
8. A. Haddad, D. Warne, "Advances in High Voltage Engineering", IET Power and Energy, Series 40, 2007.
9. Sivaji Chakravorti, Debangshu Dey, BiswenduChatterjee,"Recent Trends in the Condition Monitoring of Transformers",Springer, 2013.
10. Alston L L, High Voltage Technology, Oxford University Press, 2008.

Course Outcome:

After learning the course, the students should be able to

1. Apply numerical methods for engineering problem. (Applying)
2. Recall breakdown mechanism for dielectric materials in solid, liquid and gaseous state. (Remembering)
3. Classify insulation test techniques. (Understanding)
4. Examine methods for generation of test high voltage and as well for its measurement. (Analyzing).
5. Conclude about correctness of design and manufacturing of high voltage insulations after performing tests.(Evaluate)

List of Experiments:

1. Testing of transformer oil according toIS:6792

2. Testing of solid insulation with tapeelectrodes
3. Generation of High D.C. Voltages and measurement through spheregaps
4. Generation of High A. C. voltages and measurement through spheregaps
5. Generation of High A. C. voltages through cascadedtransformers
6. Impulse voltage generation through Marxgenerator
7. Impulse voltage generation thoughsimulation
8. Trace the field through electrolytictank
9. Generation and visualization of corona in coronacage
10. Capacitance and loss factormeasurement
11. A report on visit to high voltage laboratory

Note: At least eight practicals shall be performed depending on availability of the equipment.

Design based Problems (DP)/Open Ended Problem:

1. Design of impulse generator with various combination of wave shaping resistor andcapacitor
2. Design of CW type voltage multiplier with variousstages
3. Design of teslacoil
4. Design of Generatingvoltmeter

These problems may be done on paper by hand and/or using some simulation software.

Major Equipment:

1. Multi stage Impulse voltagegenerator
2. Multi stage Impulse currentgenerator
3. High voltage AC and DC generating source (Min 100kV)
4. Partial Discharge Measurement setup
5. Coronasetup
6. Electrostaticgenerator
7. Cascadetransformer
8. ResonantTransformer
9. Two to three sets of sphere gap assembly of variousdiameters
10. Faradaycage
11. Oil testkit
12. Solid insulation testkit
13. Scheringbridge
14. DC resistivity measurement testkit
15. Surface resistance measurement testkit
16. Paschen's law testkit

List of Open Source Software/learning website:

Open source software:

1. Finite Element Method Magnetics FEMM
2. LTSpice for circuitsimulation,
3. KiCAD for CADapplication

Web-based tools for design:

1. http://www.fairchildsemi.com/support/design-tools/power-supply-webdesigner/

2. http://www.ti.com/lsds/ti/analog/webench/overview.page

Circuit Lab:

1. https://www.circuitlab.com/editor/

Open source Math Tools:

1. http://maxima.sourceforge.net/
2. http://www.sagemath.org/
3. http://www.scilab.org/
4. http://www.gnu.org/software/octave/

Online Experiment Portal

1.http://vlab-ee1.iitkgp.ernet.in

Learning website

1. http://www.electrical-engineering-portal.com/
2. http://nptel.iitm.ac.in/courses.php

Standards

1. “IEEE Standard Techniques for High-Voltage Testing”, 6th edition, IEEE Std.4-1978.
2. “High-voltagetesttechniques,Part1:Generaldefinitionsandtestrequirements”,IEC60060-1,1989.
3. “High Voltage Test Techniques, Part 2: Measuring Systems”, IEC Publication 60060-2,1994.
4. “High Voltage Test Techniques, Part 3: Measuring Devices”, IEC Publication 60060-3,1976.
5. “High Voltage Test Techniques, Part 4: Application Guide for Measuring Devices”, 1st ed., IEC Publication 60060-4,1977.
6. IndianStandardspecificationsforHighVoltagetesttechniques”,BureauofIndianStandard,IS 2071, New Delhi,1991.
7. "IEEE Standard for High Voltage Switchgear (Above 1000 V) Test Techniques - Partial Discharge Measurements" - IEEE Std. C37.301 - 2009.
8. "IEEE guide for the application and interpretation of Frequency Response Analysis for Oil-Immersed Transformers" - IEEE Std. C57.149 - 2012.
9. "Mechanical Condition Assessment of Transformer Windings Using Frequency Response Analysis (FRA)" - CIGRE report by working group A2.26, April 2008.
10. "Power Transformers - Part 18: Measurement of frequency response" - IEC60076-18, 2012.
11. "Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis" -IEC 60599 - 2015.
12. "IEEE Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers" - C57.104-2019.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170920
Semester – VII
Subject Name: Industrial Electrical Systems

Type of course: Professional Elective Course

Prerequisite:

Rationale:

Electricity is the major power source for almost all small scale to large scale industries. Per capita consumption of electricity is an indicator of the growth of a country. In view of this, it is important for the electrical engineers to understand the components of residential, commercial and industrial electrical systems. This subject deals with the introduction to components of industrial electrical systems. The subject also includes selection of ratings for various components based on applications and basics of automation of industrial electrical systems.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Electrical System Components** LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, Protection components- Fuse, MCB, MCCB, ELCB, Symbols for wiring components, Single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices	**06**
2	**Residential and Commercial Electrical Systems** Types of residential and commercial wiring systems, General rules and guidelines for installation, Load calculation and sizing of wire, Rating of main switch, distribution board and protection devices, Earthing system calculations, Requirements of commercial installation, Deciding lighting scheme and number of lamps, Earthing of commercial installation, Selection and sizing of components	**10**
3	**Illumination Systems** Understanding various terms regarding light- lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, Various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, Energy saving in illumination systems, Design of a lighting scheme for a residential and commercial premises, Flood lighting	**08**
4	**Industrial Electrical Systems** HT connection, Industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type	**14**

	of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks	
5	**Industrial Electrical System Automation** Study of basic PLC, Role of automation, Advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation	**07**

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
20	**25**	**25**	**20**	**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. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
3. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
4. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008
5. IS Standards : https://bis.gov.in

Course Outcomes:

After completing the course, students will be able to;

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Explain electrical wiring systems for residential, commercial and industrial consumers through symbols, drawings and SLD	20
CO-2	Justify the need of industrial electrical system components and industrial automation	20
CO-3	Evaluate the size, rating and cost of electrical installations for residential and commercial applications	20
CO-4	Design appropriate electrical system with protective equipments for industrial applications	40

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170922
Semester – VII
Subject Name: Smart grids

Type of course: Professional Elective Course

Prerequisite: Power System Analysis, basics of internet

Rationale:

This course mainly focuses on basic fundamentals of smart grid for its implementation in the existing power system network. This course provides overview of smart grid and its applications in potential sectors of Modern power systems. It also provides detailed utility level analysis in terms of energy management, network analysis and operation of smart grids. The course also explores issues in management, control, protection and monitoring of grid with renewable energy source integration as well as in micro grids at remote location.

Teaching and Examination Scheme:

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

Co

Sr. No.	Content	Total Hrs
1	Basics of Load and Generation, Grid operation, Concepts of Power Flow Analysis, Economic Dispatch and Unit Commitment. Introduction to Smart Grid, Difference between conventional & smart grid, Architecture of Smart Grid, Smart Grid standards, Policies Applications, Smart Grid control layer and elements, Smart Grid Initiative for Power Distribution Utility in India.	**05**
2	Power Line Communications, Two-way Digital Communications Paradigm, Network Architectures, IP-based Systems, Advanced Metering Infrastructure, Fiber Optical Networks, Wide Area Network WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Bluetooth, Zig-Bee, GPS, Geographic Information System (GIS), Broadband over Power line (BPL).	**08**
3	Distributed generation resources, Advantages and disadvantages of DG, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid Smart Grid components control elements, Smart Grid Technologies	**08**
4	Micro Grids, Concept of micro grid, need & applications of micro grid, formation of micro grid, Modelling of AC Smart Grid components, Modelling of DC Smart Grid components, Modelling of storage devices, issues of interconnection, Operation, protection & control of micro grid. Simulation and case study of AC micro grid Islanding, need and benefits, different methods of islanding detection.	**08**
5	Load dispatch centers, Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self-Healing Systems, Applications and Challenges, , wide-area monitoring system (WAMS), Phasor	**08**

	measurement units PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI);smart metering; smart grid system monitoring, Phasor estimation, Dynamic Phasor estimation.	
6	Demand side management of Smart Grid, Demand response analysis of Smart Grid, Pricing and Energy Consumption Scheduling, Controllable Load Models, Dynamics and Challenges, Electric Vehicles and Vehicle-to-Grid Systems, Demand Side Ancillary Services Energy Management, Practical study of Smart Grid.	**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
15	**30**	**30**	**15**	**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. EkanayakeJ.,Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications.
2. Momoh J., Smart Grid: Fundamentals of design and analysis, John Wiley & Sons.
3. Smart Grid: Technology and Applications by Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama Wiley India
4. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.

Course Outcomes:

After completing the course, students will be able to;

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Summaries various aspects of the smart grid Technologies, Components, Architectures and Applications	25
CO-2	Study and compare modern communication infrastructure and justify the feasibility of the same for smart grid applications.	25
CO-3	Analyze Micro grid and distributed generation as a part of modern hybrid power system with advantages and challenges in smart gird operations	25
CO-4	Use of load modeling techniques, Demand Side Ancillary Services Energy Management in Pricing and Energy Consumption Scheduling in smart grid operations	25

List of Open Source Software/learning website:

https://nptel.ac.in/courses/108/107/108107113

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170923
Semester – VII
Subject Name: Electrical and Hybrid Vehicle

Type of course: Professional Elective Course

Prerequisite:

Rationale:

Vehicle is an unavoidable machine for the industry, individual and government. The fuel consumptions have led the nations to be dependent on electric vehicles and needs a major change in the operation in context to energy saving. The electric vehicle has drawn attention of the designers, researchers and manufacturers for the skilled persons needed in this era. The energy saving concept has lead to hybrid electric vehicle in all the concepts for the transportation.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Electric Vehicle:** History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.	4
2	**Induction to Hybrid Electric Vehicle:** Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. 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.	4
3	**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.	10
4	**Types of Storage Systems:**	10

	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, Calculation for the ratings.	
5	**Modelling of Hybrid Electric Vehicle Range:** Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2 wheeler, 3 wheeler and 4 wheeler vehicles.	**10**
6	**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. Introduction to various charging techniques and schematic of charging stations.	**07**

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
15	**30**	**30**	**15**	**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 Larminie, J. Lowry, "Electric Vehicle Technology Explaned", John Wiley & Sons Ltd. 2003.
2. 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.
3. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.
4. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.

Course Outcomes:

After completing the course, students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Select appropriate source of energy for the hybrid electric vehicle based on driving cycle.	25
CO-2	Analyze the power and energy need of the various hybrid electric vehicle.	25
CO-3	Measure and Estimate the energy consumption of the Hybrid Vehicles.	25
CO-4	Evaluate energy efficiency of the vehicle for its drive trains.	25

List of Open Source Software/learning website:

- Online course: https://nptel.ac.in/course.html
- Ocw.mit.edu/courses
- https://www.eng.mcmaster.ca/mech/content/electric-and-hybrid-vehicles

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170925
Semester – VII
Subject Name: Industrial Automation

Type of course: Open Elective Subject

Prerequisite: Knowledge of Basic Electrical Engineering, Basic Electronics, Digital Electronics, Electronics Measurement and Instruments

Rationale: Automation is playing a key role in Industries. Industries rely heavily on automation for economic viability and mass production. It is important for the students to learn basic of automation, how system works and importance of PLC, SCADA and robots in automation. This course will provide opportunity to learn industrial automation techniques.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Introduction:** Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus & profibus. Role of computers in measurement and control.	4
2	**Automation components**: Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.	6
3	**Programmable logic controllers:** Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	7
4	**Distributed Control System:** Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.	7

5	**Overview of Industrial automation using robots:** Basic construction and configuration of robot**,** Pick and place robot, Welding robot. Internet of things for plant automation and overview of Industry 4.0	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
5	**15**	**25**	**10**	**10**	**5**

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] Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies

[2] Process Control Instrumentation Technology By. C.D. Johnson, PHI

[3] Industrial control handbook, Parr, Newnem

[4] Programmable logic controller, Dunning, Delmar

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Explain automation components and systems application	25
CO-2	Identify suitable industrial automation hardware for given application	30
CO-3	Measure industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.	25
CO-4	Integrate SCADA with PLC Systems	20

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170925

List of Experiments:

(General guidelines.. Institute may change list of experiments based on laboratory set up available)

- Use industrial grade sensors and transducer introduction and characteristics like proximity detector, linear encoder, rotary encoder, touch sensor, force sensor, accelerometer, RTDs, loadcells and LVDT for measurement
- Use Various actuators such as relay, solenoid valve, process control valve and motors for control applications
- Simulate analog and digital function blocks
- Relay logic diagram and ladder logic diagram
- Understand and perform experiments on timers and counters
- Logic implementation for traffic Control Application
- Logic implementation for Bottle Filling Application
- Tune PID controller for heat exchanger using DCS
- FBD for autoclavable laboratory fermentor
- Develop graphical user interface for the plant visited by you
- Industrial visit report

There may be separate list of experiment where laboratory setup is developed by Siemens under Centre of Excellence.

Major Equipment:

1. ADC, DAC and Controller, Switches, LEDs, Solenoid valves
2. Relay, motor
3. PLC with software
4. MATLAB® or LABView®
5. AC Servo drives and DC Servo drives
6. Zeegbee and Bluetooth based short range automation system.
7. IoT boards.
8. Robot for demonstration

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3180901
Semester – VIII
Subject Name: Internship/ Project

Type of course: Project work or Internship in industry

Prerequisite: Electrical Engineering courses (Basic science, Engineering Science and core courses), Effective Technical Communication and Design Engineering

Rationale: To enhance employability skills of the students Internship or Project work is required. It provides practical experience in a field of Electrical Engineering and help to reinforce theoretical knowledge gained in different courses to solve real life challenges. The students are given exposure to explore the new developments and techniques, which can lead them to self-employment or even employment generation through extension of the work done in project.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
0	0	24	12	0	0	100	100	200

Content:
Final semester of Electrical Engineering is dedicated to Major project work. Students can also undergo internship for at least 12 weeks.

Guidelines for Internship

1. It shall be of minimum duration of 12 week.
2. A student may submit a brief proposal about the work to be carried out in the internship, to a committee formed by head of department within 3 weeks, after starting the internship.
3. The internship shall be a full time for the whole duration.
4. A detailed daily diary is supposed to be maintained by student. It shall be signed duly by the concerned supervisor of industry. It shall be submitted to the department.
5. A comprehensive report is required to be prepared and submit to the department at the end of the semester. A certificate shall be attached with this report duly signed by the competent authority of the industry for the successful completion of the internship. An attendance report shall also be attached with this report.
6. The internal evaluation shall be done at the start of the semester, at the mid of the semester and at the end of the semester. The internal marks shall be divided as decided by the head.
7. An attendance report shall be sent to the department after every four weeks.
8. A plan for the whole internship duration shall be prepared after joining the industry after consultation with the supervisor/mentor/guide of industry. It shall contain the activities/ visits to different sections etc with appropriate timelines.
9. The project report shall be submitted to the institute which may include the objective of training, about the industry, process, product line, equipment/machineries involved, divisions/sections in the industry, any competitor, scope of some improvement in the process/product/efficiency, benefit by the training etc.

10. The industry supervisor may be invited at the time of external examination of the internship, if possible. It can be an online presence.
11. The evaluation by external examiner shall be made considering the all guidelines.

The following guidelines are required to be followed for the project …

General Guidelines for Project

1. It can be either UDP (user defined project) OR IDP (Industry defined project).
2. There shall be a committee at department level to regulate the quality and quantity of the work of each team. A presentation by the team shall be made at the beginning of the semester to a committee formed by head of department. This presentation shall contain the detailed proposal of the project, which includes title of the project, wel defined problem and a plan of activities with appropriate timelines. The role of team member shall preferably be defined as far as possible in this proposal itself.
3. The group size of the project team shall not be preferably more than 4 students. In case it is required to have more students it shall be approved by a committee.
4. The stereotype study of system/circuit etc shall be avoided. E.g. study of Power transformer/400 kV substation are few examples, which shall be avoided.
5. The internal evaluation shall be done at the start of the semester, at the mid of the semester and at the end of the semester. The distribution of internal marks shall be decided by the committee.
6. The project work shall be carried out under the guidance of a faculty.
7. Every team shall submit a report at the mid of the semester.
8. A comprehensive report is required to be prepared and submit to the department at the end of the semester.
9. Considering the number of credits and the teaching hours, substantial amount of work is required to be carried out by student's team. It shall be monitored by the project guide and the department committee. The evaluation shall be done accordingly with due consideration given to the amount of work by internal examiner and external examiner.
10. The team shall be encouraged to publish project work, if possible.
11. The evaluation by external examiner shall be made considering the above guidelines.

The guidelines about the nature of project work are as following:

1. The project work can be simulation of circuits/system or hardware based depending upon the area and the complexity of the work involved.
2. If it contains only simulation, it shall be comprehensive. The team is expected to know the various aspects of simulation techniques in detail. The team shall be able to explain the results obtained in detail with all the aspects and different cases.
3. It can be a case study, innovative solution to real life problems, modeling and analysis, design, optimization, hardware prototype, industry defined problem, development of new lab setup at the department etc.
4. If it is a case study, it shall be a real-world case and of high technical relevance.
5. If the project is about a modeling, the team is expected to know the proper mathematical formulation and justification of the modeling, its limitations and its possible applications. The

comparison of performance of various models shall be covered as a part of the work. A detailed analysis of the results shall be done with the help of the model.

6. If the team and guide find it appropriate, the overall work can be combination of different types of work above mentioned.

Distribution of Marks					
R Level	U Level	A Level	N Level	E Level	C Level
5	10	30	30	10	15

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

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate a sound technical knowledge of their selected project topic	20%
CO-2	Undertake problem identification, formulation and solution	20%
CO-3	Design engineering solutions to complex problems utilising a systems approach and team work	30%
CO-4	Communicate with engineers and the community at large in written and oral forms	20%
CO-5	Demonstrate the knowledge and understanding of engineering and management principle and apply it to assigned project	10%

Reference:

- AICTE Model curriculum
- AICTE Internship Policy:

  https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL
Course / Subject Code: BE01R00051
Course / Subject Name: Basic Electrical Engineering

w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	ESC

Prerequisite:	NA
Rationale:	Electricity has been the main source of energy for the developing and developed countries. Per capita consumption of electricity of a country can be considered as an indicator of the development of the country. In view of this, it is essential for all engineering graduates to know the basic aspects of electrical engineering. This subject deals with basic circuit solution methods, introduction to electrical machines and basics of domestic electrical installations.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Apply fundamental electrical laws and circuit theorems to electrical circuits.	Application
02	Analyze single phase and three phase AC circuits.	Analyze
03	Describe operating principle and applications of static and rotating electrical machines.	Understand
04	Understand the wiring methods, electricity billing, and working principles of circuits protective devices and personal safety measures.	Read & Understand
05	Understand the electrical safety and purpose, types and scope of earthing systems	Read & Understand

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**DC Circuits:** Electrical circuit elements (R, L and C), voltage and current independent sources, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin and Norton Theorems, Star-delta/Delta-Star conversion, Time-domain analysis of first-order RL and RC circuits.	7	15
2.	**AC Circuits** Representation of sinusoidal waveforms, peak, RMS and average values of different signals, form factor and peak factor, Phasor representation of AC quantities, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), Series and parallel resonances, Three phase balanced circuits, voltage and current relations in star and delta connections, Power measurement in three phase balanced circuits.	9	20
3.	**Magnetic Circuits & Transformers** Magnetic effect of electrical current, cross and dot convention, right hand thumb rule and cork screw rule, Concepts of m.m.f, flux, flux density, reluctance, permeability and field strength, Analogy between electric and magnetic circuits, Magnetic Circuits, B-H Curve, Hysteresis Loop, Hysteresis and Eddy current losses, Construction and working principle of single-phase transformers: Construction, principle of working, voltage and current ratios, losses, definition of regulation and efficiency, Ideal and practical transformer.	8	15
4.	**Fundamentals of Electrical Machines** Generation of rotating magnetic fields, Construction and working of Single-phase induction motors (Split phase, Capacitor start, Permanent split capacitor, Capacitor start/capacitor run). Single phase induction motor applications: pumps, refrigerators, fans, compressors, and portable drills. Construction and working of brushless DC motors and its application: Electrical Vehicle, washing machines, Blowers, Computers/Laptops	9	20

5.	**Electrical Wiring and Installations** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB. Types of lamps, fixtures & reflectors, illumination schemes for domestic, industrial & commercial premises, Lumen requirements for different categories. Earthing – Types of earthing and its importance. Safety precautions for electrical appliances. Types of Batteries, Characteristics of Batteries (Voltage, storage capacity, discharge curve, cycle life). Elementary calculations for energy consumption of home appliances and electricity bill. Basic electrical measurements with Ammeter, Voltmeter, Wattmeter and Energy meter (working principle and circuit connection).	12	30
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	20	20	20	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1) D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
2) Basic Electrical Engineering - Nagsarkar and Sukhija, Oxford University Press
3) B. L. Theraja, "Electrical Technology – Part I and II", S. Chand and Co. 2012
4) D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
5) J. B. Gupta " Basic Electrical Engineering", S.K. Kataria & Sons,2023.
6) A Chakrabarti,S Nath and C K Chanda "Basic Electrical Engineering",TATA McGraw Hill,
7) S.L. Uppal "Electrical Wiring Estimating and Costing", Khanna Publisher, 1987
8) Irving M. Gottlieb ""Practical Electric Motor Handbook"Newnes,1997
9) L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
10) E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
11) V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Open source software and website:

1. https://nptel.ac.in/

Suggested Course Practical List:

1) Introduction of Resistors, Capacitors and Inductors and usage of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope.
2) To verify the Kirchoff's current and Kirchoff's voltage laws.
3) To verify the Thevenin's and Norton's theorems.
4) To verify Superposition's theorems
5) To obtain sinusoidal steady state response of R-L and R-C circuits – impedance calculation and verification phasor relationships between voltage and current and to observe the phase differences between current and voltage phasors
6) To obtain steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in DC input voltage (transient may be observed on a Digital Storage Oscilloscope)
7) To verify the phasor relationships between currents and voltages for resonances in R-L-C circuits
8) To measure the power in three phase balanced circuits using two wattmeter method
9) To verify the current phasor and voltage phasor relationships in three phase star and delta connections
10) Demonstration of cut-section models and charts of various machines
11) Demonstration of domestic switch gears like MCB, ELCB, MCCB etc. of different ratings
12) Understanding of various safety precautions for electrical installations
13) Demonstration of various types of wires, fuses and cables
14) To Calculate energy consumption of various appliances and house hold electricity bills
15) To verify the power factor improvement in single phase AC circuit
16) Study the different types of domestic wiring
17) To obtain Hysteresis loop of a magnetic material on CRO/DSO

List of Laboratory/Learning Resources Required:

Ammeters, Voltmeters, Wattmeters, Resistors, Capacitors and Inductors of appropriate rating. Multimeters, Digital storage oscilloscope, Cut section models/charts of various machines, Demo units for MCB, ELCB, MCCB etc, Samples of wires and cables. Charts for earthing and safety precautions.

- **List of suggested activities for Problem Based Learning:**

No.	Activity Name	Units Mapped	Hours	Brief Description	Evaluation Criteria/Remarks
1	Technical Video-Based Learning	Unit 1, 2, 3	10 (5+5)	Watch curated videos (e.g., NPTEL/MIT OCW) on DC circuits, AC power, Transformers. Submit a reflective report.	Report + Oral Presentation

2	Numerical Assignment Writing	Unit 1, 2, 3	10 (5 × 2h)	Solve 5 numerical assignments covering Theorems, Power factor, AC analysis, and Transformer calculations.	Correctness, method, clarity
3	Simulation & Problem Solving Using Software (Scilab, Tinkercad, LTSpice)	Unit 1, 2, 3	10 (5 × 2h)	Simulate basic circuits (RLC, transformer equivalent), transient analysis, and AC load behavior.	Report + Screenshot + Output sheet
4	Case Study: Domestic Wiring & Electricity Billing	Unit 5	5 (2.5+2.5)	Study household wiring layout and energy bills. Estimate load, usage, and suggest efficiency improvements.	Report + Practical Recommendations
5	Poster / PPT Preparation	Unit 4, 5	4	Topic examples: “BLDC Motor in EV”, “Earthing Methods”, “Difference between MCB & MCCB”	Technical clarity + Visual appeal + Presentation
6	Group Discussion / Seminar on Electrical Safety & Earthing	Unit 5	2	Discuss safety norms, role of protective devices, and earthing types.	Technical depth, articulation
7	Online Technical Quiz / Interactive Simulation (Electrical4U / vlab.co.in)	Unit 1 to 5	2	Attempt at least 3 online quizzes with screenshot of scores and a 100-word learning reflection.	Quiz scores + Reflection Note
8	Maintenance / Troubleshooting Logbook (Lab Based)	Unit 1, 2, 4, 5	2	Record at least 5 issues encountered during lab sessions and how they were resolved.	Clarity of issue, resolution steps
9	Annotated Concept Video (Optional – Higher Bloom’s level)	Unit 2, 3	Extra (Optional 5)	Make a 5–6 minute video explaining topics like phasor relationships or transformer working.	Clarity, technical accuracy, originality

10	Mini Project	Unit 1		1.Design & build a small DC lighting circuit for a room with switches & fuses, calculate load & test functionality. 2. Create a Portable Power Supply 3. Star-Delta Conversion Demonstration Board	1)Students design and wire a small DC circuit with multiple switches and a fuse. 2)Measure total current & voltage at different load configurations. 3) Document calculations & measurements 1)Design and build a small DC power supply (e.g., 6V/12V) using batteries, resistors, and regulators. 2)Test output voltage under varying loads. Mini-Project:Star-Delta Conversion Demonstration Board
11	Mini Project	Unit 2		Construct & test a power factor correction circuit using capacitors for a given inductive load	1) Build a circuit with inductive loads and capacitors to improve the power factor. 2) Measure before and after power factor.
12	Mini Project	Unit 4		Prepare a report on motors used in a household	Identify and document the types

				appliance (e.g., washing machine) and demonstrate working with a model or simulation	& ratings of motors used in 5–6 household appliances. 2)Suggest improvements for energy efficiency.
13	Mini Project	Unit 5		Design a safe, energy-efficient wiring layout for a small house/shop including earthing & protective devices	1.House Wiring Model Design and build a functional model of electrical wiring for a 1-room house with proper earthing & protection devices. 2.Energy Audit & Bill Calculation Measure energy consumption of typical home appliances and calculate monthly electricity bill. Suggest ways to reduce the bill. 3.Safety Demo Board Create a board demonstrating MCB, ELCB, MCCB operation with faulty & safe scenarios.

Unit-Wise Mapping

Unit	Topic	Relevant Activities
1	DC Circuits	Activities 1, 2, 3, 7, 8, 10
2	AC Circuits	Activities 1, 2, 3, 7, 8, 9, 11
3	Magnetic Circuits & Transformers	Activities 1, 2, 3, 9,

4	Electrical Machines	Activities 1, 5, 8,12
5	Electrical Wiring, Safety & Billing	Activities 4, 5, 6, 7, 8,13

Note:

- **All the suggested activity should be related to the subject.**
- **The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.**
- **Rubrics for the evaluation can be prepared by the faculty.**
- **All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.**
- **Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.**

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL

Course / Subject Code : BE01R00071

Course / Subject Name : Design Thinking

W. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	ESC

Prerequisite:	**NIL**
Rationale:	This course is designed for students from all disciplines who seek to understand design thinking for brand, product, and service development. It covers essential concepts, methods, and techniques of design thinking, empowering students to drive innovation in both business and the social sector.

Course Outcome:

After Completion of the Course, the Student will be able to:

No	Course Outcomes	RBT Level
01	Understand the fundamental principles and importance of Design Thinking in fostering innovation and its relevance in engineering.	UN
02	Apply systematic problem identification, problem framing-articulation, and problem-solving approaches in the context of Design Thinking.	AP
03	Analyze and evaluate different tools and methodologies used in Design Thinking, such as observation, ethnographic research, and mind mapping, to gain insights into user unmet needs.	AN
04	Develop and refine product concepts by preparing product development canvases (PDC) that consider product experience, functions, features, and components. (Synthesis level)	AP
05	Create a final working prototype or an alternative prototype for projects with limitations, showcasing the functionality and features, Viability, Impact, Sustainability, Scalability, Costing, and Resources for the Creation	CR

**Revised Bloom's Taxonomy (RBT)*

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL

Course / Subject Code : BE01R00071

Course / Subject Name : Design Thinking

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
00	00	60	00	60	02	00	00	20	00	80	100

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Design Thinking for Engineers** What Sets Design Thinking Apart? Essential Design Thinking Skills, Core Principles of Design Thinking, Foundations of Design Thinking, Building an Effective Design Thinking Team, Design Thinking Workshops and Meetings Exercises and Case-Based Discussions	08	13
2.	**Stages of the Design Thinking Approach** Class Exercise: Review the Case Study **Observation:** Role of observation in understanding product and process challenges, Techniques for effective product and process observation **Exercise:** Based on the AEIOU Framework **Empathize** with Customers/Users **Exercise:** Engage with Customers/Users **Define the Problem,** Exercise: Review and Follow-Up, Define the Point of View **Ideate** Exercise: Develop Potential Solutions **Prototype Alternate Solutions** Exercise: Create a Prototype of the Solution **Test the Solutions** Exercise: Prepare and Conduct Tests of the Prototype and Solution	14	23

	Exploring Design Thinking in Innovation: Understanding the Role of Design Thinking in Product and Process Innovation, Differentiating Engineering Design and Design Thinking Contrasting Approaches: Engineering Design vs. Design Thinking Stanford Design thinking process and Double Diamond model		
3.	**Design Thinking Techniques** Understanding Listening and Empathizing Techniques: Exploring observation methods, Utilizing a structured, open-ended approach for effective communication, Ideation Tools: Brainstorming techniques for idea generation, Applying innovation heuristics to foster creativity. **Introduction to SCAMPER technique:** Explanation of SCAMPER (Substitute, Combine, Adapt, Modify, put to another use, Eliminate, Reverse) and its application in diverse innovation contexts (product, system, process) Practical exercises and case studies demonstrating SCAMPER's effectiveness in idea generation Prototype and Test Techniques: Type of Prototype (PoC), Forms of testing in Design Thinking, Prepare and A/B Test of the prototype	14	23
4.	**Methods and Tools for Design Thinking Practice** Empathize: Ask five why questions, Empathy map, storytelling, critical items diagram, mind map, journey map Ideate: Brainstorming, 2X2 matrix, NABC Methods Prototype: Exploration map, Minimum Viable Product (MVP), Feasibility Testing, Viability Testing, Sustainability Testing Test: Collet Feedback, iterate and improve the ideas	14	23
5.	**Adopt and Adapt Design Thinking** Cautions and Pitfalls: Assumptions Exercise: Assumptions Pitfalls and Cautions in Design Thinking Workgroups Application of Design Thinking in Academic Projects Across Disciplines	10	18
	Total	**60**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
0	**15**	**40**	**15**	**20**	**10**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Pavan Soni (2020), Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Penguin Random House India Private Limited
2. Gasparini, Andrea. "Perspective and use of empathy in design thinking." In ACHI, the Eight International Conference on Advances in Computer-Human Interactions, pp. 49-54. 2015.
3. Defining a Problem Statement — Design Thinking by Priyanka Jeph in QED42
4. Scamper: How to Use the Best Ideation Methods by Rikke Friis Dam and Teo Yu Siang in Interaction Design Foundation
5. Design: Creation of Artifacts in Society by Prof. Karl Ulrich, U. Penn
6. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation."
7. Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, "Design Thinking for the Greater Good: Innovation in the Social Sector."

(b) Open-source software and website:

1. Google Workspace: Docs, Sheets, & Slides
2. Google Jamboard
3. Storyboard
4. Any other Relevant Tools

(c) Suggestive MOOC Course

1. B.K. Chakravarthy, Design Technology and Innovation, SWAYAM NPTEL (Online)
2. B.K. Chakravarthy, Innovation by Design, SWAYAM NPTEL (Online)
3. Nina Sabnani, Understanding Design, SWAYAM NPTEL (Online)
4. R T Krishnan and V Dhabolkar, Managing Innovation, SWAYAM NPTEL (Online)

Note:

1. Based on Design Thinking, individual BoS may propose mini projects in the relevant subject in higher semesters.

w. e. f. Academic Year:	2025 - 2026
Semester:	Ist Year
Category of the Course:	HSMC-01

Type of Course –

Value-based holistic personality development course for university students.

Rationale

IPDC aims to prepare students for the modern challenges they face in their daily lives. Promoting fortitude in the face of failures, unity amongst family discord, self-discipline amidst distractions, and many more priceless lessons. The course focuses on morality and character development at the core of student growth, to enable students to become self-aware, sincere, and successful in their many roles - as an ambitious student, reliable employee, caring family member, and considerate citizen.

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
30	00	00	30	60	02	70	30	00	30	00	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

The assessments should include both continuous evaluation and end-of-semester examinations. The assessment scheme should include student attendance, assignments, mid-term exams, viva, workbook submission, and end-of-semester examinations.

Course-Content:

Each lecture can be taken in a continuous two-hour session, or in two separate one-hour sessions. In addition to the core lectures, an induction and concluding lectures are recommended as shown in the below table.

Lecture No.	Module -Lecture	Lecture Description	Hours
Induction	The Need for Values	Students will learn about the need for values as part of their holistic development to become successful in their many roles - as ambitious students, reliable employees, caring family members, and considerate citizens.	2
1	**Remaking Yourself** Restructuring Yourself	Students learn how self-improvement enables them to secure a bright future for themselves. They will learn 6 powerful thought-processes that can develop their intellectual, physical, emotional, and spiritual quotients.	2
2	**Remaking Yourself** - Power of Habit	Students will undergo a study of how habits work, the habits of successful professionals, and the practical techniques that can be used to develop good habits in their life.	2
3	**Learning from Legends-** Tendulkar & Tata	Students will learn from the inspirational lives of India's two legends, Sachin Tendulkar and Ratan Tata. They will implement these lessons through relatable case studies.	2
4	**From House to Home-** Listening & Understanding	Active listening is an essential part of academic progress and communications. Students will learn to listen with their eyes, ears, mind, and heart.	2
5	**Facing Failures-** Welcoming Challenges	This lecture enables students to revisit the way in which they approach challenges. Through the study of successful figures such as Disney, Lincoln and Bachchan, students will learn to face difficulties through a positive perspective.	2
6	**Facing Failures-** Significance of Failures	Failure is a student's daily source of fear, negativity, and depression. Students will be given the constructive skills to understand failure as formative learning experiences.	2
7	**My India My Pride-** Glorious Past - Part 1	India's ancient Rishis, scholars, and intellectuals have made tremendous contributions to the world, they developed an advanced, sophisticated culture and civilization which began thousands of years ago. Students will learn the importance of studying India's glorious past so that they could develop a strong passion and pride for our nation.	2

8	**My India My Pride-** Glorious Past - Part 2	Our ancient concepts can be used to seek revolutionary ideas and to generate inspiration. Students will develop a deeper interest in India's Glorious Past – by appreciating the need to read about it, research it, write about it, and share it.	2
9	**Learning from Legends-** A.P.J. Abdul Kalam	Dr Kalam's inspirational life displayed legendary qualities which apply to students (1) Dare to Dream (2) Work Hard (3) Get Good Guidance (4) Humility (5) Use Your Talents for the Benefit of Others	2
10	**Soft Skills-** Networking & Leadership	Students are taught the means of building a professional network and developing a leadership attitude.	2
11	**Soft Skills-** Project Management	Students will learn the secrets of project management through the Akshardham case study. They will then practice these skills through an activity relevant to student life.	2
12	**Remaking Yourself-** Handling Social Media	Students will learn how social media can become addictive and they will imbibe simple methods to take back control.	2
13	**Facing Failures-** Power of Faith	Students will learn about the power and necessity of faith in our daily lives.	2
14	**From House to Home-** Bonding the Family	Students will understand the importance of strong family relationships. They will learn how to overcome the generation gap and connect with their family more.	2
15	**Selfless Service-** Seva	Students will learn that performing seva is beneficial to one's health, wellbeing, and happiness. It also benefits and inspires others.	2

- **COURSE MATERIAL / MAIN COURSE WORKBOOK -**

1. IPDC Workbook-1 *(presented by B.A.P.S. Swaminarayan Sanstha)*

IPDC REFERENCES –

These are the reference material for the IPDC lectures. This is not compulsory reading for the

students as the essential information is contained in the workbooks.

Module No.	Module	References
1	Facing Failures	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 **3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008** 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015 7. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007
2	Learning from Legends	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life-Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013
3	My India My Pride	1. Rishis, Mystics, and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011

		2. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 4. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark,
		University of Chicago Press, reprint, Kessinger Publishing, 2006
4	Remaking Yourself	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
5	From House to Home	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 **2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995** 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
6	Soft Skills	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Dan Ariely, Harper Perennial, 2010

7	Selfless Service	1. Open: An Autobiography, Andre Agassi, Vintage, 10 August 2010 2. The Physiological Power of Altruism [online], James Hamblin, The Atlantic, December 30, 2015, https://www.theatlantic.com/health/archive/2015/12/altruism-for-a-better-body/422280/ [last accessed June 10, 2020] 3. TBI Blogs: From Entrepreneurs to Doorkeepers, Everybody Serves with Love & Warmth at This Ahmedabad Café [online], The People Place Project, The Better India, May 29, 2017, https://www.thebetterindia.com/102551/small-way-serve-ahmedabad-seva-cafe/, [last accessed June 10, 2020]

Course Outcomes

- To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.
- To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.
- To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.
- To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.
- To enhance awareness of India's glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.
- To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Identify one habit to be transformed and ask student to execute it for 21 days	Activity duration =21 day. Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
2	Track social media usage: Decide one	Activity duration =15	Based on report

	social media app to be uninstalled from your phone for 15 days.	day. Duration= 5 hours	/Chart/Poster/Presentation submitted
3	To do seva activities at old age home, orphanage home, ,hospital, Cleanliness at school,society,college	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
4	Prepare a chart of famous failures.	Duration = 5 hours	Based on report /Chart/Poster/Presentation submitted
5	Make a team of 2-3 members .Plan the overall activities to be carried out for tech fest at your college, Make detailed list of activities to be done and budget plan.	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
6	Introspect and identify at least five scenario where you feel that your actions could be updated based on learning from listening and understanding	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
7	Sit with your family for 15 minutes a day discuss and share each other's activities(for Total 20 days)	Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
8	A well-organized plan for managing a **college tech fest** with a **team of 2–3 members**, including a **detailed list of activities** and a **budget plan**.	Duration =5 hour	Based on report submitted.
9	Sitting with your family for just **15 minutes a day** share each other's activities	Activity time = 5 hours (20 days) Report time = 5 hours	Based on report /Chart/Poster/Presentation submitted.
10	Group discussion: *What do I owe to my parents?* Write a Gratitude Letter to a parent/sibling/friend.	Duration= 1 hour	Based on report /Chart/Poster/Presentation submitted.
11	Prepare a "Personal Vision Statement" or "My Code of Living" booklet	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted.
12	Role-play or skit on miscommunication in relationships and solutions	Duration = 1 hour	Based on report /Chart/Poster/Presentation submitted
13	Community Seva (Service Activity): cleaning, helping elderly, teaching kids, etc. + reflection	Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
14	Self-Observation Diary: Record thoughts/emotions/actions for 10 days.	Duration = 1 hour	Based on report /Chart/Poster/Presentation submitted
15	Life Vision Journal: Write your 5-	Duration =1 hour	Based on report

	year vision—career, health, relationships, contribution. "My Life Compass" Poster: Personal motto, core values, role models, goals.		/Chart/Poster/Presentation submitted
16	Avoid all social media for 24 hours. Reflect: *What did I miss? What did I gain?*	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
17	Review and clean your social media: Unfollow toxic or negative accounts. Follow value-based, positive pages. Reflect: *What did I miss? What did I gain?*	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
18	Maintain a log of daily screen/social media usage for 3–5 days. Categorize it into productive vs unproductive time.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
19	Organize a physical or virtual tour to a local museum, heritage site, or historical monument.	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted
20	Students create weekly factsheets or digital posts sharing unknown facts from India's past (science, ethics, literature, and education).	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted
21	Watch a documentary (e.g., *Bharat Ek Khoj*, *Science in Ancient India*) and write a reflection on what surprised or inspired them.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	ESC

Pre-requisite:	NA
Rationale:	The Digital Fabrication Workshop equips students with essential hands-on skills required in the Electrical/Electronics and Computer hardware industries. With practical applications, students gain a comprehensive understanding of the Electrical hazards and electronics fabrication process. The course fosters to prepare students for more advanced studies and professional roles in engineering and technology.

Course Outcomes:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
01	Identify various electrical and electronic components, their symbols, and their functions	Remembering
02	Explain the operation and application of laboratory equipment and household wiring systems.	Understanding
03	Demonstrate proper soldering techniques and assembly of simple electronic circuits based on schematics.	Apply
04	Apply safety protocols and troubleshooting methods for electrical circuits and computer hardware.	Apply
05	Demonstrate computer system assembling and installation of Application software and System software	Apply

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
00	00	30	00	30	01	00	00	20	00	80	100

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

* **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Electrical and Electronics Components:** • Symbols: Understand the symbols used to represent various electrical and electronic components. • Types of Components: Explore resistors, inductors, capacitors, diodes, zener diodes, LEDs, photo diodes, transistors, and integrated circuits.	04	13
2.	**Laboratory Equipments:** • DC Power Supply, Function Generator, Multi-meter, LCR Meter, Wattmeter, Energy Meter, Clamp-On Meter, Digital Storage Oscilloscope (DSO). • Household Equipment and Wiring: Types of switches, types of cables, Tube light wiring, fan and fan regulator wiring, staircase wiring, godown wiring, panel layout and wiring, single line diagrams	04	14
3.	**Soldering Techniques:** • Types of Soldering (Through-Hole, Surface Mount) • Soldering Tools and Materials • Techniques for Soldering Electronic Components • Common Problems: Address issues like cold joints	04	14
4.	**Electronic Circuit Assembly and Testing:** • Reading and Understanding Circuit Schematics • Assembly of Simple Electronic Circuits • Testing and Troubleshooting Assembled Circuits	04	13

5.	**Safety and Protection:** • Electric shock, risks and precautions, safety, precaution during handling electric devices, first aid treatment for electric shock, Demonstration of CPR • Handling Electric Devices: Safety measures during handling • Earthing: Importance and methods • Fuses, MCB, ELCB: Protective devices	06	20
6.	**Computer Hardware Assembly:** • Components of a Computer System (CPU, RAM, HDD, Motherboard, etc.) • Assembling a computer: Step-by-Step Process Troubleshooting Common Hardware Issues • Understanding of Application Software and System Software and its installations.	04	13
7.	**Awareness/Demonstration On:** • Understand the basics of 3D printing technology, Types of 3D printers and Materials, Application of 3D printing in various Industries • Get Introduced Internet of Things (IoT) Concepts, Common IoT applications • Overview of Drone technology and Types of drones and their applications	04	13
	Total	**30**	**100**

Suggested Specification Table with marks (Practical):

Distribution of RBT level (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	20	60	00	00	00

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Make: Electronics by Charles Platt

2. The Beginner's Guide to 3D Printing by Samuel N. Bernier
3. Upgrading and Repairing PCs by Scott Mueller
4. Mr. S.Samaddar, Textbook of Electric Wiring, New Central Book Agency (P) Ltd., Calcutta.
5. Surjit Singh, Textbook of Electrical Design Estimating and Costing, Dhanpat Rai & Sons
6. Sengupta R., Textbook of Principles and Reliable Soldering Techniques, New Age International Ltd.
7. K. B. Bhatia, Textbook of Fundamentals of Maintenance of Electrical Equipments, Khanna Publishers.
8. Dr. S. K. Bhattacharya, Dr. S.Chatterji, Textbook of Projects in Electrical, Electronics,
9. Instrumentation and Computer Engineering, S. Chand Publishers., New Delhi.
10. National Electrical Code: Bureau of Indian Standards, Govt. Of India, 2011.
11. Operating Manuals of Various types of equipment

Suggested List of Practical/Experiments:

1. To study the symbols of various electrical and electronic equipment.
2. To understand the use of various laboratory equipments like DC power supply, Function Generator, Digital Storage Oscilloscope (DSO), Multi-meter, and Wattmeter.
3. To know about the different types of switches, indicators, and cables used in domestic wiring and panel wiring.
4. To design and verify the staircase wiring.
5. To design and verify the godown wiring.
6. To identify the components and pins of various electronic components like resistors, capacitors, diodes, LEDs, Transistors, etc.
7. Solder and de-solder electronic components on general-purpose board.
8. To demonstrate CPR as a first aid treatment for electric shock
9. To study the various protecting devices
10. To assemble-disassemble the computer system
11. To create a sample 3D model.

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w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Core Courses

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Enhance human values , create awareness about law enactment and importance of Constitution	10%
CO-2	To Understand the Fundamental Rights and Fundamental Duties of The Indian Citizen to instill morality, social values, honesty, dignity of life and their social Responsibilities.	30%
CO-3	Create Awareness of their Surroundings, Society, Social problems and their suitable solutions while keeping rights and duties of the Citizen keeping in mind.	20%
CO-4	Understand distribution of powers and functions of Local Self Government.	20%
CO-5	Understand the National Emergency, Financial Emergency and their Impact on Economy of the country.	20%

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
30	00	00	30	60	02	50	00	00	30	00	80

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

Contents:

Sr. No.	Topics	Total Hours
1	Meaning of the constitution law and constitutionalism	01
2	History of Indian Constitution	02
3	Salient features and characteristics of the Constitution of India	01
4	Fundamental rights	02
5	Right to Equality under Article – 14	02

6	Right to certain Freedom under Article 19	02
7	Scope of the Right to Life and Personal Liberty under Article 21	02
8	Fundamental Duties and its legal status	02
9	The Directive Principles of State Policy – Its importance and implementation	02
10	Federal structure and distribution of legislative and financial powers between the Union and the States	03
11	Parliamentary Form of Government in India – The constitution powers and status of the President of India	02
12	Powers and Procedure for Amendments in Indian Constitution	01
13	History of amendments in Indian Constitutional	02
14	Emergency Provisions : National Emergency, President Rule, Financial Emergency	03
15	Local Self Government – Constitutional Scheme in India	03

Reference Books:

1. Constitutional Law of India, Dr. J.N. Pandey, Central Law Agency
2. Introduction to the Consitution of India, Durga Das Basu, LexisNexis.
3. Indian Constitutional Law, M.P. Jain, LexisNexis
4. V.N.Shukla's Constitution of India, Mahndra Pal Singh, Eastern Book Company
5. Constitutional Law – I Structure, Udai Raj Rai, Eastern Book Company

* List of suggested activities for Problem Based Learning:

Each topic includes an exploratory and a reflective/creative activity, mapped to course outcomes.

Topic No.	Topic Title	Activity Details	Video Link / Reading Material Link	Estimated Time	Mapped COs
1	Meaning of Constitution, Law & Constitutionalism	1. Watch: Intro to Constitution – NPTEL After watching, list 5 key differences between Constitution, law, and constitutionalism in your own words. 2. Create a **concept map** showing relationships between Constitution, laws, and constitutionalism.	Intro to Constitution – NPTEL	2 hours	CO-1
2	History of Indian Constitution	1. Watch: https://www.youtube.com/watch?v=0U9KDQnIsNk 2. After watching, note 5 key	https://www.youtube.com/watch?v=0U9KDQnIsNk	2 hours	CO-1

		events that shaped India's Constitution and explain their significance. 3. 2. Create a **timeline chart** from 1857 to 1950 showing key constitutional developments.			
3	Salient Features of the Constitution	1. Watch: Salient Features – SBR ✎ After watching, list at least 8 salient features and mention their relevance today. 2. Prepare a **comparison table** between India's Constitution and UK/US Constitution on at least 5 points.	Salient Features – SBR ✎	2 hours	CO-1
4	Fundamental Rights	1. Watch: https://www.youtube.com/watch?v=cAjq_8JcUNw 2. After watching, write 1 paragraph summarizing the purpose of Fundamental Rights. 3. 2. Create a **flipbook or digital slides** explaining each Fundamental Right with real-life examples.	https://www.youtube.com/watch?v=cAjq_8JcUNw	2 hours	CO-2
5	Right to Equality (Art. 14)	**1 Public Policy in Action: Anti-Discrimination Notices Activity** To identify and analyze visible government or institutional efforts to promote equality and prevent discrimination in public spaces, and to connect these initiatives to the constitutional principle of equality under Article 14.	https://indiankanoon.org/doc/367586/ Article 14 in Constitution of India	2 hours	CO-2

		Task: 1. **Choose a Public Place:** Visit a public place such as a government office (e.g., Post Office, Municipal Corporation), a hospital, a transport hub (bus stand, railway station), a bank, a college, or a market area. 2. **Search for Notices/Posters:** Actively look for any official notices, posters, signboards, or information displays that reflect government policies or legal provisions aimed at preventing discrimination, promoting equality, or ensuring inclusive access. **Think broadly:** Look for signs related to: ✓ Prohibition of discrimination (e.g., against caste, gender, religion). ✓ Accessibility for persons with disabilities (e.g., ramps, special counters, accessible toilets). ✓ Equal opportunity statements. ✓ Anti-harassment policies (e.g., sexual harassment at workplace). ✓ Rights of specific vulnerable groups (e.g., women, children, senior citizens, transgender persons). ✓ Information about helplines or grievance redressal mechanisms for discrimination.			

		3. **Document Your Finding:** ➢ If possible, take a clear photo of the notice/poster (ensure no people are identifiable in the background for privacy). ➢ Note down the exact text or key message of the notice. ➢ Note where you found it (e.g., "On the notice board near the reception in X Hospital," "Near the accessible ramp at Y Bus Stand"). 4. Write a short reflection in **100-150 words** **2. Creative Poster** Design a poster or digital collage with the theme: **"Equality Before Law – Everyone Counts."** Include visuals, quotes, or examples that promote fairness, accessibility, and inclusion.			
6	Freedom Rights (Art. 19)	1. Watch: https://www.youtube.com/watch?v=l2fN9pbpa_s After watching, list 3 limitations on freedom of speech explained in the video. 2. Write a **debate script or essay** discussing whether hate speech should be protected under freedom of speech.	https://www.youtube.com/watch?v=l2fN9pbpa_s	2 hours	CO-2
7	Right to Life & Personal Liberty (Art. 21)	1. Study: Puttaswamy case. 2. After reading, explain in 100 words how the case expanded the meaning of Art. 21. 3. 2. Create a **privacy & liberty chart** with 5 examples of rights protected under Article 21.	https://indiankanoon.org/doc/91938676/ (**Justice K.S.Puttaswamy (Retd) And Anr. vs Union Of India And Ors. on 24 August, 2017**)	2 hours	CO-2
8	Fundamental	1. Watch: Fundamental Duties		2 hours	CO-2

	Duties & Legal Status	Explained After watching, list at least 5 Fundamental Duties and explain their significance briefly. 2. Design a **poster or infographic** titled "My Duties as a Citizen".	Fundamental Duties Explained		
9	Directive Principles of State Policy (DPSP)	1. Study any one DPSP-related cases where courts directed policy change. 2. After reading, summarize in 150 words how DPSPs guided the court's decision. 3. Write a **blog-style policy note** on any one unfulfilled DPSP in India and how it can be implemented.	1. https://indiankanoon.org/doc/40715/ (Mohini Jain v. State of Karnataka (1992) 1. ps://indiankanoon.org/doc/1775396/ Jnni Krishnan v. State of Andhra Pradesh (1993)) 2. https://indiankanoon.org/doc/1939993/ (Minerva Mills Ltd. vs Union of India (1980)	2 hours	CO-2, CO-3
10	Federal Structure & Power Distribution	1. Watch: https://youtu.be/jN_IVXQr3DQ?si=7rTGTlwMY2HU0eED 2. After watching, list 3 major disputes between Centre & States discussed. 3. Create a **color-coded chart** comparing Union, State, and Concurrent Lists with examples.	https://youtu.be/jN_IVXQr3DQ?si=7rTGTlwMY2HU0eED	2 hours	CO-3
11	Parliamentary Government & President's Role	1. Watch: https://www.youtube.com/watch?v=t-uMxrplttM 2. After watching, explain in 5 bullet points how the President and PM interact in government. 3. 2. Prepare a **role-play script or PPT** depicting how decisions are made between President, PM, and Parliament.	https://www.youtube.com/watch?v=t-uMxrplttM	2hours	CO-3
12	Amendment	1. Watch:	https://www.youtube.c	2 hours	CO-3

	Process	https://www.youtube.com/watch?v=yVp5QZQzYH0 2. After watching, write a short summary explaining what "Basic Structure Doctrine" means. 3. 2. Create a **timeline infographic** showing 5 major constitutional amendments and their impacts.	om/watch?v=yVp5QZQzYH0		
13	History of Constitutional Amendments	1. Read about the evolution of constitutional amendments from 1951 onward. 2. After reading, summarize key trends and changes in one page. 3. Mock amendment proposal preparation. **Task:** Think of a **current national issue or gap** (e.g., climate rights, digital privacy, mental health in education). • Write one page mock **constitutional amendment proposal**: ○ Title of the amendment ○ Proposed text ○ Why it is needed ○ How it fits into the Constitution's values	https://lawblend.com/articles/constitutional-amendments-list/ Wikipedia: Constitutional Amendments of India (well-sourced)	2 hours	CO-3
14	Emergency Provisions	1. Watch: https://www.youtube.com/watch?v=vBmPFPIm7Fk 2. After watching, explain in 150 words why Emergency provisions are considered controversial. 3. 2. Write a **reflective essay** discussing the long-term impact of the Emergency on democracy.	https://www.youtube.com/watch?v=vBmPFPIm7Fk	2 hours	CO-5
15	Local Self Government	1. Interview/visit a local	https://www.youtube	2 hours	CO-4

		Panchayat/Corporator or watch a video on Panchayati Raj functioning. https://www.youtube.com/watch?v=V24GhpZ-Mpo After the activity, write 3 key observations about challenges faced by local self-governments. 2. Write a **field report** with improvement suggestions for the Panchayat or ULB system.	.com/watch?v=V24GhpZ-Mpo		

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000191
Subject Name: Numerical Methods for Electrical Engineering

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Basic Science Course

Prerequisite:	Basics of algebra, differentiation and integration, Basic operations of Matrices, Determinants
Rationale:	The mathematical models of electrical systems generate set of linear equations, nonlinear equations, differential or partial differential equations etc. Design and analysis of the electrical systems requires the repeated performing of various basic mathematical procedures such as solving systems of linear algebraic equations, solving systems of nonlinear algebraic equations, numerical integration of set of ordinary differential equations, integration of partial differential equations etc. These types of numerical methods play very important roles in understanding the insights of the systems. These methods are useful in the real world applications of electrical engineering like fault analysis of power systems, power flow of power systems, stability of power systems, design of drives, controller designs, simulation of power electronic circuits, optimization of power systems operations, simulation of insulation materials used in transformers etc. Numerical methods invariably involve large numbers of tedious arithmetic calculations. The role of numerical methods in engineering problem solving has increased dramatically in recent years due to fast efficient digital computers.

Course Outcomes: The students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Solve set of linear algebraic equations for steady state solution of electric circuits by using direct and indirect numerical methods and LU factorization	15
CO-2	Learn how to obtain numerical solution of set of nonlinear equations using Bisection, GS method, Newton – Raphson and fixed-point iteration methods	20
CO-3	Do the numerical integration of ordinary differential equations using Euler's method, modified Euler's method, trapezoidal rule and RK4 method	25
CO-4	Apply the numerical methods for simple optimization problems	20
CO-5	Apply fundamental principles of FEM techniques to analyze complex electromagnetic fields	20

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000191
Subject Name: Numerical Methods for Electrical Engineering

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Content:

Sr. No.	Content	Total Hrs.	% Weightage
1	**Approximations and Round-off errors** : Significant figures, accuracy and precision, error definitions, Round-off errors, Truncation errors	2	5
2	**Numerical Solution of Linear Equations:** Direct Methods: The Gauss Elimination Method, The Gauss–Jordan Elimination Method, The LU Matrix Decomposition Method, The Method of Inverse Matrix, Indirect or Iterative Methods: The Direct Iteration Method, Jacobi and Gauss–Seidel Methods, Examples of Applications in Electrical Engineering: 1. Steady state solution of AC ladder circuit using mesh currents 2. Steady state solution of AC circuit with double T using nodal analysis	8	20
3	**Roots of Non-linear Algebraic and Transcendental Equations**: Bisection, false position, Secant method, Gauss-Seidel method, Newton-Raphson methods, Fixed Point Iteration, Rate of convergence, Applications to electrical engineering problems	10	20
4	**Numerical Integration of ODE:** The Initial Value Problem and Related Solution Method, The One-Step Methods: The Euler Method and its Modified Version, The Heun Method, Trapezoidal rule, The Runge–Kutta Method (RK 4), Examples of Using the RK 4 Method for Integration of Differential Equations Formulated for Some Electrical Rectifier Devices: 1. The Unsymmetrical Voltage Doubler 2. The Full-Wave Rectifier Integrated with the Three-Element Low-Pass Filter	10	25

5	**FEM :** Introduction, FEM procedure : Finite Element Discretization, Element Governing Equations, Assembling all the Elements, Solving the Resulting Equations, Examples based on Magnetostatic Fields	**6**	**15**
6	**Optimization:** Introduction to Optimization, Mathematical formulation, Continuous versus Discrete optimization, Constrained and unconstrained optimization, Global and local optimization, Stochastic and deterministic optimization, Convexity, Optimality Criteria, Exhaustive Search Method, Interval halving method, Fibonacci search method.	**6**	**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
20	**25**	**25**	**20**	**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 actualdistribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Numerical Methods for Engineers, Steven C. Chapra & Raymond P. Canale,6th Edition, McGraw Hill
2. Fundamental Numerical Methods for Electrical Engineering, Stanisław Rosłoniec, Springer
3. Introductory Methods of Numerical Analysis, S. S. Sashtry, 5th edition, PHI Learnings,
4. Principles of Electromagnetics, Matthew N. O. Sadiku, Dr. S V Kulkarni, Oxford Higher Education, Oxford University Press, 6th edition, Asian Edition
5. Numerical and Analytical Methods with MATLAB for Electrical Engineers, William Bober & Andrew Stevens, CRC Press
6. Numerical Optimization, Jorge Nocedal & Stephen Wright, 2nd edition, Springer
7. Optimization for Engineering Design, Kalyanmoy Deb, 2nd edition, PHI

List of Experiments:
This is a suggestive list only:

1. To solve linear system of equations using Gauss elimination (without pivoting) method
2. To solve linear system of equations using Gauss- seidel method
3. To integrate a function numerically using trapezoidal and Simpson's rule.
4. To solve the initial value problem using modified Euler's and Runge-kutta methods.
5. To solve the set of non-linear equations using GS method.
6. To find the root of f(x)=0 using Newton-Raphson and fixed point iteration methods.
7. To integrate the set of ODEs numerically using Euler's method and modified Euler's method.
8. To integrate the set of ODEs numerically using RK4 method.
9. To solve a power electronic circuit using suitable numerical integration method.
10. To solve single variable optimization problem using Exhaustive Search Method
11. To solve optimization problem using Fibonacci Search Method
12. Using the PDE toolbox, write an FEM code to determine the potential at any point between the parallel plates of capacitor. Consider the left edge of the bottom plate of the capacitor is at (0,0).
13. The triangular element having coordinates – node 1(2,-1), node 2 (1, 4), and node 3 (0,0) is a part of a finite element mesh. If V1 = 8 V, V2 = 12 V, V3 = 10 V, find the potential at (1,2) and at the center of the element.

Major Equipment:

List of Open Source Software/learning website:

1) **Python**
2) **GNU Octave**

- **List of suggested activities for Problem Based Learning:**

Sr.No.	Name of the activity	No. of hours	Suggested Evaluation Criteria
1.	Assignments based on numerical is must.	10 assignments of 2h each from all six units as mentioned in the content. Preferably separate assignments to all students. Total = **20 hrs.**	Based on the assignment Submitted. The assessment shall be done on regular basis during the term
2.	Write program in some programming language using some algorithm based on each of the six units as mentioned in the content. The algorithm	10 such exercises of 3 hrs each from all six units as mentioned in the content. Total = **30 hrs.**	Programs shall run during the lab sessions and the results shall be submitted. Assessment shall be equal for all exercises and they should be based on the

	should be tested on some example.		result and quality of the program. Program' coding shall be preferably submitted in soft copy.
3.	Complex problem solving.	Four problems shall be given. Study of the problem and solution. **Total = 16 hrs.**	Assessment based on the notes/presentations by the student.
4.	Tech Blog/YouTube Channel Curation	**10 hrs** (Content curation + Analysis)	Summary report on curated content and learning outcomes.
5.	Blog or Technical Article Writing	**10 hrs** (Survey – 6h, Writing – 4h)	Based on originality, technical content, references cited, and clarity of communication.
6.	Screening of videos based on the content	1 hour on each units Total **6 Hours**	Based on a small viva on the videos screened.
7.	Preparation of report on the titles given by faculty	**5 hrs** on each title given by faculty based on the content topics.	Based on the submitted report writing, its clarity, readability and quality.

Following points are to be considered:

1. Preferably these activities should be conducted on some LMS and not using pen and paper. The LMS which can be used are as follows (But not limited to): Google Classroom, MS Teams, Moodle etc.
2. The usage of LMS platform shall be done for as many activities as possible. The assessment these activities shall also be carried out on the some LMS platform.
3. The total work assigned should be of 45 hours to every student.
4. The faculty/teacher/teachers should display the distribution of Self Learning activities at the beginning of the semester.
5. The course file should include the Rubrics of the distribution of marks as per the distribution of activities.
6. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
7. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electrical
Subject Code: BE03009011
Subject Name: Analog and Digital Electronics

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite:	Nil
Rationale:	Analog and Digital Electronics is a fundamental subject that shall give engineering students essential knowledge and skills related to designing, analyzing, and implementing electronic circuits. It bridges It bridges theoretical concepts with practical applications, crucial for careers related to electronics, automation, telecommunications, and embedded systems. Analog and Digital Electronics underpins modern technological advancements.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Comprehension of various types of analog and digital components – OPAMP, Combinational and sequential circuits, ADC and DAC, involved in the analog and digital systems	20
CO-2	Describe the functioning and selection of OP-AMP as per application.	20
CO-3	Design and testing of OP-AMP based circuits.	20
CO-4	Design and implement Combinational and Sequential logic circuits.	20
CO-5	Describe the process of Analog to Digital conversion and Digital to Analog Conversion.	20

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

Content:

Sr. No.	Content	Total Hrs
1	**Differential, multi-stage and operational amplifiers** Power amplifier , Differential amplifier, Direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output Offset voltage, input bias current, input offset current, slew rate, gain band width product)	8
2	**Linear applications of op-amp** Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator and differentiator, active filter, voltage regulator, oscillators (Wein bridge and phase shift).	6
3	**Non linear applications of op-amp** Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, Peak detector.	6
4	**Combinational Digital Circuits** Standard representation for logic functions, simplification of logic functions using K- map and Boolean algebra, Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, digital comparator, parity checker/generator, code converters, priority encoders, decoders/ drivers for display devices.	8
5	**Sequential circuits and systems** A 1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flip flop, J- K, T and D types flip-flops, applications of flip-flops, shift registers, applications of shift registers, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip-flops, special counter IC's, asynchronous sequential counters, applications of counters.	9
6	**A/D and D/A Converters** Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs	8
	TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
40	**40**	**10**	**10**	**00**	**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. A.S.SedraandK.C.Smith,"MicroelectronicCircuits",NewYork,OxfordUniversityPress,1998.
2. J.V. Wait, L.P. Huelsman and G.A.Korn, "Introduction to Operational Amplifier theory and Applications", McGraw Hill U. S., 1992.
3. J. Millman and A.Grabel,"Microelectronics", McGraw Hill Education,1988.
4. P. Horowitz and W.Hill,"The Art of Electronics", Cambridge University Press,1989.
5. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.
6. Ramakant A Gayakwad, Op-Amps and Linear Integrated Circuits, Prentice Hall of India
7. R.P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
8. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
9. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India,2016

List of Experiments:

1. To Study the different parameters of op-amp.
2. To verify the working of Op-amp as an Inverting and a Non–inverting amplifier.
3. To verify the working of Op-amp as an Integrator and a Differentiator.
4. To verify the working of Op-amp as a comparator and Zero Crossing Detector.
5. To Study Phase shift and Wein's Bridge oscillator with amplitude stabilization using OPAMPs.
6. To Study Waveform generation–Square, triangular wave form generation using OPAMPs.
7. To verify working of half and full binary adder and Subtractor circuits.
8. To verify working of binary to gray and gray to binary converter circuit.

9. To verify truth tables of RS, JK, D and T flip-flops.
10. To verify the working of 4 bit comparator.
11. To Design 8 to 3 Encoder and 3 to 8 line Decoder.
12. To Design 4 to 1 Multiplexer and 1 to 4 line De-multiplexer.
13. To verify the working of binary up/down counter.
14. To verify the working of Ring counter, Johnson counters.

Major Equipment:

- ✓ Trainer kits related to Analog and Digital electronics.
- ✓ Faculties may assign mini projects to students.

List of Open Source Software/learning website:

1. Courses available through NPTEL.
2. Sequel App developed by IIT-Bombay
3. VLABS
4. website: nptel.ac.in

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Interpretation of Datasheet of IC 741 and Analyze datasheets	Preparing report	Based on the understanding
2	Making of charts of various analog and digital Ics.	Preparing of Chart	Based on understanding
3	Differential Amplifier, Multistage Amplifier and Power stage Amplifier circuit simulation using MATLAB	Use of MATLAB for circuit simulation	Based on the understanding and applying of MATLAB
4	Simulation of all Linear application of op-amp	Use of MATLAB for circuit simulation	Based on the type of application and explanation
5	Simulation of all Non- linear application of op-amp	Use of MATLAB for circuit simulation	Based on the type of application and explanation
6	Build circuits on a breadboard: all linear and non linear application of Op-amp	Any two linear and non linear applications of Op-amp.	Based on the circuit explanation and results.

7	Practice debugging of circuits, identifying faults in circuits using multimeters and oscilloscopes	One circuit for each debugging and fault identifying exercise	Based on the Skill.
8	Mini project: Design and implementation of any application of op-amp	Undertake a small home-based or simulation-based project (10 h)	Based on the understanding, implementation and results.
9	Study and simulate logic gates: AND, OR, NOT, NAND, NOR, XOR using Matlab.	Duration of task = 2h Preparation of Report = 2h	Based on the understanding and applying of MATLAB for realisation.
10	Learn and realise Boolean algebra basics and laws	Duration of task = 2h Preparation of Report = 2h	Based on report submitted. Report should contain observations and truth table.
11	Mini Task: Design and realize a logic circuit using Matlab	Any two	Based on the understanding, implementation and results/ truth table.
12	Study combinational circuits: simplification of multiplexers, decoders circuits using Karnaugh maps. Mini Project: Create and simulate multiplexer and decoder circuit using Matlab.	One circuit for each decoder and multiplexer = 5h/each	Based on the understanding, implementation and results/ truth table.
13	Study of sequential circuits: simplification of flip-flops/ latch, shift register, counters	One circuit for each flip-flop, shift register and counter = 5h/each	Based on the understanding, implementation and results/ truth table.
14	Implement a logic-based application using Arduino (e.g., traffic light controller, seven segment display)	Any one Arduino based digital application = 20h	Based on the understanding, implementation and results.
15	Technical Video based learning related to the analog and Digital electronics	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.

16	Assignment writing on number system, memory basics, IC logic families.	1 assignment of 2h each. Total = 6h	Based on the assignment submitted.
17	Online Certification Courses (NPTEL / SWAYAM / Coursera / edX) In analog and Digital electronics	Complete one MOOC (Massive Open Online Course) from NPTEL/SWAYAM relevant to ADE-Electrical Engineering.	Certificate + a 1-page summary or review presentation of the course. Certificate of the course
18	Real world case studies based learning in ADE	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
19	Discussion on research paper based on ADE	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
20	Poster/chart/power point preparation on ADE	Duration = 6 h	Based on poster/chart preparation and presentation skills
21	Working/non-working model on technical topics of ADE	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
22	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
23	Group Discussion on emerging/trending technical topics based on ADE	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
24	Involvement in Student Chapter Activities (IEEE/ISTE/IEI)	Organizing student chapter activities/workshops (5h)+ Report /writing articles for the chapter newsletter(5h)	Based on short activity report and reflection
25	Industry Visit and Report Preparation	Attend an industry visit (e.g., to a substation, manufacturing unit, renewable energy plant) and prepare a detailed report.	Based on the report

Note:

- All the suggested activity should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electrical Engineering
Subject Code: BE03009021
Subject Name: Electrical Machines-I

w.e.f. Academic Year:	2024-25
Semester:	3
Category of the Course:	PCC

Prerequisite:	Basics of Electrical Engineering
Rationale:	This course provides foundational knowledge of transformers and induction motors, essential components in electrical power systems and industrial applications. It equips students with analytical and practical skills for evaluating machine performance, efficiency, and control methods. By integrating theoretical concepts with hands-on analysis, the course prepares students for real-world challenges in power engineering.

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Single Phase Transformer:** Review of single phase transformer, E.M.F. equation, Equivalent circuit, phasor diagram for different powerfactor, Losses, separation of no-load losses, conditions for maximum efficiency, determination of equivalent circuit parameters, calculation of efficiency and voltage regulation using O.C. and S.C. Test, Sumpner's test. Polarity test, Determination of Efficiency and Voltage regulation by direct load test, Concept of all-day efficiency. Parallel operation of transformers and Load sharing under different operating conditions. Auto transformer, saving of copper and applications. Numerical based on above topics.	12	25

2.	**Three Phase Transformer:** Construction, types of connection and their comparative features, Vector groups, Types of Transformers, terminal marking and nomenclature, protective and safety devices fitted on Transformers, Parallel operation of three phase transformers, Magnetizing current, Phase conversion - Scott connection, No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers. Short Circuit Forces and Mechanical stresses, Application of transformers in various electrical systems	12	25
3.	**Three Phase Induction Machine:** Constructional details, classification, principle of operation, production of rotating magnetic field, Torque equations for starting, full load and maximum operating conditions, condition for maximum-output, slip for maximum-output, Torque-slip characteristics, Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency), Effect of Harmonics, Crawling and Cogging of induction motor, Phasor-diagram, equivalent circuit. Losses and efficiency, Tests on Induction Motor: No load and blocked rotor test-determination of equivalent circuit parameters. Predetermination of performance under different operating condition using circle diagram. Methods of starting and speed control for induction motors with conventional methods and static convertors. Energy Efficient three phase induction motor. Numerical based on above topics. Induction Generator: Principle of operation, equivalent circuit and application.	15	35
4.	**Single Phase AC Motor:** Double field revolving theory, Starting & running performance of 1-phase induction Motor, Equivalent circuit of 1- induction motor, Types of single-phase motors, Principle and operation of split phase, Resistance start, Capacitor start and capacitor start & run induction motor, Shaded pole induction motor, Universal motor. Repulsion motor. Applications of various single phase induction motors	06	15
		45	**100**

Suggested Specification Table with Marks(Theory):

DistributionofTheoryMarks					
RLevel	**ULevel**	**ALevel**	**NLevel**	**ELevel**	**CLevel**
20	20	20	20	20	0

WhereR:Remember;U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Create(asperRevisedBloom's Taxonomy)

References/Suggested Learning Resources:

(a) 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) M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
6) P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
7) G C Garg, "Electrical machines – II", Khanna Publishers,
8) S K Sen,"Principle of Electrical Machine Design with Computer Programs" Oxford & IBH

b) Open-Source Software:

Scilab (https://www.scilab.org/) – An open-source alternative to MATLAB, useful for circuit analysis, transformer calculations, and motor performance analysis.

1. **Octave** (https://www.gnu.org/software/octave/) – Useful for numerical calculations and simulation of electrical machines.
2. **PSIM (Free Version) / OpenModelica** (https://openmodelica.org/) – For modeling and simulating electrical circuits and machines.
3. **FEMM (Finite Element Method Magnetics)** (http://www.femm.info/) – Used for electromagnetic field analysis of transformers and induction motors.
4. **KiCad** (https://www.kicad.org/) – Open-source PCB design tool, useful for designing small transformer circuits.
5. **LTspice** (https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html) –

For circuit simulation, including transformer and motor circuits.

C) Websites for Learning and Simulation:

1. **All About Circuits** (https://www.allaboutcircuits.com/) – Excellent resource for learning about transformers, motors, and electrical engineering concepts.
2. **Electrical4U** (https://www.electrical4u.com/) – Provides detailed explanations of electrical machines, transformers, and motor operation.
3. **MIT OpenCourseWare** (https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/) – Free courses on electrical machines and power electronics.
4. **CircuitLab (Free with limited access)** (https://www.circuitlab.com/) – Web-based circuit simulator for testing transformer and motor circuits.
5. **Virtual Labs by IITs (Government of India Initiative)** (https://vlab.co.in/) – Simulations and experiments related to transformers and induction motors.

Suggested Course Practical List:

1) 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.
2) To conduct the open and short circuit tests on a single-phase transformer to determine core losses, copper losses, and hence determine regulation, efficiency and the parameters of the equivalent circuit.
3) To conduct Sumpner test on two identical single-phase transformers and determine their efficiency at various loads.
4) To make Scott connection of two single phase transformer and to verify the three phases to two phase conversion.
5) To conduct open circuit and short circuit test on a three-phase transformer and determine the equivalent circuit parameters.
6) To perform No load test and blocked rotor test on 3 phase Induction motor and determine equivalent circuit parameters
7) To perform No load and blocked rotor test on three phase induction motor to evaluate the performance parameters using circle diagram.
8) To perform direct load test on three phase Induction motor to evaluate its performance parameters at different load conditions
9) To perform various starting and speed control methods for three phase induction motor
10) To perform no load and blocked rotor test on single phase induction motor to obtain the parameters of equivalent circuit

List of Laboratory Resources Required:

1. Transformers and Induction Machines:

- Single-Phase Transformers (Different KVA Ratings)

- Three-Phase Transformers (Star-Delta, Delta-Delta, Star-Star, etc.)
- Auto-Transformers (Variable voltage supply)
- Tap-Changing Transformers (No-load & On-load)
- Scott-Connected Transformer Setup (Three-phase to Two-phase conversion)
- Three-Winding Transformer
- Three-Phase Induction Motors (Squirrel Cage & Slip-Ring types, various power ratings)
- Single-Phase Induction Motors (Split-phase, Capacitor start, Capacitor run, Shaded pole)
- Induction Generators
- Cut section of various machines

2. Testing and Measurement Instruments:

- Multimeters (Digital & Analog)
- Wattmeters (Single-phase & Three-phase)
- AC/DC Voltmeters & Ammeters
- Frequency Meters
- Power Factor Meter
- Open Circuit & Short Circuit Test Setup (for Transformers)
- Polarity Test Kit
- Slip Measurement Setup (Tachometer, Stroboscope)
- No-load & Blocked Rotor Test Setup (for Induction Motors)
- Torque Meter (Digital/Analog)
- Loading Rheostats
-

3. Power and Control Systems:

- Three-Phase & Single-Phase Power Supply Panels
- DOL (Direct-On-Line) Starters
- Star-Delta Starters
- Auto-Transformer Starters
- Soft Starters for Induction Motors
- Variable Frequency Drives (VFDs) (for speed control of induction motors)

Capacitor Banks (for Power Factor Improvement)

- Protection Relays (Overload, Overvoltage, Undervoltage)

4. Accessories & Safety Tools:

- Connecting Wires (High voltage & Low voltage)
- Clamp Meters & Power Analyzers
- Autotransformer (Variac)
- Breadboards & Soldering Stations
- Safety Equipment (Insulated gloves, Fire extinguisher, First Aid kit)

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical	Duration = 1 h each	Based on performance in group discussion, technical depth,

	topics based on subject		knowledge etc.
13.	Real world case studies based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Blog or Technical Article Writing	10h (Research – 6h, Writing – 4h)	Based on originality, technical content, references cited, and clarity of communication.
16	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
17	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
18	Tech Blog/YouTube Channel Curation	10h (Content curation + Analysis)	Summary report on curated content and learning outcomes.
19	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
20	Maintenance or Troubleshooting Logbook	10h (For example: lab instruments, computer hardware)	Based on documented cases, approach, and resolution.

Note:

- All the suggested activity should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electrical Engineering
Subject Code: BE03009031
Subject Name: Electrical Circuit Analysis

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite:	Solution of simultaneous linear equations, Solution of linear constant coefficient differential equations, Basics of LaPlace transform
Rationale:	Electrical Circuit Analysis equips students with essential skills to analyze and solve complex electrical circuits and networks. The syllabus encompasses key topics such as network theorems, transient and steady-state responses, sinusoidal analysis, Laplace transforms, and two-port networks. These concepts enable students to understand, model, and optimize circuit performance, fostering problem-solving and analytical abilities. This course lays the groundwork for advanced studies and practical applications in electrical engineering, preparing students for challenges in power systems, electronics, and control systems.

Course Outcomes:

The students will be able to

Sr. No.	CO Statement	Marks % weightage
CO-1	Analyze electrical circuits with independent and dependent sources by nodal analysis and mesh analysis, and network theorems	25
CO-2	Assess the initial and final conditions of circuit elements, and evaluate the transient and steady-state responses of first-order RL, RC, and second-order RLC circuits	25
CO-3	Apply the concept of the complex exponential forcing function to determine the sinusoidal steady-state response of electrical circuits by transforming circuits into their phasor equivalent representations	10
CO-4	Apply Laplace transform methods to solve differential equations and analyze electrical circuits in the s-domain by developing s-domain equivalent circuits	25
CO-5	Analyze the network behavior using two-port parameters and evaluate the interrelationships between these parameters	15

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	15	30	30	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Content:

Sr. No.	Content	Total Hrs.	% Weightage
1	**Network Theorems and Coupled circuits** Solution of circuits with independent sources using Node and Mesh analysis, Classification of dependent sources, Solution of circuits with dependent sources using Node and Mesh analysis, Concept of Super-node and Super- mesh in circuits with independent and dependent sources, Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem for circuits with independent and dependent sources, Concept of duality and dual networks, Mutually coupled circuits, Dot Convention in coupled circuits.	12	25
2	**Initial and Final Conditions** Initial and final conditions in elements, Concept of steady state and transient state response, The series RL circuit, Step response of RL circuit by solving differential equations, Features of RL circuit step response, Steady state response and forced response, Linearity and superposition in dynamic circuits, RC Circuit equations, Zero-Input response of RC circuit, Zero-State response of RC circuits for various inputs, The series RLC circuit zero-input response, Step response of series RLC circuit, Transient response of RLC circuit with sinusoidal excitation.	09	25
3	**Sinusoidal Steady State Analysis** The complex exponential forcing function, Sinusoidal steady state response using complex exponential ($e^{\pm j\omega}$), Concept of the phasor, Transforming a circuit in to phasor equivalent circuit, Sinusoidal steady state response from phasor equivalent circuit	05	10
4	**Electrical Circuit Analysis Using Laplace Transforms** Introduction to Laplace Transform, Laplace transform of standard input signals, Initial value and final value theorem, Inverse Laplace transform, Solution of differential equations using Laplace transform, s-Domain equivalents of circuit elements, The s-Domain equivalent circuit, Total response of first order and second order circuits using s-Domain equivalent circuit, Introduction of transfer function, Concept of Poles and Zeros, Transfer function representation of electrical circuits.	09	25
5	**Two Port Network and Network Functions** Introduction to Two Port Networks, relationship of two port variables, Short-circuit admittance parameter, Open-circuit impedance parameter, Transmission Parameter, Hybrid Parameter, Relationships between parameters, Parallel connection of two-port networks.	10	15
	TOTAL	**45**	**100**

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
15	**30**	**30**	**15**	**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:

- K.S. Suresh Kumar, "Electric Circuit Analysis", Pearson Publications, 2013.
- M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
- Nimje and D. P. Kothari, "Electrical Circuit Analysis and synthesis", New Age InternationalPublications, 2017
- D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
- W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
- K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
- K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

List of Experiments :

This is a suggestive list only:

(1) To verify the Superposition Theorem by comparing analytical and experimental results.
(2) To verify the Thevenin and Norton's theorems by comparing analytical and experimental results.
(3) To verify the maximum power transfer theorem by comparing analytical and experimental results.
(4) To verify the Superposition Theorem by comparing analytical and simulated results with dependent sources.
(5) To verify the Thevenin and Norton's theorems by comparing analytical and simulated results with dependent sources.
(6) To simulate and analyze the steady-state and transient time-response of series R-L circuit.
(7) To simulate and analyze the steady-state and transient time-response of series R-C circuit.
(8) To simulate and analyze the steady-state and transient time-response of series R-L-C circuit.
(9) To verify the analytical steady state solution of AC circuits using phasors with experimental

results

(10) To verify experimental results of open-circuit impedance parameter of a tow-port network with analytical results

(11) To verify experimental results of short-circuit parameter of a tow-port network with analytical results

(12) To verify experimental results of hybrid parameter of a tow-port network with analytical results

(13) To verify experimental results of transmission parameter of a tow-port network with analytical results

Major Equipment:

List of Open Source Software/learning website:

- Bhattacharya, T. K. *Network Analysis* [MOOC]. NPTEL-NOC. https://archive.nptel.ac.in/courses/108/105/108105159/
- De, N. K.,et. Al. . *Basic Electrical Technology* [Handout]. NPTEL Online Course. https://nptel.ac.in/courses/108105053

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	Activity Description and No. of hours	Suggested Evaluation Criteria	Targeted CO
1.	NPTEL Video Lectures	Watch core lecture videos from NPTEL – Network Analysis to build fundamental understanding **(20 hrs.)**	Submit assignment of the modules that student learned	CO1–CO5
2.	DIY (Do It Yourself) Circuit Construction	Construct and test circuits on a breadboard/PCB to verify Superposition, Thevenin, Norton, and Maximum Power Transfer theorems **(At least One Circuit) (6 hrs.)**	Submit the circuit observation sheet; instructor validation or peer review	CO1
3.	MATLAB Programming for Circuit Analysis	Write code for mesh/nodal analysis, Laplace solutions, and response plots **(At least five problems) (20 hrs.)**	Summary report on curated content and learning outcomes.	CO1–CO4
4.	Simulation Practice (LTspice/ngSpice/MATLAB)	Simulate RL, RC, RLC for transient response analysis **(10 hrs.)**	Submit circuit files (screenshots), results (graphs/waveforms), and a comparison table with theoretical values	CO2

5.	DIY (Do It Yourself) Circuit Construction	Construct and test circuits on a breadboard/PCB to analyse the transient response of RL, RC, RLC **(At least One Circuit) (6 hrs.)**	Submit the circuit observation sheet; instructor validation or peer review	CO2
6.	Problem Solving Practice	One Assignment per module should be given with minimum 10 question per module. The difficulty level should be medium to hard. **(20 Hrs.)**	Submit scanned solutions (on LMS) or of written work; assess accuracy, clarity of steps, and coverage of problem types	CO1–CO5
7.	Mini Case Studies (Real-World Applications)	Document at least 2 real-world examples where network theorems are used in systems like power supply, filters, audio electronics **(4hrs.)**	Submit a 2–3-page report with circuit diagram, theorem used, and explanation of functionality.	CO1–CO3
8.	MATLAB Programming for Transfer Function Analysis	Write MATLAB code for transfer function, pole-zero plots, and frequency response **(At least two problems) (8 hrs.)**	Submit .m files with plotted outputs, explain poles/zeros, and relate to system behaviour; evaluated for correctness and insightfulness	CO3–CO4

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Preferably these activities should be conducted on some LMS and not using pen and paper. The LMS which can be used are as follows (But not limited to): Google Classroom, MS Teams, Moodle etc.
5. The usage of LMS platform shall be done for as many activities as possible. The assessment of these activities shall also be carried out on the some LMS platform.
6. The total work assigned should be of 30 hours to every student.
7. The faculty/teacher/teachers should display the distribution of Self Learning activities at the beginning of the semester.
8. The course file should include the Rubrics of the distribution of marks as per the distribution of activities.
9. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
10. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Course Abstract for

DESIGN ENGINEERING – 1B

(4TH SEMESTER)

Course Initiated by:

Centre for Industrial Design

(OPEN DESIGN SCHOOL)

For any query, please write us at: design@gtu.edu.in

Design Engineering – 1B (3140005) (4th Semester)

Module 2: Applying Design Thinking

Name of the Discipline & the Programme: ***Every discipline of the Engineering***

Course category: ***Compulsory/Core - Intermediate***

Examination Pattern: ***Internal evaluation/viva at the end of semester***

Prerequisites: ***Design Engineering – 1A***

				Credit				Marks				
Subject code	**Subject Name**	**Category**	**Sem.**	**L**	**T**	**P**	**Total**	**E**	**M**	**I**	**V**	**Total**
3140005	DE - 1B	Project Work	4	0	0	2	1	0	0	20	80	100

*L=lectures, T=tutorial, P=Practical, E=Theory External, M=Theory Internal, I=Practical Internal, V=Practical External, OJT=On Job Training is equivalent to Practical

Relevance

This is a revision course designed for those who have undergone the fundamentals of Design Thinking process in 3rd semester.

Objective: Applying Design Thinking

The course aims to validate the learnings from the understanding design thinking course by translating the concepts into exercises. Here branch specific topics need to be selected by students, apply reverse engineering, modify existing solutions and refine their learning for Design Thinking phases.

Course Contents

In the 3rd semester, students have learnt the basic Design Thinking methodology in DE-1A and undergone the phases of the same with necessary tools and techniques and worked upon general topic/domain irrespective of their branch. Now in 4th semester, they need to select **branch specific existing artefact/solution, apply Reverse Engineering (RE) and modify/redesign** it as per the User's needs using Design Thinking. There are three core objectives of introducing RE and integrating Design Thinking with it: (1) Students will learn some basic concepts from their branch and relate all stages/phases of Design Engineering with their regular core subjects of particular branch in current or further semester/s as one of the key objectives of Design Engineering subject is to imbibe Design Thinking approach into core engineering subject for practical learning, (2) they will use Design Thinking process again to refine their learning and (3) some of the existing solutions will be modified/redesigned through

DE projects which can be helpful to user/society. In this module also whole Design Thinking process will be used by students, but more emphasis on Ideation and initial Product Development phases. The content is divided into week-wise activities to better understand the course and to give enough time to all the learning aspects, but depending upon the type and nature of projects, students and guide may allocate more/less time to the activities.

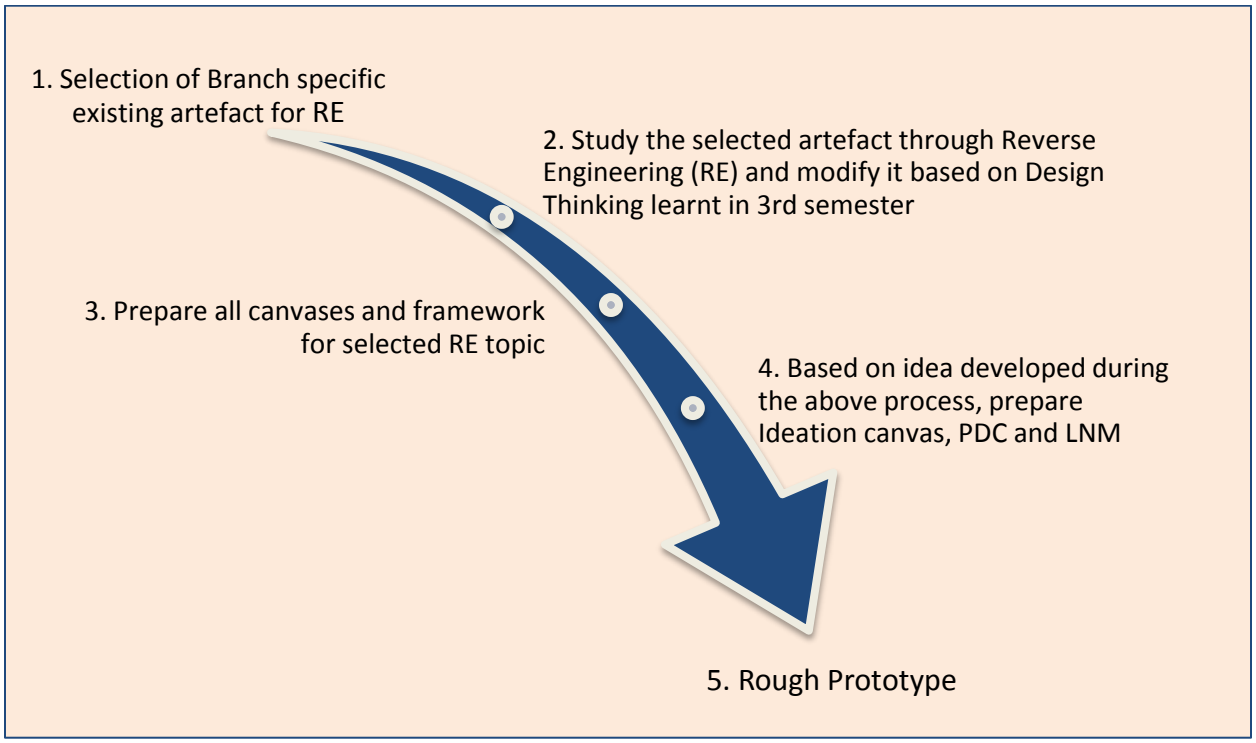
Students in 4th semester need to follow week-wise activities as mentioned below to complete course requirements.

Design Thinking Process – with Tools & Techniques			
Module 2 (DE-1B): Applying Design Thinking			
Broad segment	**Week**	**Description**	**Operational need**
Domain/Topic Selection	1	○ Branch Specific existing topic selection for Reverse Engineering (This topic must be different from 3rd sem topic) ○ Team Selection (you may change your team member here in 4th sem)	○ Brief lecture/exercise ○ In this semester, student will use Design Thinking process learnt in 3rd semester to modify the selected RE topic
Reverse Engineering (RE)	2, 3	○ Reverse Engineering – Detailed study for Branch Specific topic ○ Dissemble the existing selected artefact/product/component/process/system to study technical aspects and design detail involved ○ Identify issues related to existing solutions	○ Brief lecture/exercise ○ Hands-on practice sessions with cases /examples ○ Reverse engineering document link is given in General Guidelines document
Empathization Phase	4, 5	○ **Observation:** Through AEIOU framework and other Ethnography tools available ○ **Immerse via Role Playing** ○ **Interview:** ✓ Formal and Informal interview ✓ Students may use Stanford	○ Students need to visit their domain/place where they can interact with user for getting insights. ○ Here, observation can be of direct user of the selected solutions, manufacturer and dealer or from point of view

		methods given in below link - http://dschool.stanford.edu/wp-content/uploads/2013/10/METHODCARDS-v3-slim.pdf ○ Modification for existing artefact/product/component/process/system based on User's need ○ Preparation of Mind Map, Empathy Map ○ Secondary research/Prior art search (prior art search is continuous activity and can be used in any phase to strengthen the idea) ○ Group wise presentation followed by Discussion ○ Define Problem statement (format is given in reference PPT on DE portal) ○ Verification of problem identified by team through users/stakeholders	of repairer/maintenance person/services provider. Minimum 3-4 field trips will be required to get better insights on users' needs. ○ Based on User's need, students need to redesign/modify the selected existing artefact/product/component/process/system for RE
Note: For details of activities on various phases, students should consider the 3rd semester week-wise guideline, as Design Thinking process will be same with different projects.			
Ideation Phase	6, 7, 8	○ Preparation of Ideation canvas based on modification considered at Empathy phase ○ **Learning Tools:** ✓ Learning by analogy, artefactual, heuristic and gestalt model ○ Combination of Ideas from Ideation canvas ○ Sketching of rough ideas ○ Preparation of Ideation canvas	○ Students will work on their Ideation canvas ○ Ideation activities shall be performed in class with team members under guidance of teacher

Product Development Phase	9, 10	○ Preparation of Product Development Canvas (PDC) to modify existing product ✓ Product Experience ✓ Product Functions ✓ Product Features ✓ Components ○ Discussion on PDC	○ Students will work on their PD canvas (min 3 hour continuous workshop) ○ Students team will discuss on their PDC with other groups and faculty guide and get the feedback ○ Refinement of PDC after discussion
	11	○ Customer/User Revalidation (Reject/Redesign/Retain) ○ Refinement	○ Till 12th week of course, student team will consult Users/Stakeholders for their inputs on concept and incorporate necessary changes
Pre-Design & Rough Prototype	12, 13	○ Learning Need Matrix (LNM) ○ Detail design and refinement ○ Prototype (Here strategy is to fail fast to succeed fast)	○ Building the solutions exercises ○ Iterate, Iterate, Iterate….. ○ LNM document link is given in General Guidelines document
Feedback & Final Report	14	○ Upload duly signed Continuous Assessment Card ○ Feedback, Online certificate generation through DE portal ○ Final Report	○ As per the feedback received from Users/Stakeholders/other student groups/guide, student teams need to modify their design and further action plan. ○ Report writing should be continuous activity throughout the semester

Description of activities for DE – 1B (4th semester)



Reverse Engineering (Tear Down Lab approach)

Reverse Engineering, also called as *Back Engineering*, is the processes of extracting knowledge or design information from anything man-made and re-producing it or reproducing anything based on the extracted information. The process often involves disassembling something (a mechanical device, electronic component, computer program, or biological/chemical/organic matter) and analysing its components and workings in detail [1].

[1] https://en.wikipedia.org/wiki/Reverse_engineering

Steps need to follow for Reverse Engineering (but not limited to, it may vary as per selected topic/project):

1. Select branch specific existing artefact/component/process/system/solution
2. Disassemble/Understand it for learning the technical/engineering aspects involved in it
3. Identify issues related to selected existing solution and try to modify it using Design Thinking approach
4. Apply Design Thinking approach to find out the Unmet needs of User related to selected artefact/component

5. Follow phases of Observation, Empathy, Ideation and Product Development by preparing related canvases/frameworks
6. Modify/redesign the artefact/component to meet Users unmet needs

Activity 01 - Select Branch Specific artefact/component and disassemble it

Each group has to select one branch specific existing artefact/component/process/system/solution for reverse engineering activity for their DE-1B project and modify the same based on extracted information as per User's needs. This activity is to learn about some basic technical aspects involved in designing something related to particular branch.

After *Reverse Engineering study*, with extracted information from branch specific artefact/component, Students' team need to apply Design Thinking approach learnt in 3rd semester (all phases of 3rd semester DE-1A would repeat here) to modify/redesign that selected artefact/component based on User's unmet needs. Here one need to make all canvases and framework again as topic is different than 3rd semester.

Activity 02 – User Feedback based refinement and redesign (Using Design Thinking Process learnt in 3rd semester, for further refinement of learning)

After Reverse Engineering phase, Students must have to verify their identified problems of selected artefact/component with the user before investing their time and efforts further. This will help students to verify their concepts and help in clarifying the insights that they need for implementing their idea. Students will visit the domain/area of their selected artefact/component for reverse engineering and verify their modification approach taken up in the PD canvas with the user for functions, features and components. At this stage, one may find that one has to modify the prepared Canvases on the basis of feedback given by user.

After carrying out the feedback analysis, students are required to verify the important aspects, in line with the context of five principles, namely:

i. Technological,
ii. Aesthetic,
iii. Ergonomics,
iv. Environment, and
v. Cost.

For the design problem, each of their components, functions and features of the proposed solution will be checked using the above five principles. This verification may lead to modification and improving of the concept.

Activity 03 - Prior art search

Each student will search at least 2 most relevant research and development work through journals, patent databases, literature of similar products and any other resource, which can provide information related to their product/ idea/ concept. The students are expected to read thoroughly these documents and make a summary (2-3 pages) of the work described in the documents in their own words. *This exercise will ensure, to some extent, the novelty of the idea, as well as enable students to understand on-going works in the field, relevant to their project.*

Phase 2: Pre-Design

Now, after getting feedback from Users on the modification requirements and finalization on the concept, students need to work on Pre-Design phase. Basic Pre-design calculations which roughly decide size/shape/material requirements/manufacturing process/design specifications/applicable standards etc. needs to be identified. Students' need to work on identifying the learning needs in Phase 2 that would help to complete the projects further as well as in their professional career. These needs would be mostly industrial/practical needs which are not included in the regular BE syllabus and are important for the students' to learn these skillsets required by the industry.

Activity 04 - Learning Need Matrix (LNM)

Learning Needs Matrix will help students to **identify the learning requirements that are much needed in industry or in their career** at an early stage along with *prioritization of specific learning*. Every students individually or in team, with the guidance of their Faculty Guide/Industry mentor, would identify the industrial skills for the generic learning. The learning requirements may depend upon and may be specific for the concept/idea for their solution **or** completely independent as per their choice and the field in which they wish to pursue their career. This will help students to do the research in a timely manner so that they are able to obtain the specific learning/ understanding, they would require for designing the product/solutions.

With understanding of the basic branch/ project related subjects, (after having discussions with and the guidance of their Faculty Guide) students will be able to identify *tools/ use of software/ applicable standards/ material / design specifications/ theories/ principles/ methods/ experiments* related needs to be acquired by them to complete their projects successfully or to

succeed in their professional career after graduation. Students can maintain the same LNM sheet till final year (8th sem) and learn the specific skill sets that they want to pursue at each semester. As per change in requirements and learning needs at each semester, LNM may be refined and versions of it shall be prepared and present to examiners during final viva exam. The semester wise allocation for each skill sets need to be done by students and guide. Priority learning shall be taken up as per the core subject of each semester. Internal Guide will track and evaluate the learnings of students through LNM. Students may co-learn the skill sets with other students.

Students need to make LNM and include it in their report. LNM would include four major aspects as below:

1. Theories/ Methods/ Application Process Involved/ Mathematical Requirement
2. Applicable Standards and Design Specifications/ Principles & Experiments
3. Software/ Tools/ Simulation Methods/ Skill
4. Components Materials' & strengths criteria (Exploration- varieties/testing requirements)

Basic instructions for LNM:

a) The requirements of the core discipline should be identified, may be in relation with the topic of projects or independently, to better correlate the learnings. At the same time the group has to work out the learning needs of the inter-disciplinary domains. The learning ***responsibilities shall be distributed*** equally among the group members. Also all learnings requirement to be brought on a mutually fixed ***timeline.***
b) Here do not concentrate only the requirements that are useful for current project, but aim for gaining practical learning/skillset that is required by industry and not included in the syllabus and try to learn gradually all the required skills before graduation.
c) Students (along with faculties) shall identify practical limitations due to non-coverage in syllabus to develop their product and focus on the same from the early stages (i.e. Sem. 4) so that development (manufacturing level detailing) of their project, as desired, can be finished.
d) Student must learn **at-least one** component in Sem. 4 which may be learnt in greater details in the rest of the semesters. The students, with the help of the Faculty Guide, will need to prioritize the learning needs and the level of understanding required. However, basis of interest, students may learn more than one components identified in LNM.
e) The students may prepare a comprehensive LNM for the learning needs for their interest/idea/concept/projects. Ideally, students need to prepare timeline for all the stages of LNM by the end of the 4th semester with aim of learning at least one component by each group members.

Proof of Concept

This would be the very early stage of prototyping technique where the objective is "To succeed faster, you need to fail fast" to save on energy, time and money. So failure in projects shall be welcomed by students and faculty members to learn from it.

Activity 05 – Dirty Mock-ups/ Fast-prototype/ Schematic plan

The students shall be preparing the rough prototype/ schematic plan on the product/ concept they wish to develop. Here, the students need to show the very basic design calculations/ mathematical aspects (estimated) in the process report, involved in the product development, based on which the rough prototype/ schematic plan has been prepared. The students shall be expressing their concept/idea in a clear and understandable form through description, figures, calculations, drawings, model etc. They may also use animations, pictures, drama, skits or video-clips to explain the idea. By doing this students will learn and understand the technical and feasibility aspects of their concept.

Upon preparation of the fast-prototype/ schematic plan on the concept they wish to develop, it needs to be verified by involving some actual users. The students may take their rough prototype to the user and discuss their conceptual thoughts and verify whether the user's expectations are along with the anticipated lines. This interaction may require the inclusion of any missing or overlooked functions and/or features. Based on such discussions, students will further perform refinement in their design.

Submissions by the end of 4th semester shall be:

A. Process Report comprising:
   a. Introduction (Reverse Engineering (RE) – Selection and disassembling of artefact/component)
   b. Images of canvases using Design Thinking based on reverse engineering exercise
   c. Feedback analysis with the user shall be clearly included in the report
   d. Summary of findings of Prior Art Search on their purpose/project theme (2 summary papers per student)
   e. Summary of the learning from Reverse Engineering activity
   f. Basic Pre-design calculation which roughly decided size/shape/material requirement/manufacturing process/design specifications/applicable standards
   g. Summary on validation process and refinement in the first-prototype
   h. Any other important aspects you feel should be included

B. AEIOU framework
C. Mind Map
D. Empathy Map
E. Ideation Canvas
F. Product Development Canvas (PDC)
G. Learning Needs Matrix (LNM)
   a. Summary on learning needs by students in the 4th Semester shall be included in report with allocation of learning requirements among the members of the group
   b. With timeline and semester specific learning by team members

H. Rough prototype model/Conceptual Plan-Layout for process related branches
I. Individual Log Book (duly signed by faculty guide)
J. Continuous Assessment Card for Internal Evaluation (Document separately available on GTU website)

Note: As per the guidelines and evaluation schemes given in this document, students need to prepare report for their projects. Separate report format will not be provided by University, students and faculty members may create their own creative formats. However, in general guidelines document uploaded on GTU website, there are some report format links are given which may help for report format.

Appendix 1: The END SEMESTER Evaluation Scheme for

Design Engineering – 1B (3140005) (4th Semester)

BE – II year – all branches

To,

The Principals/Directors of Colleges/Institutes, the Heads of Departments and GTU/Design Engineering coordinators:

Students deserve a proper practical/ viva/project examination of the work that they have done over the semester (or over the year for a 2-semester project). It is the responsibility of the University and Colleges that all its examinations are conducted fairly, sincerely and with due diligence. So please look into the following:

1. Please make proper arrangements so that all the examinations start in-time. If due to any reason, the exam should not start at the scheduled time, please inform the examiners that they should take extra time. But in no case the viva/ practical exam be conducted in a hurry without giving sufficient time for evaluation of every student. If an exam is scheduled to be held over two days, please make the necessary arrangements.

2. The University expects the Deans (and or special teams headed by the Dean or his/ her nominee) to visit the Colleges during the practical/ viva examinations. *As it came to University's notice that some examiners and colleges are completing viva exam in 1 or 2 hours' time of entire class which is not acceptable in any case and it's immoral practice for any education institute. So all stakeholders need to take extra care of this issue.*

3. Please see that all the necessary help and information is provided to examiner. Please receive them so that they can do their job properly without wasting their time in searching for the place and in contacting the concerned departments and students. If they wish to visit the laboratories/workshops, please make the necessary arrangements.

4. Please inform the examiner that he/she must note down **the best 3 projects of the department** and convey the details of such projects by uploading the details of the project or/and the complete project report on the University's server or send it to design@gtu.edu.in .

5. In case Internet or the server should not work, please provide the technical help to the examiner for preparing a CD of the reports of the best three projects of every department and please make arrangements to deliver the CD to the examination/BE section of the University.

PROCESS OF EVALUATION: At the ensuing 4th semester examinations, the work of the students in Design Engineering – 1B is to be evaluated through **Internal Viva exam and the evaluation is to be out of 80 marks.** Institute may organize inter-department viva or project show case so students would get various expert opinions to motivate them.

For 4th semester, internal Viva-Voce examination will be conducted at the end of the semester by **a team of three examiners - One internal guide, one inter/own departmental faculty, one industry expert (industry expert may be optional but recommended).** Internal examiners/teachers must be trained in Design Thinking through the FDP conducted by University.

EVALUATION SCHEME:

Sr. no.	Particular	Sub-Head Weightage
1.	**Phase 1: Reverse Engineering (RE)** ✓ Selection of Branch specific component/product/artefact/program ✓ Disassembly/Analysis of the component/product/artefact/program and learning about the topic	15
2.	**User Feedback based refinement and redesign of the RE topic based on 3rd semester learning** ✓ Understanding of User's need for Reverse Engineering topic and preparation of canvases/framework for this topic (AEIOU, Mind Mapping, Empathy mapping, ideation, product development) ✓ Prior art search (Two Papers study and summary reports) ✓ Summary of the learning from Reverse Engineering activity	15
3.	**Phase 2: Pre-Design** ✓ Learning Need Matrix (LNM) and the skill set learnt in this semester so far ✓ Basic Pre-design calculation which roughly decide size/shape/material requirement/manufacturing process/design specifications/applicable standards	15
4.	**Phase 3: Proof of Concept** ✓ Dirty Mock-ups/ Fast-prototype/ Schematic plan	15
5.	**Log book** (Individual completed log book, duly signed by guide regularly) **Continuous Assessment Card** for Internal Evaluation (Complete and duly signed by guide regularly)	10

6.	**Report:** Compilation of work report (process report), Online Certificate generated through DE Portal, Future action plan, Question and Answer, Communication Skill, Attitude	10
		80

Note:

- ✓ Total Marks for the subject: 100 (Internal end semester viva exam – 80 & Internal continuous evaluation – 20)
- ✓ Minimum passing marks: 40/80
- ✓ Examiner essentially needs **to evaluate the learning process** of the student during the semester, not only the final outcome. As outcome is important for any project but during the student stage, projects are intended for practical learning and "Learning by doing" is the Mantra for Design Engineering subject *(One should celebrate the failure also and learn from it to get success).* So please evaluate the Design Thinking process and their learning properly with giving sufficient time for each project.
- ✓ Students need to explain all canvases prepared in hard copy to the panel of examiners.
- ✓ Power point presentation is not mandatory.

For any query & suggestions, kindly contact course coordinator:

Mr. Karmjitsinh Bihola, Assistant Professor,

Centre for Industrial Design, GTU.

Email: design@gtu.edu.in

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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
L	T	P	C	Theory Marks		Practical Marks		
				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**

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

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

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**

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

	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

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
L	T	P	C	Theory Marks		Practical Marks		
				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**

	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

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

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:

.

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

	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

	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

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

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.

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
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
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

	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.

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:

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

GUJARAT TECHNOLOGICAL UNIVERSITY

Course Abstract for

DESIGN ENGINEERING - II A

(5th Semester)

Course initiated by:

Centre for Industrial Design

(OPEN DESIGN SCHOOL)

For any query, please write us at: design@gtu.edu.in

Design Engineering – II A (3150001) (5th Semester)

Module 3: Applying Design Thinking

Name of the Discipline & the Programme: **Every discipline of the Engineering**

Usual time of occurrence: **5th Semester**

Duration: **Six (6) months**

Course category: **Core Advance**

Credits: **03**

Examination Pattern: **External Practical/Viva exam at the end of semester**

Prerequisites: **Design Engineering – 1A, Design Engineering – 1B**

Relevance: This is a mid-level course designed for those who have undergone the fundamentals of Design Thinking process in 2nd year and understand the importance and process completely.

Objective: Understanding Design Thinking: The course aims to validate the learnings from the understanding Design Thinking course, by translating the concepts into exercises. In this module, students will work upon community-based projects to validate their learning of Design Thinking process.

Course Contents: Students have learnt the fundamentals of Design Thinking methodology in 2nd year and successfully gone through the process twice while working on general as well as branch specific topics. Now in 5th and 6th semester, being a socially responsible engineer, students need to work on community/society-based project using Design Thinking process. Here in 5th semester emphasis would be on Observation, Empathy, Ideation and Product Development; while in 6th semester emphasis will be on detail design, prototyping and validation of the solutions in real environment. At this stage, it is essential to identify parameters and check five basic design principles viz. 1) Technical, 2) Ergonomics, 3) Aesthetics, 4) Cost and 5) Environment keeping System Approach in mind. Designing something new involves several iterations on different stages/ components/ aspects. Before investing further resources in terms of time/ money/ manpower it is important to strengthen these five principles to advance for novelty. It will include several rigorous iterative efforts to make final product/process.

It is essential for students to enhance and refine their learning by using Design Thinking process, keeping System Approach in mind while working on projects.

The content is divided into week-wise activities to better understand the course and to give enough time to all the learning aspects, but depending upon the type and nature of projects,

students and guide may re-schedule the activities. Students in 5th semester need to follow below week-wise activities to complete the course requirement for 5th semester.

Design Thinking Process – with Tools & Techniques			
Module 3: DE-2A Applying Design Thinking			
Broad segment	**Week**	**Description**	**Operational need**
Orientation with revision of Design Thinking	1,2	• Domain Selection (Community/Society based topic) • Students need to decide their community/society-based problem (here community people would be main stakeholder for the project) • Team Building Exercise • Log book	• Brief lecture/exercise • Government, NGO or any Social agencies can be contacted for project • Individual logbook is required
Empathization Phase	3,4,5	• **Observation:** Through AEIOU framework • **Immerse via Role Playing** • **Interview:** ✓ Formal and Informal interview ✓ Students may use Stanford methods given in below link – **http://dschool.stanford.edu/wp-content/uploads/2013/10/METHODCARDS-v3-slim.pdf**	• Students will use different observation/scouting methods for Observation and Empathy • Then, they need to visit their domain/place of interest for getting insights and define problems. • Several field trips will be required to get better insights on users' needs. • Class as well as homework/field activity
		• Summary of AEIOU activity/inputs • Preparation of Mind Map, Empathy Map	
Problem Definition by secondary	6	• Secondary research/Prior art search • Diachronic and Synchronic analysis • Group wise presentation followed by Discussion	• After rigorous and systematic field exercises, empathization and Secondary Research

research, group work and presentation		• Define Problem statement (format is given in reference PPT on DE portal • Verification of problem identified by team through users/stakeholders	activities -student teams need to define their problem here (it can be further validated through Ideation phase)
Ideation Phase	7,8,9	• Preparation of Ideation canvas ✓ Brainstorming (What, Why, How, When, For Whom) ✓ Situation/Context/Location ✓ Props/non-living things/tools/equipment ✓ Opportunity mapping • Combination of Ideas from Ideation Canvas • Sketching of mock concepts in log book • Design Thinking is a Convergent Divergent process	• students will work on their Ideation canvas • Student teams need to discuss their combination of ideas from Ideation canvas with other teams, faculty guides and users and take feedbacks.
	10	• Prioritizing and finalizing Idea (After group discussion and consulting with faculty guide, student teams need to select their final problem & idea for further development)	• Students team need to validate the final Problem & idea/concept with Users/Stakeholders after this activity
Product Development Phase	11	• Preparation of Product Development Canvas (PDC) ✓ Product Experience ✓ Product Functions ✓ Product Features ✓ Components • **SCAMPER tool**	• students will work on their PD canvas • Till 12th week of the course, Students team will discuss on their PDC with other groups and faculty guide • Refinement of PDC after discussion
	12	• Customer/User Revalidation (Reject/Redesign/Retain) • Refinement	• Till 13th week of the course, student team will consult the Users/Stakeholders for their inputs on concept and incorporate necessary changes
Proof of concept	13	• Pre-Design • Iteration & Modification based on feedbacks • Rough Prototype • Iterate, Iterate, Iterate…..	• Design Thinking is iterative and experimental in nature, so before investing in material, money, resources and time, one should have all possible iterations

	14	• Upload duly signed Continuous Assessment Card	• As per the feedback received from

Feedback & Final Report		• Feedback, Online certificate generation through DE portal • Final Report	Users/Stakeholders/other student groups/guide, student teams need to modify their design and further action plan. • Report writing should be continuous activity throughout the semester

By the end of 5th semester, student's team will be ready with their well-defined Design Problem and probable solutions to that problem as shown in above table.

♦ Submissions by the end of 5th semester shall be:

A. Process Report comprising:
   a) Introduction (Describe your project in detail including domain – type, place, why and how team selected this domain and why this domain is important in relation to Design Thinking/Human-centred process etc.)
   b) Preparation of canvases based on different phase of Design Thinking
   c) Feedback analysis with the user shall be clearly included in the report
   d) Summary of findings of Prior Art Search on purpose/project theme (2 summary papers per student)
   e) Summary of the learning from Design Thinking
   f) Summary on validation process and refinement in the rough prototype
   g) Any other important aspects you feel should be included

B. AEIOU framework
C. Mind Map
D. Empathy Map
E. Ideation Canvas
F. Product Development Canvas (PDC)
G. Rough prototype model/Conceptual Plan-Layout for process related branches
H. Individual Log Book (duly signed by faculty guide)
I. Continuous Assessment Card for Internal Evaluation (Document separately available on GTU website)

Note: As per the guidelines and evaluation schemes given in this document, students need to prepare report for their projects. Separate report format will not be provided by University, students and faculty members may create their own creative formats. However, in general guidelines document uploaded on GTU website, there are some report format links are given which may help for report format.

Appendix 1: The END SEMESTER Evaluation Scheme for

Design Engineering-2A (3150001) (5th Semester)

BE III year – all branches

To,
The Principals/Directors of Colleges/Institutes, the Heads of Departments and GTU/Design Engineering coordinators:

Students deserve a proper practical/ viva/project examination of the work that they have done over the semester (or over the year for a 2-semester project). It is the responsibility of the University and Colleges that all its examinations are conducted fairly, sincerely and with due diligence. So please look into the following:

1. Please make proper arrangements so that all the examinations start in-time. If due to any reason, the exam should not start at the scheduled time, please inform the examiners that they should take extra time. But in no case the viva/ practical exam be conducted in a hurry without giving sufficient time for evaluation of every student. If an exam is scheduled to be held over two days, please make the necessary arrangements.

2. The University expects the Deans (and or special teams headed by the Dean or his/ her nominee) to visit the Colleges during the practical/ viva examinations. As it came to University's notice that some examiners and colleges are completing viva exam in 1- or 2-hours' time of entire class which is not acceptable in any case and its immoral practice for any education institute. So, all stakeholders need to take extra care of this issue.

3. Please see that all the necessary help and information is provided. Please receive them so that they can do their job properly without wasting their time in searching for the place and in contacting the concerned examiners and students. If they should want to visit the laboratories/ workshops, please make the necessary arrangements.

4. Please inform the external examiner that he/she must note down **the best 3 projects of the department** and convey the details of such projects by uploading the details of the project or/ and the complete project report on the University's server or send it to design@gtu.edu.in.

5. In case Internet or the server should not work, please provide the technical help to the external examiner for preparing a CD of the reports of the best three projects of every department and please make arrangements to deliver the CD to the examination department of the University.

PROCESS OF EVALUATION: At the ensuing 5th semester examinations, the work of the students in Design Engineering – 2A is to be evaluated by **External VIVA** and the evaluation is to be out of 80 marks.

A Viva-Voce examination will be conducted at the end of the semester by **a team of two examiners**, one of whom will be an internal Faculty Member, who may have taught the subject.

(Internal examiner must remain the same throughout the entire of examination for batch). The other will be an external examiner to be appointed by the University. Both examiners must be trained in Design Thinking through the FDP conducted by University.

EVALUATION SCHEME

Sr. No.	Particular	Sub-Head Weightage
1.	**Observation towards Empathy** ➢ Field Activity/observation and outcome ➢ Mind Mapping - Summarization and data analysis ➢ Observation Technique (AEIOU Summary)	20
2.	**Log book** (Individual completed log book, duly signed by guide regularly) **Continuous Assessment Card for Internal Evaluation** (Complete and duly signed by guide regularly)	10
3.	**Design Problem Definition** ➢ Secondary research/ Prior art search ➢ Diachronic and Synchronic analysis	10
4.	**Canvases/Frameworks** ➢ AEIOU, Mind Mapping ➢ Empathy mapping ➢ Ideation Canvas ➢ Product development	15
5.	Pre-Design Calculations	15
6.	**Report**: Compilation of work report (process report), Online Certificate generated through DE Portal, Future action plan, Question and Answer, Communication Skill, Attitude	10
		Total: 80

Note:

1. Total Marks for the subject: 100 (Practical viva – 80 (External – 40 & Internal – 40), Internal continuous evaluation – 20)
2. Minimum passing marks: 40/80
3. Ratio of evaluation by internal & external examiner appointed: 50% in each sub-head
4. Examiner essentially needs to evaluate the learning process of the student during the semester, not only the final outcome. As outcome is important for any project but during the student stage, projects are intended for practical learning and "Learning by doing" is the Mantra for Design Engineering subject (One should celebrate the failure also and learn from it to get success). So please evaluate the Design Thinking process and their learning properly with giving sufficient time for each project.
5. Students need to explain all canvases prepared in hard copy to the panel of examiners (internal and external).
6. Power point presentation is not mandatory.

For any query & suggestions, kindly contact : design@gtu.edu.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150005
Semester – V

Sujbect Name : IPDC - 1 (Integrated Personality Development Course)

Type of Course –

Value-based holistic personality development course for university students.

Rationale

IPDC aims to prepare students for the modern challenges they face in their daily lives. Promoting fortitude in the face of failures, unity amongst family discord, self-discipline amidst distractions, and many more priceless lessons. The course focuses on morality and character development at the core of student growth, to enable students to become self-aware, sincere, and successful in their many roles - as an ambitious student, reliable employee, caring family member, and considerate citizen.

Teaching and Examination Scheme:

Teaching Scheme

Teaching and Examination Scheme per semester:

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

The assessments should include both continuous evaluation and end-of-semester examinations. The assessment scheme should include student attendance, assignments, mid-term exams, viva, workbook submission, and end-of-semester examinations.

Course-Content :

Each lecture can be taken in a continuous two-hour session, or in two separate one-hour sessions. In addition to the core lectures, an induction and concluding lectures are recommended as shown in the below table.

Lecture No.	Module -Lecture	Lecture Description	Hours
IPDC-I			
Induction	The Need for Values	Students will learn about the need for values as part of their holistic development to become successful in their many roles - as ambitious students, reliable employees, caring family members, and considerate citizens.	2

1	**Remaking Yourself** Restructuring Yourself	Students learn how self-improvement enables them to secure a bright future for themselves. They will learn 6 powerful thought-processes that can develop their intellectual, physical, emotional, and spiritual quotients.	2
2	**Remaking Yourself** - Power of Habit	Students will undergo a study of how habits work, the habits of successful professionals, and the practical techniques that can be used to develop good habits in their life.	2
3	**Learning from Legends-** Tendulkar & Tata	Students will learn from the inspirational lives of India's two legends, Sachin Tendulkar and Ratan Tata. They will implement these lessons through relatable case studies.	2
4	**From House to Home-** Listening & Understanding	Active listening is an essential part of academic progress and communications. Students will learn to listen with their eyes, ears, mind, and heart.	2
5	**Facing Failures-** Welcoming Challenges	This lecture enables students to revisit the way in which they approach challenges. Through the study of successful figures such as Disney, Lincoln and Bachchan, students will learn to face difficulties through a positive perspective.	2
6	**Facing Failures-** Significance of Failures	Failure is a student's daily source of fear, negativity, and depression. Students will be given the constructive skills to understand failure as formative learning experiences.	2
7	**My India My Pride-** Glorious Past - Part 1	India's ancient Rishis, scholars, and intellectuals have made tremendous contributions to the world, they developed an advanced, sophisticated culture and civilization which began thousands of years ago. Students will learn the importance of studying India's glorious past so that they could develop a strong passion and pride for our nation.	2
8	**My India My Pride-** Glorious Past - Part 2	Our ancient concepts can be used to seek revolutionary ideas and to generate inspiration. Students will develop a deeper interest in India's Glorious Past – by appreciating the need to read about it, research it, write about it, and share it.	2
9	**Learning from Legends-** A.P.J. Abdul Kalam	Dr Kalam's inspirational life displayed legendary qualities which apply to students (1) Dare to Dream (2) Work Hard (3) Get Good Guidance (4) Humility (5) Use Your Talents for the Benefit of Others	2
10	**Soft Skills-** Networking & Leadership	Students are taught the means of building a professional network and developing a leadership attitude.	2
11	**Soft Skills-** Project Management	Students will learn the secrets of project management through the Akshardham case study. They will then practice these skills through an activity relevant to student life.	2
12	**Remaking Yourself-** Handling Social Media	Students will learn how social media can become addictive and they will imbibe simple methods to take back control.	2
13	**Facing Failures-** Power of Faith	Students will learn about the power and necessity of faith in our daily lives.	2

14	**From House to Home-** Bonding the Family	Students will understand the importance of strong family relationships. They will learn how to overcome the generation gap and connect with their family more.	2
15	**Selfless Service-** Seva	Students will learn that performing seva is beneficial to one's health, wellbeing, and happiness. It also benefits and inspires others.	2

- **COURSE MATERIAL / MAIN COURSE WORKBOOK -**

1. IPDC Workbook-1 *(presented by B.A.P.S. Swaminarayan Sanstha)*

IPDC REFERENCES –

These are the reference material for the IPDC lectures. This is not compulsory reading for the students as the essential information is contained in the workbooks.

Module No.	**Module**	**References**
1	Facing Failures	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 **3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008** 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015 7. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007
2	Learning from Legends	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life-Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013
3	My India My Pride	1. Rishis, Mystics, and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011

		2. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 4. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
4	Remaking Yourself	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
5	From House to Home	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 **2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995** 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
6	Soft Skills	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Dan Ariely, Harper Perennial, 2010
7	Selfless Service	1. Open: An Autobiography, Andre Agassi, Vintage, 10 August 2010 2. The Physiological Power of Altruism [online], James Hamblin, The Atlantic, December 30, 2015, https://www.theatlantic.com/health/archive/2015/12/altruism-for-a-better-body/422280/ [last accessed June 10, 2020] 3. TBI Blogs: From Entrepreneurs to Doorkeepers, Everybody Serves with Love & Warmth at This Ahmedabad Café [online], The People Place Project, The Better India, May 29, 2017, https://www.thebetterindia.com/102551/small-way-serve-ahmedabad-seva-cafe/, [last accessed June 10, 2020]

Course Outcomes

- To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.
- To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.
- To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.
- To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.
- To enhance awareness of India's glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.
- To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150709
SUBJECT NAME: Professional Ethics
Semester V

Type of course: NA

Prerequisite: NA

Rationale:

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	Concepts and theories of Business Ethics: Definitions of Ethics, Personal ethics and Business ethics, Morality and law, How are moral standards formed? Religion and Morality, Morality, Etiquette and Professional codes, Indian Ethical Traditions.	6
2	Business Ethics: Principles of personal Ethics, Principles of Professional ethics, Evolution of Ethics Over the years, Honesty, Integrity and Transparency are the touchstones of Business Ethics, Distinction Between Values and Ethics, Roots of unethical Behaviour, Ethical Decision – Making	6
3	Ethical Dilemmas, Sources and Their resolutions: What is an Ethical Dilemma, Sources of Ethical Behaviour, Code of Personal Ethics for Employees, How to Resolve an Ethical Problem, How to Resolve Ethical Dilemmas.	5
4	Ethical Decision – marking in Business: Ethical Models that Guide Decision making, Which Approach to use, Ethical Decision Marking with Cross – holder conflicts and competition, Applying Moral Philosophy to Ethical Decision Making, Kohlberg's Model of Cognitive Moral Development, Influences on Ethical Decision Making, Personal values and Ethical Decision Marking	10
5	Individual factors: Moral Philosophies and values – Moral Philosophy defined, Moral philosophies, Applying Moral Philosophy to Ethical decision Making, Cognitive moral Development, White – Collar Crime, Individual factors in Business Ethics	9
6	Human Values for Indian Managers, Lessons from Ancient Indian Education system, The law of Karma, Quality of Working life, Ethics of Vivekananda, Gandhiji, Aurobindo and Tagore.	9

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3150709

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	20	10	25	20	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. Business Ethics by AC Fernando
2. Business Ethics by Ferrell, Fraedrich and Ferrell.
3. Ethics in Management and Indian Ethos by Biswanath Gosh

Course Outcomes: After learning the course the students will able to

Sr. No.	CO statements	Marks %Weightage
CO-1	Awareness of types of ethical challenges and dilemmas confronting members of a range of professions (business, media, police, law, medicine, research)	25
CO-2	Identify and describe relevant theoretical concepts related to professional ethics in engineering	20
CO-3	Understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories	20
CO-4	Distinguish among morals, values, ethics, and the law and to explore how they each impact engineering practice	25
CO-5	Apply learning from Indian history and ethos to ethical practices in engineering.	10

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150910

Semester –V
Subject Name: Electrical Machine- II

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. In view of this, the rotating electrical equipments play a vital role for the society. This subject deals with the theory and performance analysis of various electrical machines.

Teaching and Examination Scheme:

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
1	**Induction Machines:** Revision of the concept of rotating magnetic field. Construction, working and types ofinduction motor (squirrel cage and slip-ring), Torque Slip Characteristics,Starting andMaximum Torque. No-load & blocked rotor test, Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting,braking and speed control for inductionmotors.Induction generator operation. Self-excitation of induction generator. Double cage induction motor. Circle diagram of induction motor. Effect of harmonics, Cogging & Crawling, Effect of unbalanced voltages on performance of motor.	**16**
2	**Single-phase induction motors:** Constructional features double revolving field theory, equivalent circuit,Determination ofparameters. Split-phase starting methods and applications. Universal motor. Repulsion motor. Shaded pole single phase motor.	**08**
3	**Synchronous machines:** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalentcircuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Methods to find voltage regulation: Synchronous impedance method, MMF method, ZPF method. Operating characteristics of synchronous machines, Salient pole machine – tworeaction theory, power angle characteristics. Parallel operation ofalternators - synchronization and load division.	**16**

4	**Synchronous motors:** Methods of starting of synchronous motors, Different torques in Synchronous motor, Stability, Synchronous condenser, Synchronous phase modifiers, V-curvesof Synchronous motors, **Auto Synchronous Motor:** Construction, principle of operation, equivalent excitation current for various rotor connections, circle diagram.	**08**
5	**Special machines:** Magnetic levitation principle, advantages and applications of linear induction motor. Introduction to axial flux machines. Construction, working and applications of Permanent magnet brushless DC motor, Stepper motor and Switched reluctance motor.	**08**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**20**	**20**	**20**	**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. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
6. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
7. G C Garg, "Electrical machines – II", Khanna Publishers,
8. S K Sen,"Principle of Electrical Machine Design with Computer Programs" Oxford & IBH

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe the construction, working principle and applications of induction machines and synchronous machines	30

CO-2	Analyze the performance of rotating electrical machines using the tools like equivalent circuit, phasor diagram and circle diagram	30
CO-3	Evaluate the performance parameters of rotating machines with different operating conditions	30
CO-4	Illustrate the construction, working, applications and advantages of special machines	10

List of Experiments:

- To perform no load and blocked rotor test on three phase induction motor to obtain the parameters of equivalent circuit
- To perform no load and blocked rotor test on three phase induction motor to evaluate the performance parameters using circle diagram
- To perform no load and blocked rotor test on single phase induction motor to obtain the parameters of equivalent circuit
- To obtain the performance parameters of three phase induction motor using direct load test.
- To find out the voltage regulation of three phase alternator using direct load test
- To perform open circuit, short circuit and resistance measurement tests on alternator to find out its voltage regulation using synchronous impedance method and MMF mehod.
- To perform open circuit, short circuit, zero power factor and resistance measurement tests on alternator to find out its voltage regulation using ZPF method.
- To perform synchronization of alternator using dark lamp method, two bright one dark lamp method and synchroscope.
- To obtain direct axis and quadrature axis reactance of salient pole synchronous machine using slip test.
- To obtain the v-curves of a synchronous motor.
- To study the construction and working of special electric machines like stepper motor, permanent brushless DC motor and switched reluctance motor.

Major Equipments:

Required number 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

GUJARAT TECHNOLOGICAL UNIVERSITY
Bachelor of Engineering
Subject Code: 3150911

Subject Name: Power System II
Semester V

Type ofcourse: Engineering – Professional Core Course

Prerequisite: Fundamental knowledge of Electrical Engineering and Power System – I

Rationale: The course is aimed to provide exposure about the modeling of power systems components and transmission line, its analysis and performance including the fault analysis of power systems, brief introduction to corona and transients in power system.

Teachingand 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	% Weightage
1.	**Basic Principles:** Power in single phase AC circuits, Complex power, Complex power balance, Complex power flow, Balanced Three Phase Circuits, Star connected loads, Delta connected loads, Delta-star transformation, Per phase analysis, Balanced three phase power.	04	05
2.	**Representation of Power System Components:** One line and impedance diagram, Per unit system, Per unit representation of transformer, Per unit impedance diagram of power system, Examples – per unit system and impedance diagram, Synchronous machine, Power factor and power control, Salient pole synchronous generator, Operating chart of a synchronous generator, Representation of loads.	08	10
3.	**Transmission Line Modeling and Performance:** Introduction, Short transmission line, Medium transmission line, Long transmission line – Rigorous solution,Evaluation of ABCD constants, Interpretation of long line equations, Ferranti effect,Tuned power lines, Power through a transmission line, Circle diagrams, Methods of voltage control, Examples.	14	25
4.	**Symmetrical Fault Analysis:** Introduction, Transient on a transmission line, Short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine, Selection of circuit breakers, Examples, Z_{BUS} formulation – by inverting Y_{BUS}, current injection technique, Z_{BUS} building algorithm (Type – 1, 2, 3, 4 modifications).	08	10
5.	**Symmetrical Components:** Symmetrical component transformation, Phase shift in star-delta transformers, Sequence impedances of transmission lines, Sequence - impedances and networks of synchronous machines, Sequence impedances and networks of transformers, Construction of sequence networks of a power system, Examples.	07	15
6.	**Unsymmetrical Fault Analysis:** Introduction, Symmetrical component analysis of unsymmetrical faults,	07	15

	Single line to ground fault, Line to line fault, Double line to ground fault, Open conductor faults.		
7.	**Corona:** Critical Disruptive Voltage, Corona Loss, Line Design based on Corona, Disadvantages of Corona, Radio Interference, Inductive interference between Power and Communication lines, Examples.	04	05
8.	**Over-voltages in Power Systems:** Causes of over-voltages, Internal causes of over-voltages, Mechanism of lightning discharge, Types of lightning strokes, Harmful effects of lightning, Protection against lightning, Earthing screen, Overhead ground wires, Lightning arresters, Surge absorber, .	05	07
9.	**Transients in Power Systems:** Travelling waves on transmission lines, Open end line, Short circuited line, Line terminated through a resistance, Line connected to a cable, Reflection and refraction at a T-junction, Line terminated through a capacitance, capacitor connection at T, Attenuation of travelling waves. Capacitance switching, Over-voltages due to arcing ground.	07	08

Reference Books:

1. Modern Power system Analysis: I. J.Nagrath, D. P. Kothari,McGraw Hill Education
2. Power System Analysis: HadiSaadat, McGraw Hill Education India Pvt Ltd.
3. Electrical Power systems: C. L .Wadhwa, New Age International Publishers
4. Principles of Power System: V. K. Mehta, Rohit Mehta, S. Chand Publications
5. Power System Analysis and Design: J. Duncan Glover, Thomas J. Overbye, Mulukutla S. Sarma, Cengage Learning India Pvt. Ltd.
6. Elements of Power Systems Analysis: W. D. Stevenson Jr., McGraw Hill Education.
7. Power System Analysis : John J. Grainger, William D. Stevenson Jr.,McGraw Hill Education

Suggested list of practical but not limited to:

1. To write computer program for plotting instantaneous voltage, current and power in a single phase ac circuit.
2. To write computer program and obtain voltage regulation and efficiency of short transmission line for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
3. To write computer program and obtain voltage regulation and efficiency of short transmission line for different specified set of sending end quantities (sending end leading, unity and lagging power factor).
4. To write computer program and obtain voltage regulation and efficiency of a Medium transmission line (using π model& T model) for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
5. To write computer program and obtain voltage regulation and efficiency of a Medium transmission line (using π model& T model) for different specified set of sending end quantities (sending end leading, unity and lagging power factor).
6. To write computer program to calculate voltage regulation and efficiency of a Long transmission line using distributed capacitance model for different specified set of receiving end quantities (different load at leading, unity and lagging power factor) and compare the results with results obtained with program for equivalent π model.
7. To write computer program to calculate voltage regulation and efficiency of a Long transmission line using distributed capacitance model for different specified set of sending end quantities (sending end leading, unity and lagging power factor) and compare the results with results obtained with program for equivalent π model.

8. To analyse the performance of long transmission line for specified load impedance.
9. To obtain voltage profile and loadability curve for a transmission line.
10. To compute shunt reactor compensation and performance of open circuited line.
11. To compute shunt capacitor compensation and performance of loaded line.
12. To compute series capacitor compensation and performance of loaded line.
13. To develop program for formulation of Z_{BUS} matrix through Z_{BUS} building algorithm.
14. To simulate transient in series R-L circuit with special attention to change in DC offset current for application of excitation at different instant.
15. Dynamic simulation of three phase fault on terminal of unloaded synchronous generator. The simulation should show the waveforms of all three line current for fault at different instant on voltage wave of phase A.
16. To develop program to transform three phase unbalanced phasor into its symmetrical components.
17. To develop program to transform symmetrical components into its original phasors.
18. To analyzeline to line fault in power system (Using program/simulation).
19. To analyze line to ground fault in power system (Using program/simulation).
20. To analyze double line to ground fault in power system (Using program/simulation).
21. To write a computer program for animation of travelling waves of a long transmission line with different operating conditions.

Suggested Specification tablewith marks(Theory):

Distribution ofTheoryMarks					
RLevel	ULevel	ALevel	NLevel	E Level	CLevel
10	20	20	25	15	10

Legends:R:Remembrance;U:Understanding, A:Application,N:Analyze, E:Evaluate C: Createand above Levels (RevisedBloom's Taxonomy)

Note: Thisspecificationtable shallbetreated as ageneralguidelineforstudents and teachers.The actual distributionofmarks in thequestionpapermay varyslightlyfromabove table.

Course Outcome (Theory):

After learning the course the students should be able to:

Sr. No.	CO Statement	Marks % Weightage
1.	Prepare the model of transmission line, generator and transformer of power system for single line diagram representation and per unit quantity calculation.	15
2.	Evaluate performance of short, medium and long transmission lines.	25
3.	Analyze symmetrical and unsymmetrical faults in power system.	40
4.	Describe various aspects of over-voltages and corona in power transmission.	12
5.	Describe travelling wave and transientsin power system.	08

Course Outcome (Laboratory):

After performing the practical, the students should be able to:

1. Evaluate transmission line parameters and operating performance using computer program and simulation.
2. Calculate fault current and voltages for three phase symmetrical and unsymmetrical faults on power systems using computer program and computer simulation.
3. Calculate important Design parameters of transmission line design and calculate ratings of circuit breakers for transmission system.

GUJARAT TECHNOLOGICAL UNIVERSITY
Bachelor of Engineering
Subject Code: 3150911

Major software:

MATLAB, C/C++, SciLab, PowerWorld Simulator

List of Open Source Software/learning website:

1. https://www.scilab.org/
2. https://www.powerworld.com/download-purchase/demo-software/simulator-demo-download
3. https://swayam.gov.in/nd1_noc19_ee61/preview
4. https://swayam.gov.in/nd1_noc19_ee62/preview
5. http://vp-dei.vlabs.ac.in/Dreamweaver/list.html

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150912

Semester – V
Subject Name: Signals and Systems

Type of course: Engineering Science Course

Prerequisite:

Rationale: Automation in industries and domestic level has made engineers to understand about various systems and signals. The interfacing of the machines with the different controllers specifically needs to calculate and estimate the basics about the signals and systems. Every domain expects engineers to be fundamentally clear about the signals and systems. This subject clears mainly the classification of the signals and systems with their various time and frequency domain analysis for future applications.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Signals and Systems:** Signals and systems everyday life, biomedical, instrumentation domestic and industries. Representations of Signals, Classifications of Signals – Continuous time, Discrete time, comparison among Analog, Digital and Discrete Signals, Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, and the complex exponential. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.	**06**
2	**Mathematical operations on Signals and Systems:** Addition, subtraction, multiplication and division of the signals, parallel and series combinations of the systems, cascading of the systems,impulse response characterization and convolution integral for CT- LTI system, signal responses to CT-LTI system, properties of convolution, LTI system response properties from impulse response, Examples. Impulse response characterization and convolution sum, Causal signal response to DT-LTI systems. Properties of convolution summation, Impulse response of DT-LTI system. DT-LTI system properties from Impulse response. System analysis from difference equation model, examples.	**10**
3	**Fourier, Laplace and z-transforms:** Representation of periodic functions, Fourier series, Frequency spectrum of aperiodic	**14**

	signals, Fourier Transform, Relation between Laplace Transform and Fourier Transform and its properties. Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.	
4	**Sampling & reconstruction:** The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.	**05**
5	**Applications based on IoT:** Introduction of the Internet of Things, Types of sensors, Types of actuators, Introduction of Arduino Interfacing of the sensors and actuators with Arduino. Programming in Arduino. Signals storage and its analysis using Arduino, Design of a minor project based on Arduino.	**05**

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

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**20**	**30**	**10**	**5**	**5**

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. Signals and Systems by Alan V. Oppenheim, Alan S. Wilsky and Nawab, Prentice Hall
2. Signals and Systems by K. Gopalan, Cengage Learning (India Edition)
3. Signals and Systems by Michal J. Roberts and Govind Sharma, Tata Mc-Graw Hill Publications
4. Signals and Systems by Simon Haykin and Bary Van Veen, Wiley- India Publications
5. Linear Systems and Signals by B.P.Lathi, Oxford University Press
6. Signal, Systems and Transforms by Charles L. Philips, J. M. Parr and E. A. Riskin, Pearson Education
7. Signal and Systems by Anand Kumar, 3rd Edition, PHI
8. Internet of Things: Technologies, Applications, Challenges and Solutions by B. K. Tripathy & J. Anuradha, CRC Press, 2017.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150912

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe the type of system and signal in Industries and Domestic level for Interfacing.	40
CO-2	Derive mathematical model of the systems and signals for the applications.	30
CO-3	Analyze the response of system for the efficient usage of the systems.	15
CO-4	Design of the system from the available input signals and expected output signals of the industrial model.	15

List of Experiments:

1. Generations and capturing various continuous time signals from sensors.
2. Generation and capturing of discrete time signals and plot them.
3. Discretization using different sampling rate and observing aliasing effect.
4. Observing the effects of lower sampling rate and higher sampling rate on CT signal.
5. Performing various operations on the signal using circuits and computational software.
6. Using digital circuit building block to perform operations on signals.
7. Simulation of continuous time LTI system.
8. Simulation of discrete time LTI systems.
9. Obtaining impulse response of the systems.
10. Computing FT and DTFT of the CT signals and DT sequences.
11. Interfacing of the IR sensors and measurement of distance using arduino.
12. Automation of single phase load using Arduino.

Design based Problems (DP)/Open Ended Problem:

1. Design of active noise removal / cancellation circuit.
2. Design of digital building blocks to perform various operations on discrete time sequences and singals.
3. Design of efficient and accurate signal converter.
4. Design of sample and hold circuits
5. Design of a system for the Industrial applications from the input and out put signals.

Major Equipments:

Analog & Digital signal generator kits, CRO, DSO, Mathematical operations kit using OPAMP, sensors, actuators, Arduino and necessary interfacing wires, relays, switches, etc.

List of Open Source Software/learning website:

- http://www.scilab.org/
- http://www.gnu.org/software/octave/
- http://www.vlab.co.in
-http://www.arduino.cc

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150913

Semester – V
Subject Name: DISASTER MANAGEMENT

Type of course: Applied Mechanics

Prerequisite: NA

Rationale: This subject is conceptual applications of principles of management to mitigate various disasters.
Teaching and Examination Scheme:

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

0

Content:

Sr. No.	Content	Total Hrs
1	Understanding Disasters Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management	4
2	Types, Trends, Causes, Consequences and Control of Disasters Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves); Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters); Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters	8
3	Disaster Management Cycle and Framework Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment;	8

	IDNDR, Yokohama Strategy, Hyogo Framework of Action	
4	Disaster Management in India Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter-Governmental Agencies	**10**
5	Applications of Science and Technology for Disaster Management & Mitigation Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non-Structural Mitigation of Disasters S&T Institutions for Disaster Management in India	**12**

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
10	**50**	**30**	**10**	**0**	**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:

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain types, trends, causes consequences and control of disaster	30
CO-2	Recall disaster management cycle and frame work	20
CO-3	Summarize disaster management agencies and their roles in india.	20

CO-4	Relate applications of sciences and technology for disaster management and mitigation.	30

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3151108
Semester – V
Subject Name: Python Programming

Type of course: Open Elective Subject

Prerequisite: Fundamental knowledge about computer systems and positive aptitude to learn programming, Basic knowledge of C Programming.

Rationale:

Python is general purpose programming language becomes very popular in last decade. In this age, every Electronics, Electrical and Computer engineers must learn Python Programming to build applications in their core domain. Python is becoming popular in artificial intelligence and machine learning. MicroPython is sub-set of Python Programming useful to port in hardware for embedded and IoT applications.

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)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction, Data Types and Operators:** Installation and working with Python, Variables and data types in python, Perform computations and create logical statements using Python's operators: Arithmetic, Assignment, Comparison, Logical, Membership, Identity, Bitwise operators, list, tuple and string operations	6	20%
2	**Python Decision making and Loops:** Write conditional statements using If statement, if ...else statement, elif statement and Boolean expressions, While loop, For loop, Nested Loop, Infinite loop, Break statement, Continue statement, Pass statement, Use for and while loops along with useful built-in functions to iterate over and manipulate lists, sets, and dictionaries. Plotting data, Programs using decision making and loops.	8	20%
3	**Python Functions and Modules:** Defining custom functions, Organising Python codes using functions, Create and reference variables using the appropriate scope, Basic skills for working with lists, tuples, work with dates and times, get started with	6	20%

	dictionaries, Importing own module as well as external modules, Programming using functions, modules and external packages		
4	**Python File Operations:** An introduction to file I/O, use text files, use CSV files, use binary files, Handle a single exception, handle multiple exceptions, Illustrative programs, Exercises	4	15%
5	**MicroPython:** Introduction, main difference between MicroPython and Python, Installation of MicroPython on Hardware, MicroPython libraries, GPIO programming on MicroPython Hardware, Sensor Programming using MicroPython	8	25%

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
20	**20**	**25**	**15**	**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. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India
2. Python Programming Fundamentals- A Beginner's Handbook by Nischay kumar Hegde
3. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication
4. Introduction to Python for Engineers and Scientists, By. Sandeep Nagar, Apress
5. MicroPython for the Internet of Things (A Beginner's guide to programming with Python on microcontrollers) By. Charles Bell, Apress

Course Outcomes:

After completion of this course students will be able …

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	To test and debug code written in python	25

CO-2	To create applications using Python Programming	20
CO-3	To perform file operations to read and write data in files	25
CO-4	To write programs for general purpose I/O devices using MicroPython	30

List of Experiments:

[1] Write Python programs to understand control structures

[2] Write Python programs to understand list and tuples

[3] Use conditional statements and loops in Python programs

[4] Write python programs to create functions and use functions in the program

[5] Import module and use it in Python programs

[6] Write python program to plot data using PyPlot

[7] To become familiar with MicroPython and NodeMCU. Configure NodeMCU for MicroPython.

[8] Write program in MicroPython to send digital data on GPIO pins of NodeMCU and glow LED connected with NodeMCU or any other MicroPython supported board.

[9] Connect Digital/Analog I/O module with NodeMCU and write program to display temperature in MicroPython.

[10] Connect NodeMCU with with WiFi Access Point and transmit data from NodeMCU to Cloud. Connect Digital/Analog I/O module with NodeMCU and send temperature and light data on cloud (Thingspeak, Firebase or any other cloud service)

Major Equipment/software:

- NodeMCU boards or any other microcontroller board supporting MicroPython firmware
- Digital analog Input Output boards consisting LEDs, Switches, LDR, Temperature sensor, POT

List of Open Source Software/learning website:

- NPTEL Video lecture on Python Programming
- https://www.coursera.org/learn/python-programming
- Python Software

- Turtle - https://docs.python.org/2/library/turtle.html
- PyLab - https://scipy.github.io/old-wiki/pages/PyLab
- Anaconda software

GUJARAT TECHNOLOGICAL UNIVERSITY

Course Abstract for

DESIGN ENGINEERING – II B

(6th Semester)

Course initiated by:

Centre for Industrial Design

(OPEN DESIGN SCHOOL)

For any query, please write us at : design@gtu.edu.in

Design Engineering – II B (3160001) (6th Semester)

Module 2: Building The Solution

Name of the Discipline & the Programme: **Every discipline of the Engineering**

Usual time of occurrence: **6th Semester**

Duration: **Six (6) months**

Course category: **Core Advance**

Credits: **03**

Examination Pattern: **External Practical/Viva exam at the end of semester**

Prerequisites: **Design Engineering – 1A, Design Engineering – 1B, Design Engineering – 2A**

Relevance: This is an advance level course designed for those who have undergone the fundamentals of Design Thinking process and understand the importance and process completely.

Objective: Understanding Design Thinking: The course aims to validate the learnings from the understanding Design Thinking course by translating the concepts into exercises. In this module, student will continue their work from 5th semester on Community based project and complete the Design Thinking cycle with emphasis on product development, detail design, prototyping and validation of the solutions in real environment.

Course Contents: Students have started community-based projects and successfully gone through the process of Observation, Empathy, Ideation and initial stages of Product Development in 5th semester. Now in 6th semester, they will continue their work from concept to product development, detail design, prototyping and validation of the solutions in real environment. All students' team need to work towards final prototype and then test it in real environment. Final working model with YouTube video link is required for this module.

In 6th semester, students will consider various design considerations as described further in this document for detail design and then first prepare their models in software if required and then use prototyping techniques to further build the concepts. The content is divided into week-wise activities to better understand the course and to give enough time to all the learning aspects, but depending upon the type and nature of projects, students and guide may re-schedule the activities. Students in 6th semester need to follow below week-wise activities to complete the course requirement for 6th semester.

Design Thinking Process – with Tools & Techniques			
Module 4: DE-2B Building the Solutions			
Broad segment	**Week**	**Description**	**Operational need**
System level Design	1	• Plan of Action in 6th semester ➢ Based on revalidation, feedback from last semester (5th semester) plan for future aspects	• Discussion with faculty guide and modification based on feedbacks
Detailed Design	2, 3, 4	• Detailed Design (including all aspects of products, material, process, resources, standards etc.)	• Brief lecture/exercise • Very minute details of the concept will be considered • Prototyping techniques may be used to iterate
CAD Modelling & Analysis	5, 6, 7	• CAD Modelling & Analysis (Branch specific software will be used depending on projects)	• Software saves on time, money, resources etc. • Branch specific software must be provided by the college for students to use for their projects
Building the solutions	8, 9, 10, 11	• Prototyping (sequential prototyping for iterations) • Customer Revalidation • Modification • Iterate, Iterate, Iterate…..	• Prototype does not mean final product or working model but it is the process/phase to reach up to final product
Final Prototype	12	• Final working model should be prepared (The projects that involve higher cost and limitations on technology should be allowed other ways of prototyping other than working model)	• YouTube link of final working model is required for full mark
Project Fair	13	• Open project showcase/fair for showing the projects for Students, faculty members, local people and industrialists	• This fair should be open for all in surrounding area of college • It is compulsory to organize DE project fair
Feedback & Final Report	14	• Upload duly signed Continuous Assessment Card • Feedback, Online certificate generation through DE portal • Final Report	• As per the feedback received from Users/Stakeholders/other student groups/guide, student teams need to modify their design and further action plan. • Report writing should be continuous activity throughout the semester

In the 6th semester, student's team will validate their concept and detailed design part with reference to (1) Design for performance, safety and reliability, (2) Design for Ergonomics and Aesthetics, (3) Design for Manufacturing & Assembly (DFMA), (4) Design for cost & Environment, (5) Modelling and Analysis of their design (6) Prototyping (7) Engineering Economics of Design, (8) Design for Use, Reuse and Sustainability and (9) Test the prototype. And additionally, students will also learn topic like (10) Ethics in Design.

Following aspects should be taken into account while developing product.

1. **Design for Performance, Safety and Reliability:**

- Design for performance: The final product/process must perform for designed (projected in Product Development Canvas - PDC) features and functions as per the requirement of the user in actual working environment (revealed through rough prototype validation).
- Design for Safety: Safety is the most important aspect of human centric product/process. Reasonable factor of safety should be taken into account considering all adverse and factual factors (Ideation canvas – location/context/situation may be referred back here) as there is human interaction with product/process in manifold circumstances.
- Design for Reliability: Reliability is the ability of a system or component to perform its required functions under stated conditions for a specified period of time1 . Your final product/process should be reliable as required by the user and should perform its desired functions as required for desired time period.

2. **Design for Ergonomics and Aesthetics:**

- Ergonomics is all about designing for human factors/comforts wherever they interact with product/process and surrounding environments. According to the **International Ergonomics Association** within the discipline of ergonomics there exist domains of specialization:

  (a) Physical Ergonomics – is concerned with the human anatomy, bio mechanical and physiological ability and its relevance to the product and surrounding systems;
  (b) Cognitive Ergonomics – is concerned with the mental ability such as perception, memory, reasoning and response power as they affect the interactions between humans and products/systems;
  (c) Organizational Ergonomics – is concerned with the optimization of socio-technical systems including organizational structures, policies and processes

- Aesthetics is all about designing for physical appearance (looks) of the product. In current time, customers are willing to buy the products which have stunning looks with respect to their competitive products. Design for Aesthetics includes appearance, style, colour, form/shape, visuals and so on.

3. **Design for Manufacturability & Assembly (DFMA):**

DFMA stands for two terms; DFM – Design for Manufacturability which means for ease of manufacturing of parts/components of final product. DFA – Design for Assembly which means manufactured parts can be easily assembled to form a final product. DFMA approach helps to design and manufacture/construct the product easily and economically. Designer must design

components/parts that can be easily manufactured with available resources at minimum cost of production and can be easily assembled by assembly personnel. The intentions behind implementing DFMA practice in product development is to minimize manufacturing and assembly cost, improve efficiency, eliminate waste of material and time. Iteration on involved raw materials may be performed to check available alternatives – as materials play a major role in production cost. Basic guidelines may be followed as below:

♣ Check for alternative and compatible raw materials (Refer/ revise to LNM)
♣ Minimize the number of parts (Refer/ revise to PDC)
♣ Develop a modular design
♣ Design parts to be multi-functional
♣ Design parts for multiple-use
♣ Design for ease of fabrication/ production/ assemble
♣ Minimize assembly paths
♣ Avoid separate fasteners (i.e. monolithic units)
♣ Eliminate adjustments as possible (i.e. movement in parts addressing multiple use – it's a trade-off)
♣ Design for minimum handling
♣ Avoid use of additional tools when possible
♣ Minimize subassemblies (i.e. joining and removing some of the parts)
♣ Use standard parts when possible (refer/ revise to LNM)
♣ Simplify operations
♣ Design for efficient and adequate testing (refer/ revise to LNM)
♣ Use repeatable & understood processes
♣ Analyse failures
♣ Rigorously assess value (i.e. cost of production against minimizing cost of human efforts being done at present – Refer to AEIOU observation framework)

4. Design for Cost, Environment:

- Design for cost means designing for lowest possible life cycle cost. It involves – assumed product design cost (manufacturing), delivery cost (to the end-user) as well as cost of operation and maintenance.
- Design for environment strategy describes best practices of designing a product/process to minimize health and environmental ill-impacts. Four main concepts of Design for Environment includes: (a) Design for Environmental aspects during Processing and Manufacturing; (b) Design for Environmental aspects in Packaging; (c) Design for Disposal or Reuse (i.e. after end of product/ process life-cycle as involved in one's case); (d) Design for Energy Efficiency (i.e. energy consumption during the product/ process usable life)

5. Modelling and Analysis using Software:

- Branch Specific software can be used for simulation/analysis purpose to further refine the design before investing more time, money and resources.

6. **Prototyping and Proofing of Concepts:**

- Prototypes, Models and Proof of concepts
  - Prototypes [1]: Prototypes are the first full scale and usually a functional form of design and in this sense, it is a working model of designed parts/artefacts. They are tested in the same environments in which they are expected to perform as final products.
  - Models [1]: A model is "a miniature representation of something". They may be a paper model or computer model or physical model. Models are usually a smaller and made of different material than are of original products, and they are tested in laboratory or controlled environment to validate their expected behaviour.
  - Proof of Concepts [1]: A proof of concept, in this context, refers to a model of some part of a design that is used specifically to test whether a particular concept will actually work as proposed. Proof of concept test will validate the idea or concept in controlled environment.

- Building series of Prototypes to further refine the project
- How much it will cost?

7. **Engineering Economics of Design:**

- Cost Estimation
- Labour, Material and overhead cost
- The time value of money

8. **Design for Use, Reuse and Sustainability**

- Design for USE – How long this design will work?
  - o Reliability
  - o Maintainability
- Design for Reuse
- Design for Sustainability

9. **Test the prototype**

- Test your design in real operational environment and then iterate if required.

[1] Engineering Design – A project Based Introduction by Clive L. Dym, Patrick Little, Elizabeth J. Orwin – Wiley publications

10. **Ethics in Design**

- Codes of Ethics
- Ethics: Understanding Obligations
- Ethics: on engineering practice and the welfare of the public
- Ethics: Always a part of engineering practice

Optional Areas:

GTU Innovation Council will help in below areas for the students whose projects are innovative & extraordinary and who really want to develop their projects further.

Visit **http://www.gtuinnovationcouncil.ac.in/** or **http://dic.gtu.ac.in/** for more info.

- Design and Product Development Support
- Intellectual Property Right
- Business Model Canvas
- Student Start-up, Funding, Idea to Product
- Incubation and Co-working space

♦ Submissions by the end of 6th semester shall be:

A. Process Report comprising:

a. Introduction (Describe your project in detail including domain – type, place, why and how team selected this domain and why this domain is important in relation to Design Thinking/Human-Centred process etc.)

b. Canvases and framework from 5th semester based on different phase of Design Thinking

c. Feedback analysis with the user and Summary on validation process and refinement in the rough prototype shall be clearly included in the report

d. Detail design calculations/data

e. CAD/Software modelling details

f. Testing of final model if available

g. Any other important aspects you feel should be included

B. Iterative versions of the prototype models with all necessary details

C. Individual Log Book (duly signed by faculty guide)

D. Continuous Assessment Card for Internal Evaluation (Document separately available on GTU website)

Note:

As per the guidelines and evaluation schemes given in this document, students need to prepare report for their projects. Separate report format will not be provided by University, students and faculty members may create their own creative formats. However, in general guidelines document uploaded on GTU website, there are some report format links are given which may help for report format.

Appendix 1: The END SEMESTER Evaluation Scheme for

Design Engineering – II B (3160001) (6th Semester)

BE III year – all branches

To,

The Principals/Directors of Colleges/Institutes, the Heads of Departments and GTU/Design Engineering coordinators:

Students deserve a proper practical/ viva/project examination of the work that they have done over the semester (or over the year for a 2-semester project). It is the responsibility of the University and Colleges that all its examinations are conducted fairly, sincerely and with due diligence. So please look into the following:

1. Please make proper arrangements so that all the examinations start in-time. If due to any reason, the exam should not start at the scheduled time, please inform the examiners that they should take extra time. But in no case the viva/ practical exam be conducted in a hurry without giving sufficient time for evaluation of every student. If an exam is scheduled to be held over two days, please make the necessary arrangements.

2. The University expects the Deans (and or special teams headed by the Dean or his/ her nominee) to visit the Colleges during the practical/ viva examinations. As it came to University's notice that some examiners and colleges are completing viva exam in 1- or 2-hours' time of entire class which is not acceptable in any case and its immoral practice for any education institute. So, all stakeholders need to take extra care of this issue.

3. Please see that all the necessary help and information is provided. Please receive them so that they can do their job properly without wasting their time in searching for the place and in contacting the concerned examiners and students. If they should want to visit the laboratories/ workshops, please make the necessary arrangements.

4. Please inform the external examiner that he/she must note down the best 3 projects of the department and convey the details of such projects by uploading the details of the project or/ and the complete project report on the University's server or send it to design@gtu.edu.in.

5. In case Internet or the server should not work, please provide the technical help to the external examiner for preparing a CD of the reports of the best three projects of every department and please make arrangements to deliver the CD to the examination department of the University.

PROCESS OF EVALUATION: At the ensuing 6th semester examinations, the work of the students in Design Engineering-2B is to be evaluated by **External VIVA** and the evaluation is to be out of 80 marks.

A Viva-Voce examination will be conducted at the end of the semester **by a team of two examiners**, one of whom will be an internal Faculty Member, who may have taught the subject. (Internal examiner must remain the same throughout the entire of examination for batch). The other will be an external examiner to be appointed by the University. Both examiners must be trained in Design Thinking through the FDP conducted by University.

EVALUATION SCHEME

Sr. No.	Particular	Sub-Head Weightage
1.	• Design calculation (it may include size & shape specifications, tolerances, material requirement, standards/safety rules/govt. policies, sketches, detail & assembly drawings, list of components with specifications etc.) These all aspects are case sensitive so one can add/remove some aspects from the list. • For CE, IT, other process related branches, one may also use Flow chart/Block Diagrams/Algorithms/Programming etc. • Measuring Instruments/techniques - knowledge and use • Comparison of existing materials, methods, tools and equipment for your project **Detail Design:** Considerations for **Design for Performance, Safety and Reliability** ➢ Different aspects of design for performance, safety and reliability introduced/ considered for defined problem **Design for Ergonomics and Aesthetics** ➢ Consideration of Ergonomics and Aesthetics aspects to raise the value of product **Design for Manufacturability & Assembly (DFMA)** ➢ Reference, different considerations and guidelines followed for DFMA during the work **Design for Cost, Environment** ➢ Cost and Environment consideration as they play major role in Product **Design for Use, Reuse and Sustainability**	25
2.	Simulation & Analysis (CAD/Software modelling), Mathematical model	15
3.	**Prototyping & Testing:** ➢ Versions of Prototypes with all possible modification and iterations to further refine the solutions (15 marks out of 25 - for	

	students who have made iterative versions for prototype with refinement; if students only present final prototype without any version/s or modification/s then this 15 marks will not be counted for such students) Note: Report should carry all details/modification for the versions of prototype with images, it is not required to have different physical models for the different versions ➢ Testing/user feedback results (10 marks out of 25 - if the details and testing/user feedback results are there) ➢ Video of Prototypes (YouTube link)	25
4.	**Report, Logbook, Continuous Assessment Card:** Compilation of work report (process report), duly signed Logbook and Continuous Assessment Card, Online Certificate generated through DE Portal, Future action plan, Question and Answer, Communication Skill, Attitude	15
		Total: 80

Note:

1. Total Marks for the subject: 100 (Practical viva – 80 (External – 40 & Internal – 40), Internal continuous evaluation – 20)
2. Minimum passing marks: 40/80
3. Ratio of evaluation by internal & external examiner appointed: 50% in each sub-head
4. Examiner essentially needs to evaluate the learning process of the student during the semester, not only the final outcome. As outcome is important for any project but during the student stage, projects are intended for practical learning and "Learning by doing" is the Mantra for Design Engineering subject (One should celebrate the failure also and learn from it to get success). So please evaluate the Design Thinking process and their learning properly with giving sufficient time for each project.
5. Students need to explain all canvases prepared in hard copy to the panel of examiners (internal and external).
6. Power point presentation is not mandatory.

Note:

In final year, students will use their learning of Design Thinking from these four modules of DE-1A, 1B, 2A, 2B to complete their IDP/UDP projects. There would not be separate Design Engineering subject in final year. On successfully completion of these four modules and repeating Design Thinking process again and again, students would be able to use it effectively and can solve any problem with creativity.

For any query & suggestions, kindly contact : design@gtu.edu.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160003
IPDC - 2 (Integrated Personality Development Course)

SEMESTER VI

Type of Course –

Value-based holistic personality development course for university students.

Rationale

IPDC aims to prepare students for the modern challenges they face in their daily lives. Promoting fortitude in the face of failures, unity amongst family discord, self-discipline amidst distractions, and many more priceless lessons. The course focuses on morality and character development at the core of student growth, to enable students to become self-aware, sincere, and successful in their many roles - as an ambitious student, reliable employee, caring family member, and considerate citizen.

Teaching and Examination Scheme:

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

The assessments should include both continuous evaluation and end-of-semester examinations. The assessment scheme should include student attendance, assignments, mid-term exams, viva, workbook submission, and end-of-semester examinations.

Course-Content :

Each lecture can be taken in a continuous two-hour session, or in two separate one-hour sessions. In addition to the core lectures, an induction and concluding lectures are recommended as shown in the below table.

Lecture No.	Module -Lecture	Lecture Description	Hours
IPDC-2			
1	**Remaking Yourself-** Begin with the End in Mind	Students will learn to visualize their future goals and will structure their lives through smart goals to give themselves direction and ultimately take them to where they want to go.	2
2	**Remaking Yourself-** Being Addiction-Free	Students will explore the detrimental effects of addictions on one's health, personal life, and family life. They will learn how to take control of their life by becoming addiction free.	2
3	**Selfless Service-** Case Study: Disaster Relief	Students will apply previous lessons of seva, to analyse the case study of the Bhuj earthquake relief work.	2
4	**Soft Skills-** Teamwork & Harmony	Students will learn the six steps of teamwork and harmony that are essential for students' professional and daily life.	2
5	**My India My Pride-** Present Scenario	To implement the transformation of India from a developing country into a developed country it is necessary to have a value-based citizen. Students will see how the transformation to a greater India relies on the vision and efforts of themselves as a youth.	2

6	**Learning from Legends-** Leading Without Leading	Students will explore a new approach to leadership, through humility.	2
7	**My India My Pride-** An Ideal Citizen - 1	Students will learn that to become value-based citizens, they must first develop good values in their lives. They start by exploring the values of responsibility and integrity.	2
8	**My India My Pride-** An Ideal Citizen - 2	Students will learn that by developing the values of loyalty, sincerity, and punctuality; they become indispensable and can leave a strong impression. They will start developing these values by trying to keep perfection in every small task and by looking at the bigger picture.	2
9	**Facing Failures** Timeless Wisdom for Daily Life	Students will learn the role wisdom plays in finding long-term stability. They will use ancient wisdom to solve their modern-day challenges.	2
10	**From House to Home-** Forgive & Forget	Students will understand the importance and benefits that forgiveness plays in their personal and professional life. They will learn to apply this knowledge in realistic situations.	2
11	**Remaking Yourself-** Stress Management	Students will learn to cope with current and future causes of stress.	2
12	**Remaking Yourself-** Better Health Better Future	A healthy body prevents disease and stress; increases positivity, productivity, and brainpower. Students will learn to maintain good health through regular exercise, healthy eating habits, and regular and sufficient sleep.	2
13	**Learning from Legends -** Words of Wisdom	A panel of learned and experienced mentors will personally answer practical questions that students face in their daily life.	2
14	**Soft Skills –** Financial Planning	Students will develop a variety of practical financial skills that prepare them to become financially stable throughout their future careers.	2
15	**Remaking Yourself** Impact of Company	Students will understand that the type of company that we keep, has a crucial role in determining who we are and who we will become. They will develop the ability to create a positive environment around them.	2
Concluding	Life After IPDC	This concluding lecture encourages students to keep practising these priceless lessons and prepares them for the next steps in their lives.	2

- **COURSE MATERIAL / MAIN COURSE WORKBOOK -**

1. IPDC Workbook-2 *(presented by B.A.P.S. Swaminarayan Sanstha)*

IPDC REFERENCES –

These are the reference material for the IPDC lectures. This is not compulsory reading for the students as the essential information is contained in the workbooks.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160003

Module No.	Module	References
1	Facing Failures	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 **3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008** 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015 7. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007
2	Learning from Legends	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life-Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013
3	My India My Pride	1. Rishis, Mystics, and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011 2. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 4. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
4	Remaking Yourself	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
5	From House to Home	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 **2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995** 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
6	Soft Skills	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Dan Ariely, Harper Perennial, 2010
7	Selfless Service	1. Open: An Autobiography, Andre Agassi, Vintage, 10 August 2010 2. The Physiological Power of Altruism [online], James Hamblin, The Atlantic, December 30, 2015, https://www.theatlantic.com/health/archive/2015/12/altruism-for-a-better-body/422280/ [last accessed June 10, 2020]

		3. TBI Blogs: From Entrepreneurs to Doorkeepers, Everybody Serves with Love & Warmth at This Ahmedabad Café [online], The People Place Project, The Better India, May 29, 2017, https://www.thebetterindia.com/102551/small-way-serve-ahmedabad-seva-cafe/, [last accessed June 10, 2020]

Course Outcomes

- To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.
- To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.
- To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.
- To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.
- To enhance awareness of India's glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.
- To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160914
MICROPROCESSORS AND MICROCONTROLLERS
Semester VI

Type of course: Engineering

Prerequisite: Analog and Digital Electronics

Rationale: Microprocessor and microcontrollers are the most useful electronic chips which are used to design and develop processor and computer based automatic smart electronics systems for home and industry application. This subject is devoted to the study of microprocessor and microcontroller interfacing of memory and I/O devices like A to D converter, D to A converter LED, LCD etc. The students learn Programming language (Both assembly and Embedded C) used for microcontrollers. They learn the basics of Microprocessor and designs of Microcontroller based systems and also get a brief idea of advanced microcontrollers used in industries. They will be able to use the same in electrical engineering related fields like Power system protection, instrumentation, power electronics, Electrical Drives and control of Electrical Equipments.

Teaching and Examination Scheme:

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	**Microprocessor Based Systems:** Digital Computer, Microprocessor, Microcomputer, Microcontroller, Van Neumann and Harvard Architecture, CISC and RISC Processors	**02**	5
2	**8085 Microprocessor:** Architectural Block Diagram, Schematic and Pin diagrams, Pin functions, Bus Organization, Internal operations and registers, Externally initiated operations, Serial interrupt and I/O Control, Timing and Control Unit ,Microprocessor communication, Multiplexing of address/data bus, Generation of control signals, 8085 machine cycles, Fetch and execution of only MOV, MVI, and OUT instructions with timing diagram. (Other 8085 instructions and Programming of assembly language using 8085 should not be covered & asked in the exam)	**06**	10
3	**8051 Microcontroller architecture**: Introduction to MCS -51 Family Micro-controllers, Architectural block Diagram, Pin diagram and Pin Functions, General Purpose and Special Function Registers, Oscillator and clock circuit, Reset circuit, I/O Port circuits, Memory organization, Internal program and data memory.	**08**	10

4	**8051 Assembly language programming:** Programming model of 8051, Addressing modes, programming of 8051 based on data transfer, arithmetic and logical group, branching instructions, bit manipulation instructions and I/O Port programming. Concept of stack, subroutine and related instructions, writing programs for generating time delay, code conversions in assembly language of 8051 and testing the same using IDE.	**08**	15
5	**8051 Programming in C:**Data types in 8051 C, programming for time delay, I/O programming in 8051 C, Logic operations in 8051 C, Control statements and loops in embedded C, Functions and Arrays in embedded C, Data conversion programs in 8051 C, Accessing code ROM space using 8051 C, Data serialization using 8051 C.	**05**	20
6	**8051 Timer/Counter and Programming:** Use of counter as timer, Timer/Counters and associated registers, Various modes of timer/counter operations, Time delay programs in Assembly language/ Embedded C	**04**	
7	**8051 Serial Port and Programming:** Basics of serial communication, RS232 standards, 8051 connection to RS232, Serial data input/output and associated registers, Various modes of serial data communication, serial data communication programs in Assembly language/ Embedded C	**04**	10
8	**8051 Interrupts:** Concept of Interrupt, interrupt versus polling, Types of interrupts in 8051, Reset, interrupt control and associated registers, interrupt vectors, Interrupt execution, RETI instruction, software generated interrupt, interrupt handler subroutine for timer/counter and serial data transmission/reception in Assembly language/ Embedded C ,	**04**	30
9	**External Memory Interfacing:** Memory address decoding, interfacing 8031/8051 with ROM/EPROM and Data ROM	**02**	
10	**Applications and design of microcontroller based systems:** Interfacing of LEDs, 7 Segment display device, LCD display, DIP Switches, Push Button switches, Key denounce techniques, Keyboard connections load per key and matrix form, Interfacing A/D converter, D/A converter, Relay, opto isolator stepper motor and DC motor.	**09**	
11	**ARM Processor Fundamentals:** Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts and Vector Table, Core Extensions, Architecture Revisions, Arm Processor Families	**04**	

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**30**	**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. Microprocessor Architecture, Programming, and Applications with the 8085, By Romesh Gaonkar, Penram International Publishing (India) LTD.
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2/e by Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay (Second Edition , Pearson Education)
3. The 8051 Microcontroller & Embedded Systems using Assembly and C By K. J. Ayala, D. V. Gadre (Cengage Learning , India Edition).
4. ARM System Developer's Guide, Designing & Optimizing System Software, by Andrew Sloss, Dominic Symes, Chris Wright, Elsevier Publications.

Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Describe 8085 microprocessor and microcontroller architecture of MCS-51 family.	
CO-2	Develop assembly language/ embedded C- language code for a given problem	
CO-3	Configure a given microcontroller/ microprocessor based system for timer-counter/serial communication/interrupt operation in assembly/embedded C	
CO-4	Interface appropriate peripheral devices, memory with microcontroller for given application/problem	

Suggested List of Experiments:

1. Introduction to IDE, assembler, compiler, linker, simulator, debugger and assembler directives.
2. 8051 Assembly language programming based on data transfer, arithmetic and logical group instructions.
3. 8051 Assembly language programming using bit manipulation instructions.
4. 8051 Assembly language programming using branching group instructions
5. 8051 Timer/counter programming using assembly language and C
6. 8051 Serial programming using assembly and embedded C.
7. I/O port programming in embedded C.
8. Programming of LCD in assembly & embedded C.
9. Programming of matrix keyboard in assembly & embedded C.
10. Programming of parallel ADC and DAC in embedded C.
11. Interfacing Stepper Motor.
12. Speed Control of DC motor using PWM Technique and Microcontroller
13. Designing of SCR firing Circuit for D. C. Converter using Microcontroller
14. Interfacing Relay and opto isolators using Microcontroller

Additional experiments using ARM boards are suggested as they would be beneficial to students for project development in final year (Refer NPTEL course based on 'Embedded system design using ARM' Link:https://nptel.ac.in/courses/106/105/106105193/)

1. Interfacing of LM35 temperature sensor with STM32F401 Nucleo board
2. Interfacing of electric bulb with STM32 through SRD-05DC-SL-C relay
3. Speed control of DC motor using STM32
4. Interface relay, speaker, LDR, LM35 to the STM32 board.
5. Interfacing of SIM900A GSM module with STM32
6. Design of home automation system using STM32
7. Design of simple alarm system using touch sensor with STM32

Major Equipment: Kit for Microcontroller 8051, µVISION2/3/4 IDE, STM32F401 Nucelo Development Board

List of Open Source Software/learning website: NPTEL, www.infineon.com, www.silabs.com

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160915

Semester – VI
Subject Name: Electrical Measurements and Measuring Instruments

Type of course: Professional Core Course

Prerequisite: NA

Rationale: Electrical installations ranging from residential consumers to huge industrial estates all are equipped with measuring instruments. In view of this, study of principles of Electrical measurements and measuring instruments becomes mandatory for all electrical engineers. This subject deals with principles of measurements, analog and measuring instruments as well as transducers.

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	**Concepts of Measurement :** Measurement System, Classification of instrument system, Methods of Measurement, Static Characteristics like accuracy, precision, sensitivity, linearity, range, reproduciblity, drift, threshold, dead zone etc. Dynamic Characteristics like speed of response, fidelity overshoot etc., Measurement Standards Errors in measurement, Basic statistical evaluation of measurement data and errors - mean, standard deviation, Six sigma estimation.	**06**
2	**Transducers and Sensors :** Definition, different types of transducers, criteria for selection, general characteristics and dynamic characteristics, transducers for measurement of temperature ((Thermocouple and RTD), transducers for measurement of pressure, strain, transducers for measurement of displacement, speed, torque, Hall Effect transducer Sensors – basic concept – Speed and position sensors	**10**
3	**Measurement of Parameters :** Measurement of resistance, , Extending the range of meters - Shunts, Potential divider, Instrument Transformer and their applications in the extension of instrument range, Measurement of voltage, current, power, energy, power factor and frequency (constructions and operating principles of corresponding instruments)	**10**
4	**Measurement of R, L and C :** Different methods of measuring low, medium and high resistances, Wheatstone Bridge,	**10**

	Measurement of inductance & capacitance with the help of AC Bridges (Hays Bridge, Schering Bridge, Maxwell bridge, Anderson Bridge), LCR meter - working principle with block diagram	
5	**D.S.O. :** Digital recorders, Digital Storage Oscilloscope - Block Diagram, theory and applications, Power scope.	**03**
6	**Display devices:** Characteristics of digital display, DVM and Digital multi meter, Clamp on meter, Megger.	**03**

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. Gupta J. B., "A Course in Electronics and Electrical Measurements and Instrumentation", S.K. Kataria & Sons
2. A.K.Sawhney, "Electrical and Electronic Measurements and Instrumentation", DHANPAT RAI & CO.
3. Golding & Widis, 'Electrical Measurement and Measurement instrument', Wheelar Books
4. D. Patranabis, 'Sensors & Transducers', PHI.
5. H. S. Kalsi, " Electronic Instrumentation", Tata McGraw-Hill Education.
6. A.J. Bouwens, 'Digital Instrumentation', Tata Mc-Graw hill.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Comprehend the basics of electrical measurements.	20
CO-2	Explain basic principle, working, characteristics and applications of the various measuring instruments and transducers.	40

CO-3	Apply AC and DC bridges for measurement of electrical parameters like resistance, inductance and capacitance.	20
CO-4	Prepare the specifications of required measurement systems to be used for measurement of parameters for a specified application.	20

List of Experiments:

- To measure value of unknown capacitance by Schearing's bridge.
- To measure unknown inductance by & demonstrate operation of Maxwell's bridge.
- To demonstrate distance measurement using LVDT.
- To demonstrate the Kelvin Double Bridge for Low resistance measurement.
- To measure value of unknown capacitance by Owen's bridge.
- To measure value of unknown inductance using LCR meter.
- To measure high resistance and insulation resistance using Megger.
- To demonstrate usage of DSO for steady state periodic waveforms produced by a function generator.
- To measure value of unknown capacitance using LCR meter.
- Measurement of current using shunt.

Major Equipment:

Necessary number of 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 instruments should be provided for better understanding.

List of Open Source Software/learning website:
- http://www.scilab.org/
- http://www.vlab.co.in/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160916
Semester – VI
Subject Name: Energy Conservation

Type of course: Professional Elective Course

Prerequisite: Fundamentals of power systems, electrical machines and power electronics.

Rationale: The course provides basic understanding of energy audit and management. The consumption of energy is increasing day by day. One way to cope up with the increase in energy demand is to increase the production of energy which demands more investment and the other way is to conserve the energy because energy conserved/saved is energy generated. Energy conservation means reduction in energy consumption but not compromising with the quality or quantity of energy production. Essential theoretical and practical knowledge about the concept of energy conservation, energy management, different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit and measuring instruments in commercial and industrial sector will be achieved by this course.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1.	**Energy Audit Methodology and recent trends.** General Philosophy, need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy, Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS, Case-studies / Report studies of Energy Audits, Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations, Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.	**10**
2.	**Electrical Distribution and Utilization:** Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient	**11**

	motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Case Studies related to Power factor improvement, Electric motors, Drives, Industrial/Commercial Lighting system, etc. with respect to energy conservation	
3. \	**Thermal Systems:** Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- it's limitations and constraints. Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controls, waste heat recovering options, Furnaces refractory- types and sections. Thermic Fluid heaters, need and applications, Heat recovery and its limitations. Insulators- Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria. Steam Utilization Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery.	**11**
4.	**System Audit of Mechanical Utilities:** Pumps: types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. Blowers: types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors: types & applications, specific power consumption, compressed air system & economics of system changes. Energy Saving in Compressors & Compressed Air Systems Cooling towers: types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers . Case Studies of Energy Audit & Management in Industries	**10**

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
15	30	30	15	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. Energy Audit and Management, Volume-I, IECC Press

2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
4. Energy Management Principles, C.B.Smith, Pergamon Press
5. Industrial Energy Conservation, D.A. Reay, Pergammon Press
6. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
7. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
8. Hand Book of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press

Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate the basic knowledge of energy audit and management.	**20**
CO-2	Identify the energy conservation opportunities	**15**
CO-3	Assess the energy saving & conservation in different electric system	**25**
CO-4	Analyze the heat utilization, saving and recovery in different thermal system	**25**
CO-5	Prepare energy audit report.	**15**

List of Experiments: Not Applicable

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://beeindia.gov.in/
http://nptel.ac.in/
https://lbre.stanford.edu/sem/energy_conservation

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160917
Semester – VI
Subject Name: Wind And Solar Energy

Type of course: Professional Elective Course

Prerequisite: Fundamental knowledge of electrical machines and power electronics

Rationale: This subject is offered to emphasize the role of renewable energy technologies (especially wind and solar energy) and their potentials. The course aims to introduce the basic concepts of wind and solar energy and the preliminary analysis to estimate the energy generation from the wind and solar systems. Various components involved in the wind and solar system are covered and the control approaches to improve the performance of the systems are also included. In addition to the various applications of solar and wind energy generation systems, the course also covers the issues related to the integration of these systems in the existing network. Thus, the course is intended to provide the foundation for the solar PV and thermal as well as wind energy generation systems.

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	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Module 1: Physics of Wind Power** History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.	4
2	**Module 2: Wind generator topologies** Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converter, Generator-Converter configurations, Converter Control.	11
3	**Module 3: The Solar Resource** Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.	3
4	**Module 4: Solar photovoltaic** Solar Cell fundamentals, Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array; Power Electronic Converters for Solar	11

	Systems, Maximum Power Point Tracking (MPPT) algorithms, Converter Control, Solar PV applications, Grid-Connected System and Standalone system, Solar Water Pumps, Solar street lights, Battery sizing	
5	**Module 5: Network Integration Issues** Overview of grid code technical requirements, Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances, Power quality issues, Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems	**8**
6	**Module 6: Solar thermal Systems** Solar Collectors, Solar water heater, Solar Passive Heating and Cooling Systems, Solar Cookers, Solar Refrigeration and Air Conditioning, Solar thermal power generation technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.	**5**

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
15	**30**	**25**	**15**	**10**	**5**

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. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. S. P. Sukhatme and J.K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 3rd ed., 2008.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.
7. B.H. Khan, "Non-Conventional Energy Resources", McGraw Hill 2nd Edition 2017.
8. G.D. Rai, "Non-Conventional Sources of Energy", Khanna Publishers, 4th Edition, 2009

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160917

Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate the importance of renewable energy source and various applications of solar and wind systems	**20**
CO-2	Do the preliminary analysis related to wind energy systems	**15**
CO-3	Do the preliminary analysis and design of solar PV and solar thermal systems	**30**
CO-4	Identify the power electronic converters for solar PV and wind energy systems	**20**
CO-5	Describe the issues related to the renewable energy in the electrical utility network	**15**

List of Experiments: Not Applicable

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://nptel.ac.in

http://web.mit.edu/renewable-iap09

https://www.digimat.in/index.html

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160918

Semester – VI
Subject Name: Element of Electrical Design

Type of course: Professional Elective Course

Prerequisite: NA

Rationale: This course is a preliminary course for design of various electrical equipments. The aim is to provide the basic principles useful for the subjects related to design in subsequent semesters. The course also includes basics of estimation and costing of house wirings and commercial wirings.

Teaching and Examination Scheme:

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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	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**GENERAL DESIGN ASPECTS:** Basic principles of magnetic circuits – use of B-H curves in magnetic circuit; Calculationsof MMF for air gap and teeth; Real and apparent flux density; Field Form; Air gap flux distribution factor (field form factor); Magnetizing current calculation; Leakage Reactance calculation for various types of slots, Iron loss calculation concepts; Application of FEM in calculation of force, torque, potential distribution and magnetic flux density; Insulating Materials & Classifications.	**10**
2	**DESIGN OF STARTERS AND FIELD REGULATORS:** Introduction and review of A.C. and D.C. starters; Schematic diagrams of control circuit and power circuit for starters with contactors and timers. Design of starters and Field regulators. **DESIGN OF SMALL TRANSFORMERS AND CHOKE COILS:** Design of Small single-phase transformers; Design of variable air gap single phase and three phase choke coil.	**08**
3	**Armature Windings:** **DC windings :** Simplex & Duplex windings; Lap & Wave windings; Applications; Basic terms related to armature windings; Dummy Coils; Equalizer connections; Split coils. **AC windings :**	**08**

	Introduction; No. of phases; Phase spread; Concentric winding, Hemitropic winding; Whole coil winding; Mush winding; Double layer windings; Integral slot lap and wave winding; Fractional slot lap and wave windings; Performance analysis of various windings.	
4	**Estimation and Costing for Residential and Commercial wiring:** Preparation of schematic diagrams and estimation of cost of wiring for Tenaments, Row houses, Bungalows, Flats, Multi – Storied Buildings, Commercial Complexes like Offices, Hospitals, Hotels,Theatres.	**08**
5	**Design consideration of Electrical Installation:** Types of load, Electrical Supply Systems, Wiring systems, Load Assessment, Permissible voltage drops & Conductor size calculations, Design of Control panel. Estimation and costing for service connections.	**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
20	**20**	**20**	**10**	**0**	**0**

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

(Question paper should include 40 to 60% numerical problems based on design or analysis)

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. A course in electrical machine Design – A. K. Sawhney
2. Electrical Machine Design – R. K. Agrawal
3. Design of Electrical Machine - V. N. Mittle
4. Elements of Electrical Design – J G Jamnani.
5. Electrical Design, Estimating and Costing – K. B. Raina
6. Residential, Commercial and Industrial Systems – H. Joshi
7. Principles of Electromagnetics, 6th edition – Matthew N. O. Sadiku & S. V. Kulkarni
8. Finite Element Analysis of Electrical Machines – Sheppard J Salon (chapter-6)

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain the basic principles of electrical machine design with relevant applications	20%

CO-2	Design the electrical equipments like small transformers, choke coils, starters and field regulators	20%
CO-3	Develop the winding diagrams for AC and DC machines as per specifications	20%
CO-4	Compute the cost of wiring for residential and commercial premises	20%
CO-5	Design the supply systems for residential and industrial applications	20%

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160919
Semester – VI
Subject Name: Electric Drives

Type of course: Professional Elective Course

Prerequisite: Electrical Machine and Power Electronics

Rationale: Today's industrial and domestic loads demands precise and smooth variable speed control. In the era of renewable energy and electric vehicle the efficient electric drive required for DC and AC motors. The major industrial electric load is induction motor. The development of compact power converters has made this possible. This course enables to develop the basics of electric drives and advantage over conventional speed control methods.

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	**Module 1. DC motor characteristics:** Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation.	5
2	**Module 2 Chopper fed DC drive** Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.	5
3	**Module 3: Multi-quadrant DC drive** Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.	6
4	**Module 4 Closed-loop control of DC Drive** Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller	6

	specification and design, speed controller specification and design.	
5	**Module 5 Induction motor characteristics** Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.	**6**
6	**Module 6 Scalar control or constant V/f control of induction motor** Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.	**6**
7	**Module 7 Control of slip ring induction motor** Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.	**6**

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
15	**30**	**20**	**25**	**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. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989.
2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall, 2001.
3. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press, 2002.
4. W. Leonhard, "Control of Electric Drives", Springer Science & Business Media, 2001.
5. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education
6. Vedam Subrahmanyam, "Electric Drives", TMH (I), Second Edition,
7. J.M.D. Murphy and F.G. Turnbull, "Power Electronics Control of AC Motors", Peragmo
8. Theodore Wildi, "Electrical Machines, Drives and Power Systems", sixth edition, Pearson

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160919

Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the characteristics of dc motors and induction motors.	**30**
CO-2	Understand the principles of speed-control of dc motors and induction motors.	**30**
CO-3	Understand the power electronic converters used for dc motor and induction motor speed control.	**30**
CO-4	Compare conventional control and drives control for dc/ac motor.	**10**

List of Experiments:

1. To study the fundamental and block diagram of Electric drive.
2. To study different methods of speed control of D.C. Motor.
3. To study and simulate 1-Φ Semi Control of D.C. separately excited Motor.
4. To study and simulate 1-Φ Fully Controlled converter of separately excited Motor.
5. To study the control techniques used in D.C. chopper.
6. To study control of D.C. motor for (a) Current limit control (b) Closed loop torque control(c) Closed loop speed control.
7. To study chopper control of D.C. Motor for motoring and generating control.
8. To study D.C. Motor drive using PLL.
9. To study and simulate AC voltage controller based speed control of AC motor.
10. To study and simulate v/f speed control of Induction motor.

11. To study and simulate Cycloconverter based speed control of synchronous motor.
12. To study Induction Motor drive with slip power recovery scheme

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160920
Semester – VI
Subject Name: Inter Connected Power System

Type of course: Professional Elective Course

Prerequisite: Power Systems-I and Power Systems-II

Rationale: This subject is offered to study of behavior of power systems during normal operating conditions and/or when subjected to disturbances by mathematical modeling of components of power systems. It also briefs the students about the modeling of power systems networks for steady state analysis. They will also learn the economic operation and planning of power system network and also use the knowledge for the selection of components like Circuit Breaker for Power system protection.

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	**Introduction:** Concept of Interconnection, Hierarchical Grid arrangements, Regulatory framework Cascade Tripping, Islanding, Load dispatch centre,	3
2	**Power system matrices** Brief explanation of Graph theory, Primitive Network, Ybus formation methods, Singular transformation method, Direct method, effect of addition and deletion of shunt elements on YBus, Numerical	4
3	**Load flow studies** Introduction, Bus Classifications, formation of Static Load Flow Equations (LFE), Approximate method of solution of LFE, Application of Numerical method for solution of nonlinear algebraic equations - Gauss-Seidel Method, Newton Raphson Method, Fast Decoupled Load Flow Method, Comparison of different methods of solution of load flow equations, Numerical,	12
4	**Economic operation of power systems** Generator operating cost, Economic operation of generators within thermal plant, Optimal operation by co-ordination equation, Penalty factor, Derivation of transmission loss formula (Kron's method), Unit commitment problem solution by dynamic programming, Numerical, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically	08

	Integrated, Purchasing Agency.	
5	**Frequency and voltage control methods** Speed governing mechanism, Mathematical modeling, Adjustment of Governor characteristics, Single area control, Flat frequency control, Selective frequency control, Tie line load bias control, Methods of voltage control, Numerical,	**06**
6	**Power system stability** Introduction, Mechanics of angular motion, The swing Education, transfer reactance, power relations, Steady state stability, Synchronizing power coefficient, Analysis of steady state stability, steady state stability with automatic voltage regulators, concept of shunt fault, transfer reactance during fault, reduction of power system to one machine connected to infinite bus, Transient stability, simplified transient generator model, The equal area stability criterion, solution of swing equation, Numerical	**12**

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
15	**30**	**20**	**25**	**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. Modern Power System Analysis, D. P. Kothari, I. J. Nagrath, Tata McGraw-Hill Education,
2. Power System Analysis and Stability, S.S. Vadhera, Khanna Publication
3. Power System Analysis, Hadi Saadat, Tata McGraw-Hill Education
4. Computer Aided Power System Analysis, G.L. Kusic, © 1986
5. Elements of Power System Analysis by William D. Stevenson McGraw-Hill
6. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
7. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160920

Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Define the actual power system structure scenario and its operating mechanism in a state and country with major entities and their functions	**10**
CO-2	Develop proper mathematical model of transmission network for analysis of power flow study, form Static Load Flow Equations, Select and identify the most appropriate numerical technique Solving SLFE	**25**
CO-3	Demonstrate the methods used for voltage and frequency regulation in electrical power network by mathematical analysis	**20**
CO-4	Solve the Unit Commitment problem using Dynamic programming techniques. Analyze the power system economics and factors effecting the economic load dispatch with and without considering network loss	**20**
CO-5	Demonstrate the factors which determine steady state and transient angle stability. Analyze the same for a single machine/infinite bus system using both analytical and graphical (Equal area) methods. Apply numerical technique for stability study	**25**

List of Experiments:

1. To study the Ybus formation with the help of simple study system
2. To formulate Static Load Flow Equations of few simple sample study systems
3. To obtain solution of some small study system using approximate load flow method
4. To obtain solution of some small study system using G-S method
5. To obtain solution of some small study system using N-R method
6. To obtain solution of a study system using FDLF method
7. To obtain unit commitment of a power plant
8. To obtain economic load dispatch of power plant

9. To obtain economic load dispatch of generators considering transmission losses

10. To apply analysis of various principles of Load Frequency control with the help of numerical problems

11. To apply analysis of various principles of Power system angle stability with the help of numerical problems

12. To determine stability of a small system using numerical method.

Hands-on and computational experiments related to the course contents. This should include programming of numerical methods for solution of the power flow problem, economic load dispatch, Load frequency control and stability analysis.

Visit to load dispatch centre is suggested

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160921
Semester – VI
Subject Name: HVDC Transmission Systems

Type of course: Professional Elective Course

Prerequisite: Electrical Power system I and II. The knowledge of Power Electronics I and II is additionally required.

Rationale: This subject is offered at higher UG level to study the various operating as well as configurational aspects of HVDC transmission system. The control strategy for frequency and voltage regulation in DC link is covered in detail for interconnected HVDC system. It also presents the power system stability and fault analysis. Students will be able to enhance their learning domain by distinguishing the requirement of HVDC system over HVAC system. They will also learn the components used and role of power electronics involved for regulating the voltage angle and frequency for power flow and interconnection.

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	**HVDC Transmission: The State of Art** Introduction, Historical Developments, Comparison of AC and DC Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission, Types of HVDC Systems, Limitations of HVDC Transmission lines, Components of a HVDC system, Line Commutated Converter and Voltage Source Converter based HVDC Systems.	06
2	**Analysis of Line Commutated Converters** Line Commutated Converters (LCCs): Basic Principal of three-phase AC–DC Conversion, six pulse converter operation, Effect of Delaying the Firing Instant, The Commutation Process, Analysis of the Commutation Circuit, Analysis neglecting commutation overlap, Rectifier Operation, Inverter Operation, Power Factor and Reactive Power, Characteristic Harmonics, DC Side Harmonics, AC Side Harmonics, Twelve Pulse Converters operation, AC/DC side voltage and current waveforms, Expressions for average dc voltage.	08

3	**Voltage Source Converters (VSCs)** VSC Operating Principle, PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation, PWM Carrier-Based Implementation, Naturally Sampled PWM, Uniformly Sampled PWM, Equation in rotating reference frame, Real and Reactive power control using a VSC.	**04**
4	**Control of HVDC Converters and System** Principles of DC Link Control in a LCC HVDC System. Control Hierarchy, Firing Angle Control, Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a DC Link. Higher level Controllers, Power control, Frequency Control, Reactive Power Control, Principles of DC Link Control in a VSC based HVDC system: Power flow and dc voltage control. Reactive Power Control / AC voltage regulation using VSC.	**10**
5	**Components of HVDC Systems** Smoothing Reactors, Reactive Power Sources and Filters in LCC HVDC systems DC line: Corona Effects, Insulators and Transient Over-voltages. DC line faults in LCC systems. DC line faults in VSC systems, dc breakers, Mono-polar Operation. Ground Electrodes.	**08**
6	**Stability Enhancement Using HVDC Control** Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/DC systems.	**04**
7	**Multi Terminal HVDC System** Introduction, Types of Multi-terminal HVDC System, Parallel Operation of HVDC, Control of Power in MTDC, Disconnecting of units or converters, Modern Trends in HVDC Technology. Introduction to Modular Multi-level Converters.	**04**

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
15	**30**	**20**	**25**	**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. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley- Inder-science, 1971.
4. Vijay K Sood, "HVDC and FACTS Controller" Springer Publication, 2004.
5. S Kamakshaiah and V Kamaraju, "HVDC Transmission" TMH Publications, 2011.
6. M. H Rashid, "Power Electronics Handbook" Academic Press, 2001.

Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the advantages of dc transmission over ac transmission.	**10**
CO-2	Analysis of Line Commutated Converters and Voltage Source Converters in HVDC Transmission System.	**35**
CO-3	Application of suitable control strategies used for LCC and VSC based HVDC transmission system.	**25**
CO-4	Evaluation of Power system angular, voltage and frequency stability using simulation models for various configuration of an HVDC system.	**30**

List of Experiments: Suggested List (But not the least)

1. Study of various HVDC transmission system components and its applications.
2. Study of AC/DC side voltage and current waveforms of six pulse converter system under variable R-L Load using simulation. (Hint: input PF, THD, converter efficiency, reactive power flow etc).
3. Study of AC/DC side voltage and current waveforms of twelve pulse converter system under variable R-L Load using simulation. (Hint: input PF, THD, converter efficiency, reactive power flow etc).
4. Study of reactive power control in HVDC transmission system.
5. Study of various types of Multi terminal HVDC transmission system.
6. Some simulation practices based on HVDC power and voltage stability.
7. Study of DC link control in VSC based HVDC transmission system.
8. Study of various passive filters used in LCC based HVDC transmission system.
9. Operation of VSC for power factor correction at AC side of HVDC system using sinusoidal pulse width modulation.

The above practical list is based on model syllabus. However, Hands-on MATLAB simulation based models related to the course contents can be carried out. It can include modeling of power electronics based switching devices used for rectification and inversion procedure in HVDC transmission system. The coupling of two asynchronous systems can also be modeled for power flow and frequency control analysis.

Note**: Visit to HVDC Transmission Substation is encouraged near Chandrapur–Padghe, Maharastra.

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://nptel.ac.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160922
Semester – VI
Subject Name: Object Oriented Programming

Type of course: Open Elective

Prerequisite: Basic Programming Concepts

Rationale: This course is an introductory course in Object Oriented Programming (OOP). The fundamental concepts of OOP will be studied using the C++ programming language. OOP has become a fundamental part of software development. OOP facilitates reuse of code, flexibility and effective problem solving. This course introduces standard tools and techniques for software development, using object oriented approach.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**OOP Concepts** : Introduction OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Applications of OOP	2
2	**Expression and Statements** : Data types, Expression, control statements and Iteration, typecasting	3
3	**Arrays and Functions** : 1D and 2D arrays, passing data to functions, scope and visibility of variables in functions, inline function, default arguments	5
4	**Classes** : Basics of object and class in C++, access specifiers - private and public members, static data members, class scope, constructors and their types, destructors, operator overloading, scope operator,	6
5	**Overloading** : Function overloading, Operator overloading, Type conversion	3
6	**Inheritance** : Concept of Inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members, overriding,	4
7	**Exception Handling :** Introduction to exception, try-catch-throw, multiple catch, catch all, rethrowing exception, implementing user defined exceptions	2
8	**I/O and File management** : Concept of streams, cin and cout objects, C++ stream classes, Unformatted and formatted I/O, manipulators, File stream,	3

Reference Books:

1 Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia
2 The Compete Reference C++, Herbert Schlitz, TMH
3 Object Oriented Programming With C++, E Balagurusamy, TMH
4 C++ Programming, Black Book, Steven Holzner, dreamtech
5 C++ Primer Stanley B Lippman, Josée Lajoie, Barbara E. Moo

Course Outcomes (CO):

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3160922

Sr. No.	CO statement	Marks % weightage
1	Understand Object Oriented Programming concepts and basic characteristics of C++	**20**
2	Differentiate between object oriented and procedure-oriented methodology.	**10**
3	Understand the concept of function and overloading	**20**
4	Know the principles of data encapsulation, inheritance, polymorphism, access specifiers, exceptions	**35**
5	Know the concept of streams	**15**

List of Experiments:

1.	Write a program that will allow computer to be used as an ordinary calculator. Consider only common arithmetic operations.(+, -, *, /) The program should display a menu showing the different options available. Do using if and also using switch statements.
2.	Write a program to arrange an array of N elements into ascending order
3.	Write a program to demonstrate the use of Scope Resolution Operator:: with variable name.
4.	Write a program to demonstrate the use of Manipulators (setw () and endl).
5.	Write a program which calculates volume of cube, cylinder, and rectangular box. (Use function overloading).
6.	Create a class SPACE having three member data x(int),y(int),z(int).overload the unary '-' operator for the class SPACE.
7.	Create a class Box whose default constructor initializes the dimensions length, width and height of the box. The main method is to be created for the above class that creates a Box object of dimension 3.89 cm, 2.1 cm and 1.5 cm. compute the volume of this box.
8.	Write a program to create a copy constructor. A constructor should be created, then a second constructor should be created which should have values of the previous constructor.
9.	Write a simple program that multiplies two numbers and then also divides the two numbers.(Use Inline Functions)
10.	Create a class called ITEM that has separate member data for item number(int) and item cost(float).Include the following member functions: • setdata( )to set these values to predefined values in the program • getdata( )to get these values from the user • putdata( ) to display these values.
11.	Write a program to demonstrate the use of static member data and static member function.
12.	Define a class to represent a bank account. include the following members: **Data members :** 1) name of the depositor 2) account number 3) type of account 4) balance amount in the account **Member functions:** 1) to assign initial value 2) to deposite an amount 3) to withdraw an amount after checking the balance 4) to display name and balance Write a main function to test the program.
13.	Implement Student class having proper member variables and functions for the following : • To input marks of 5 subjects. • Check whether or not student is pass. (above 40 marks is required to pass) • Check grade of student

	If percentage is >=70 then A grade >=60 and <70 then B grade >=50 and <60 then C grade >=40 then D grade • Display whole result of a given student Write main program to create such, n objects for n students and enter information for all students. Write a function to display information of all students who are PASS. Write a function to display information of those students who are FAIL. Also write a function to Display information of first 3 ranker students.
14.	Implement a string class containing the following functions. • Overloaded + operator function to carry out the concatenation of strings. • Overloaded = (assignment) operator function to carry out string copy. • Function to display the length of a string. • Function to overload comparison operator (= =) for two strings.
15.	Assume that a bank maintains two kinds of accounts for customers, one called as savings account and the other as current account. The savings account provides compound interest and withdrawal facilities but no cheque book facility. The current account provides cheque book facility but no interest. Current account holders should also maintain a minimum balance and if the balance falls below this level, a service charge is imposed. Create a class account that stores customer name, account number and type of account. From this derive the classes cur_acct and sav_acct to make them more specific to their requirements. Include necessary member functions in order to achieve the following tasks: • Accept deposit from a customer and update the balance. • Display the balance. • Compute and deposit interest. • Permit withdrawal and update the balance. • Check for the minimum balance, impose penalty, necessary, and update the balance.
16.	Create a class called TIME that has separate member data for hour(int) and minutes(int). Include the following member functions: • setdata( )to set these values to predefined values in the program • getdata( )to get these values from the user • putdata( ) to display these values. • add_time( ) to add two time objects to a third time object (e.g. T3.add_time(T1,T2). • Make new function to return a time object after addition of object passed as argument with the calling object, so that the function works as follows: T3=T1.add_time(T2).
17.	Write a program with the following: • A function to read two double type numbers from keybord. • A function to calculate divison of these two numbers. • A try block to throw an exception when a wrong type of data is keyed in . • A try block to detect and throw an exception if the condition “divide by zero ” occurs. • Appropriate catch block to handle the exception thrown.
18.	WAP in c++ to convert lowercase to uppercase from a file.