Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Electrical Engineering **Semester-VI**

A) Course Code : 2024671(024)

B) Course Title : Utilization of Electrical Energy and Traction

C) Pre-requisite Course Code and Title : Power Electronics, DC machines and Transformers, A.C. Rotating Machines

D) Rationale :

This course is designed to introduce the students to the concepts, principles and applications related to the utilization of electrical energy. The course will enable the students to know the different types utilization aspects of electrical energy with special emphasis on electric traction. The students will understand the current and future trends in electric tractions, control of traction motors and the related auxiliary equipment's in electrical locomotive. The students will also acquire knowledge on different lighting and welding system used in domestic and Industrial applications.

E) Course Outcomes:

CO-1 Maintain electrical drives used in industries.

CO-2 Select heating and welding scheme for a given application.

CO-3 Troubleshoot various lamps and fittings in use.

CO-4 Determine track electrification system for the given requirements.

CO-5 Estimate energy consumption of the various traction schemes.

F) Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)					
			L	P	T	SL	Total Study Hours (L+P+T+SL)	Total Credits (L+T+P/2)
Electrical Engineering	2024671 (024)	Utilization of Electrical Energy and Traction	3	-	1	1	7	4
	2024661 (024)	Utilization of Electrical Energy and Traction (Lab)	-	2	-	-	-	1

Lecture (L) L Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.)

Practical (P) Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Tutorial Includes sessional work (SW) (assignment, seminar, mini project etc),

Self-Learning (SL) includes self-study, group study and learning from subject teacher or use of multi media

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Title	Scheme of Examinations					
			Theory			Practical		Total Marks
			ESE	CT	TA	ESE	TA	
Electrical Engineering	2024671 (024)	Utilization of Electrical Energy and Traction	70	20	30	-	-	120
	2024661 (024)	Utilization of Electrical Energy and Traction (Lab)	-	-	-	40	60	100

Legend:

ESE: End semester exam CT: Class Test TA: Teachers Assessment
PRA: Process Assessment, PDA: Product Assessment

Note:

i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30 % weightage of total respectively.
ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.
iii. Minimum two experiment from each unit is mandatory.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Maintain electrical drives used in industries.

(Approx. Hrs:CI+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Identify given types of drives. SO1.2 Use suitable drives for given load. SO1.3 Use suitable frame size, rating of motors and drive for given load.	LE1.1 Identify the different drives used in material handling system. LE1.2 Determine Torque / speed and Torque / current characteristics of DC motor. LE1.3 Determine Torque / speed and Torque / current characteristics of three phase induction motor. LE1.4 Test the temperature rise and the steady state value for a given motor for under rated loading condition.	**Unit1.0 Electrical Drives** 1.1 Types of electrical drives 1.2 Motors used for electrical drives;DC series, shunt and separately excited motors, Induction Motor 1.3 Selection of Electrical motors. 1.4 Torque / speed and torque / current characteristics of DC series, shunt and separately excitedmotors, characteristics of threephase induction motors. 1.5 Heating and Cooling of electrical motors – Heating and cooling curves, insulating materials. 1.6 Size and rating of motors-standard ratings of motors, classes of duty, ambient temperature and ratings, ambient temperature and ratings, motors used for different types of applications, temperature rise with short time ratings. 1.7 Types of load: Classification of loads with respect to time,	• Use of flywheels. • Methods employed for the reduction of noise in a drive. • Need of load equalization.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
		classification of loads with respect to duty cycles. Enclosures for rotating electrical machines.	

SW-1 Suggested Sessional Work (SW):

- Assignments:
  i. Classify the drives based on (a) their operations and (b) their applications.
  ii. State the types of loads for which drives are needed.
- **Mini Project:**
  i. Make a report of at least five domestic/ commercial applications of drives.
  ii. Make a report on the methods of plugging for the following motors (a) D.C Shunt motor (b) D.C Series motor (c) Induction motor.
- **Other Activities (Specify):**
  i. Write the criteria to select the suitable motors for the following drives (A) Steel Mills (B) Sugar Mills (C) Flour Mills (D) Cranes (E) Lifts And Hoists (F) Lathes (G) Drill And Grinding Machines (H) Pump Sets (I) Punches And Presses (J) Wood Working Machines (K) Printing (L) Belt Conveyor (M) Textile Mills (N) Paper Mills (O) Rolling Mills (P) Ship Propulsion (Q) Mines (R) Cement Works.
  ii. Interpret the complete specification plate of an induction motor and develop a chart.

CO-2 Select heating and welding scheme for a given application.

(Approx. Hrs: CI+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Use basic knowledge of modes of heat transfer. SO2.2 Explain the nature of variation of resistance welding with arc welding. SO2.3 Compare the nature of variation between AC and DC welding.	LE2.1 Compare the various types of supply required for different types of welding. LE2.2 Investigate the various electronic circuits used in welding. LE2.3 Draw the characteristics of a welding generator. LE2.4 Draw the basic circuit for electric arc furnace showing the arrangements of OCBs, Control panels, CTs through relays, furnace transformer and arrangement of electrode movement.	**Unit2.0 Electric Heating and Welding** 2.1 Advantages of Electrical heating. 2.2 Essential Requirements of a good heating element, materials of heating element, causes of failure of heating element. 2.3 Methods of electric heating – resistance heating, arc heating, high frequency heating, induction heating, dielectric heating. 2.4 Types of resistance welding, choice of welding time, electric arc welding, Types of welding electrodes, 2.5 Welding transformers and rectifiers.	• List the applications of direct arc furnaces in industries. • List the industrial applications of core type, coreless type and high frequency type furnaces. • List the conditions for successful welding. • Explain the 'sequence weld' with a block diagram.

SW-2 Suggested Sessional Work (SW):

- **Assignments:**
  i. Enumerate the safety precautions to be taken in the process of welding.
  ii. Prepare a short note on the welding of aluminum and copper material.

- **Mini Project:**
  i. Visit a site/plant having arc furnace and make a report on its construction and working principles.
- **Other Activities (Specify):**
  i. Make a report on heating principle and applications of microwave heating.
  ii. Draw automatic temperature control circuits for (coolers, greasers, air conditioners, and iron boxes).

CO-3 Troubleshoot various lamps and fittings in use.

(Approx. Hrs: CI+ LI+SW+SL=19)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain the various metals like carbon, osmium, tantalum and tungsten used for making the filaments. SO3.2 Describe the working of high pressure sodium vapour lamps and low pressure sodium vapour lamps. SO3.3 Explain the nature of variation between the performances of two given types of lamp. SO3.4 State the various principles of light control.	LE3.1 Draw automatic illumination control circuits using LDR's. LE3.2 Measure intensity of light with lux-meterfor various types of illuminating lamps. LE3.3 Draw the circuit diagram of a lighting of a two wheeler. LE3.4 Draw the circuit diagram of a lighting of a four wheeler.	**Unit3.0 Illumination** 3.1 Introduction: Terms used in illumination, laws of illumination. 3.2 Types of sources of illumination - Electric arc, incandescent, gaseous discharge, fluorescent. 3.3 Arc lamps, incandescent lamps, laser, LED, neon, Tungsten-Halogen and Sodium Vapour lamps, Fluorescent lamps. 3.4 Types of lighting schemes: direct, semi direct, Semi-indirect, Indirect lighting and general lighting schemes. 3.5 General ideas about street lighting, factory lighting and flood lighting.	• State the advantages of power saving devices. • List the advantages of remote operated power utility devices like TV, fans and lamps. • State the principles of energy efficient systems.

SW-3 Suggested Sectional Work (SW):

- **Assignments:**
  i. Make a report on LED lights and compare the performance of it with ordinary lamps.
  ii. Make a report on the different types of light fixtures used in present scenario.
- **Mini Project:**
  i. Calculate the number of light points for interior illumination of an area 20 m × 10m × 3m and determine illumination at different points.
  ii. Design a simple lighting scheme for (a) Drawing halls (b) Flood lights of a football stadium.
- **Other Activities (Specify):**
  i. Measure Illumination at different places in college by luxmeter.
  ii. Enumerate the considerations involved in simple lighting design of a room (absence of glare, contrast and shadow, etc)
  iii. Explain the principle of operation of starter less tube lights and its usefulness.

CO-4 Determine track electrification system for the given requirements.

(Approx. Hrs: CI+ LI+SW+SL=22)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Compare the advantages and disadvantages of AC and DC traction. SO4.2 Explain the various components in electric traction system. SO4.3 Enlist the advantages of pantograph collector over other types of current collectors in overhead lines. SO4.4 Describe the general power supply arrangements in any one metro system in India. SO4.5 Describe the different traction systems used worldwide.	LE4.1 Investigate the various Electric drives used in traction system in Indian railways. LE4.2 Draw the layout of D.C locomotive and Diesel locomotive. LE4.3 Draw the power diagram of A.C locomotive and its equipment.	**Unit4.0 Electric Traction Drives** 4.1 Requirements of ideal traction system, advantages and disadvantages of electric traction 4.2 System of track electrification – DC system, single phase AC system, three phase AC system, Composite system 4.3 Special mechanical and electrical features of traction motors, current collectors 4.4 Traction motors: DC series, Three phase induction motors 4.5 Types of electric braking: Plugging, Rheostat or Dynamic braking, Regenerative braking.	• Describe the function of current collecting equipment with the help of sketch. • Make a report of current collector of bow and pantograph type current collector. • Investigate the various latest trends in electric traction systems.

SW-4 Suggested Sectional Work (SW):

- **Assignments:**
  i. Prepare a report/ chart on various types of traction systems.
  ii. Prepare a report on A.C /D.C locomotive.
- **Mini Project:**
  i. Make a report on the Kando system (Single phase to three phase system).
- **Other Activities (Specify):**
  i. Prepare a report after visiting nearby electric-traction substation. (otherwise from Internet)
  ii. Explain the principle of various types of motors used in trolley buses and trams.

CO-5 Estimate energy consumption of the various traction schemes.

(Approx. Hrs: CI+ LI+SW+SL=22)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Describe the important features of electric locomotives. SO5.2 Mention the important features of traction motor.	LE5.1 Determine the energy saving by series and parallel control of D.C motors. LE5.2 Calculate tractive power and energy consumption for a basic electric traction system. LE5.3 Calculate the energy	**Unit5.0Other Aspects of Electric Traction** 5.1 Types of service- Main line services, Urban services, suburban services. 5.2 Speed-time and speed distance curves for main line service, suburban service and urban and city	• Explain the purpose and material used for catenary, droppers, trolley wires, bow collector, pantograph

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.3 Describe the various tractive efforts for the propulsion of a locomotive.	recovered during regenerative braking.	service. 5.3 Basic definitions: Crest speed, average speed, schedule speed, schedule time, Factors affecting the schedule speed of a train. 5.4 Factors affecting the schedule speed of a train, Simplified trapezoidal and quadrilateral speed time curves, Tractive effort. 5.5 Specific energy consumption, dead weight, accelerating weight, adhesive weight, coefficient of adhesion, advantages and disadvantages of regenerative braking.	collector. • State the methods of raising and lowering of pantographs. • Explain the various train lighting systems.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sectional Work (SW):

- **Assignments:**
  i. State the need of booster transformer.
  ii. List the various overhead equipment.
- **Mini Project:**
  i. Make a report on the recent energy saving measures used in traction.
  ii. Make a report on typical speed time curve for a suburban and urban service.
- **Other Activities (Specify):**
  i. Make a report on EMUs and Metro locomotives of India.
  ii. Investigate the various traction systems in Indian railways.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Electrical Drives	5	5	4	14
II	Electrical Heating and Welding	6	4	5	14
III	Illumination	6	4	5	14
IV	Electric Traction Drives	5	4	5	14
V	Terminologies in Electric Traction	4	5	5	14
Total		**19**	**25**	**26**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESA of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Identify the different drives used in material handling system.	50	40	10
LE1.2	Determine Torque / speed and Torque / current characteristics of DC motor.	50	40	10
LE 1.3	Determine Torque / speed and Torque / current characteristics of three phase induction motor.	50	40	10
LE 1.4	Test the temperature rise and the steady state value for a given motor for under rated loading condition.	50	40	10
LE2.1	Compare the various types of supply required for different types of welding.	50	40	10
LE2.2	Investigate the various electronic circuits used in welding.	50	40	10
LE2.3	Draw the characteristics of a welding generator.	50	40	10
LE2.4	Draw the basic circuit for electric arc furnace showing the arrangements of OCBs, control panels, CTs through relays, furnace transformer and arrangement of electrode movement.	50	40	10
LE3.1	Draw automatic illumination control circuits using LDR's	50	40	10
LE3.2	Measure intensity of light with lux-meter for various types of illuminating lamps.	50	40	10
LE3.3	Draw the circuit diagram of a lighting of a two wheeler.	50	40	10
LE3.4	Draw the circuit diagram of a lighting of a four wheeler.	50	40	10
LE4.1	Investigate the various Electric drives used in traction system in Indian railways.	50	40	10
LE4.2	Draw the layout of D.C locomotive and Diesel locomotive.	50	40	10
LE4.3	Draw the power diagram of A.C locomotive and its equipment.	50	40	10
LE5.1	Determine the energy saving by series and parallel control of D.C motors.	50	40	10
LE5.2	Calculate tractive power and energy consumption for a basic electric traction system.	50	40	10
LE5.3	Calculate the energy recovered during regenerative braking.	50	40	10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend:PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture Method
2. Tutorial
3. Group Discussion
4. Industrial visits
5. Industrial Training
6. Field Trips
7. Portfolio Based Learning
8. Demonstration
9. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Art and Science of Utilization of Electrical Energy	H. Partap	Dhanpat Rai &Sons, Delhi	Jan. 2017,ISBN 13: 97881477001440
2.	Utilization of Electrical Power and Electric Traction	J. B. Gupta	S.K.Kataria and Sons, 2000.	10th Edition, ISBN: 13: 9789350142226
3.	A Text Book. of Electrical Power	S.L. Uppal	Khanna Publications, Delhi	2009, ISBN :9788174092380
4.	Modern Electric Traction	H. Partap	Dhanpat Rai & Sons, Delhi	2013, ISBN:1234546147206
5.	Generation, Distribution and Utilization of Electrical Power	C. L. Wadhwa	New Age International Publications, New Delhi	4th Edition, ISBN:9781906574765
6.	Generation and Utilization of Electrical Energy	M. Balasubba Reddy, D. Srilatha, S. Sivanagaraju	Pearson Publications	2010 , ISBN: 9788131733325
7.	Utilization of Electrical Power	R. K. Rajput	Laxmi Publication(P) Ltd. New Delhi	2nd Edition, 2016, ISBN :9788131808290
8.	Utilisation of Electric Power: Including Electric Drives and Electric Traction.	N.V, Suryanarayana	New Age International Publication.	2nd Edition, 2014, ISBN: 9788122436815

(b) Open source software and website address:

1. http://www.vssut.ac.in/lecture_notes/lecture 1424084684.pdf
2. http://www.ene.ttu.ee/elektriajamid/oppeinfo/material/AAV0020/4Drives_Lethla.pdf
3. http://ftp.elect.polimi.it/users/massimo.Ghioni/Power%20TO%20Electronics%20/Motor%20control/motor%20control%20overview/INTRODUCTION%20TO%20ELECTRICAL%20Drives.pdf
4. http://www.nptel.ac.in/courses/108105061/Illumination%20%20Engineering/Lesson-05/pdf/L-5(NKK)(IE)%20(EE)(NPTEL).pdf
5. http://www.Irc.rpi.edu/resources/publications/pdf/illuminationfund.pdf
6. http://www.darshan.ac.in/Upload/DIET/Documents/EE/UEET_2160907_CH_7_27012018_042415AM.pdf

(c) Others:

1. Learning Packages
2. BIS standards
3. Manufacturers' Manual
4. User's Guide

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1.	Digital Multimeter	3 ½ Digit Display	LE1.1, LE1.2, LE1.3, LE1.4, LE2.2, LE2.3, LE2.4, LE4.1, LE5.1, LE5.2, LE5.3
2.	Digital Multimeter	4 ½ Digit Display	LE1.1, LE1.2, LE1.3, LE1.4, LE2.2, LE2.3, LE2.4, LE4.1, LE5.1, LE5.2, LE5.3
3.	DC power supply	Voltage 0 to +-10 V Current 0 to +-2 Amp	
4.	DC Voltmeter	i. Range 0-50 V ii. Range 0-100V	LE1.1, LE1.2, LE1.3, LE1.4, LE2.2, LE2.3, LE2.4, LE4.1, LE5.1, LE5.2, LE5.3
5.	DC Ammeter	i. Range 0-2 Amp ii. Range 0-5 Amp	LE1.1, LE1.2, LE1.3, LE1.4, LE2.2, LE2.3, LE2.4, LE4.1, LE5.1, LE5.2, LE5.3
6.	Rheostat	0-200 Ohm, 2.5 Ampere	LE1.1, LE1.2, LE1.3, LE1.4, LE2.2, LE2.3, LE2.4, LE4.1, LE5.1, LE5.2, LE5.3
7.	1 phase inverter	DC supply 12V,7 Ah, Output 230 Volt with fuses for protection from short circuit. Provisions for display of Inverter ON, Low battery voltage. Over load	
8.	Photometer digital Lux meter	Measuring range: 0Lux~200,000Lux/0Fc~185806Fc. Accuracy: +/-3% rdg+/-0.5%f.s. (<10,000Lux), +/-4% rdg+/-10dgs (>10,000Lux).	LE3.2
9.	Three phase transformer	2kVA, 415V / 415 V, 50 Hz, 2.8A	LE2.3, LE2.4
10.	DC motor	1.5 kW,1500 rpm	LE1.2, , LE 4.1
11.	Three phase induction motor	2 H.P, 440V, 1460 rpm, 8A, 50 Hz, Squirrel cage	LE1.1, LE1.3,
12.	Three phase induction motor	5 H.P, 440V, 1460 rpm, 4.2A, 50 Hz, Slip ring cage	LE1.1, LE1.3, LE1.4, LE 4.1
13.	Synchronous motor	5HP, 3-Φ, 415 V, 50 Hz, 6.0 A, 1500 rpm , Excitation-120V DC	LE1.1, LE 4.1
14.	Single phase induction motor	1 HP, 220 V, 50Hz, 1440 rpm	LE1.1, LE1.3

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Maintain electrical drives used in industries.	3	3	3	2	1	1	1	3	2	3	3	2
CO-2 Selectheating and welding scheme for a given application.	2	3	3	3	1	1	1	3	2	3	3	2
CO-3 Troubleshoot various lamps and fittings in use.	3	3	3	3	2	2	1	3	2	3	3	2
CO-4 Determine track electrification system for the given requirements.	3	3	3	3	1	1	1	3	2	3	3	2
CO-5 Estimate energy consumption of the various traction schemes.	3	3	3	3	2	1	1	3	2	3	3	2

Legend:1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-1 Maintain electrical drives used in industries.	SO1.1 SO1.2 SO1.3	LE1.1 LE1.2 LE1.3 LE1.4	Unit-1.0 Electric Drives 1.1 , 1.2, 1.3, 1.4, 1.5.1.6, 1.7	As mentioned
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-2 Selectheating and welding scheme for a given application.	SO2.1 SO2.2 SO2.3	LE2.1 LE2.2 LE2.3 LE2.4	Unit-2.0 Electric heating and welding 2.1, 2.2, 2.3, 2.4,2.5	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-3 Troubleshoot various lamps and fittings in use.	SO3.1 SO3.2 SO3.3 SO3.4	LE3.1 LE3.2 LE3.3 LE3.4	Unit-3.0 Illumination 3.1, 3.2, 3.3, 3.4, 3.5	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-4 Determine track electrification system for the given requirements.	SO4.1 SO4.2 SO4.3 SO4.4	LE4.1 LE4.2 LE4.3	Unit-4.0 Electric traction Drives 4.1, 4.2, 4.3, 4.4, 4.5	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-5 Estimate energy consumption of the various traction schemes.	SO5.1 SO5.2 SO5.3	LE5.1 LE5.2 LE5.3	Unit-5.0 Terminologies in Electric Traction 5.1, 5.2 , 5.3, 5.4, 5.5	

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A) Course Code : 2024672(024)

B) Course Title : Wind and solar Power Technology

C) Pre-requisite Course Code and Title : AC Machines, Power Electronics

D) Rationale :

India is a country where a large number of wind and solargrid connected electric power installations, and competent technicians are needed to maintain these vital renewable energy power plants, and are a dire need of the industry. It is to fulfill this need, that this curriculumhasbeendesignedsothatthediplomaengineerwouldbeabletomaintainthe installations thereby minimizing the downtime. This course will enable the diploma students to acquire essential skills, which will help him/her when he/she starts working in the industry to discharge his role effectively for installation, upkeep and maintenance of small and large solar and wind power plants.

E) Course Outcomes:

CO-1 Use renewable sources of energy.

CO-2 Analyze the working of various components of wind power plants.

CO-3 Maintain wind power plants.

CO-4 Analyze the working of series and parallel connection of PV cells.

CO-5 Implement PV modules with battery for domestic/commercial applications.

F) Scheme of Studies:

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Note:

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CO-1 Use renewable sources of energy.

(Approx.Hrs:CI+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Differentiate between conventional and Non-conventional sources of energy. SO1.2 Classify various renewable energy resources on the basis of the given parameter. SO1.3 State the major features of given Non-conventional energy sources. SO1.4 Describe the advantages of Green power.	LE1.1 Make a list of various non-conventional energy sources with its specifications, available in lab and explain its working using suitable diagram. LE1.2 Enlist applications of various non-conventional energy sources available in lab	**Unit1.0 Renewable Energy Sources** 1.1 Various sources of Energy – Conventional and Non-conventional. 1.2 Importance of Non-Conventional Energy Sources. 1.3 Energy Chain – Energy Flow block diagram from primary energy source to final energy consumption via electrical and non-electrical route. 1.4 Advantages and disadvantages of conventional energy sources. 1.5 Salient features of Non-conventional energy sources. 1.6 Green Power- Definition and advantages.	• Latest trends in various non-conventional energy sources available in the vicinity and technology used.

SW-1 Suggested Sessional Work (SW):

- **Assignments:**
  i. Classify the energy sources based on (a) their origin and (b) their applications.
  ii. Make a survey of non-conventional energy sources available nearby your surroundings.
- **Mini Project:**
  i. Make a report on current power generation through non-conventional energy sources in India.
- **Other Activities (Specify):**
  i. Select a typical non-conventional energy source nearby your area and make a report containing installed capacity, technical features and power generation capacity.
  ii. Prepare power point presentation on present energy scenario and its utility.

CO-2 Analyze the working of various components of wind power plants.

(Approx. Hrs: CI+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain the aerodynamic features of a given wind power plant. SO2.2 Explain the nature of variation of wind speed with height from the ground. SO2.3 Explain the factors responsible for distribution of wind energy on the surface of earth. SO2.4 State the most favorable sites for installation of wind turbines.	LE2.1 List the various parts of a small wind power training system. LE2.2 Dismantle the given small wind turbine and write the name of different parts. LE2.3 Assemble an already dismantled wind turbine and check its proper working.	**Unit2.0Wind Energy** 2.6 Wind Energy - Introduction 2.7 Factors effecting the distribution of wind energy on the surface of earth. 2.8 Variation of wind speed with height-existing formula and related plot 2.9 Estimation of wind energy at a site – Power in wind, empirical formula, Wind speed duration curve, Power versus wind speed characteristics. 2.10 Capacity Factor of a Wind power plant – Definition and formula. 2.11 Selection of Site for a Wind Power Plant- Factors effecting wind power generation, important features. 2.12 Important terms and definitions used in wind power plants – Blade, Chord, Wind Velocities, Angle of attack, Pitch angle (Blade setting angle), drag force, Lift force, Solidity. 2.13 Elementary Fluid Flow concepts – nature of flow around a body, relative motion of fluid at the boundary wall, fluid friction, pressure difference, drag on a body, lift force.	• Applications of wind power plants for meeting the load demand. • Installed capacity and power generation capacity of wind power plants in India.

SW-2 Suggested Sessional Work (SW):

- **Assignments:**
  i. Collect the data of wind speed (in m/sec) and hours of availability over a year and draw the plot, for a particular place where wind power plant is located.
  ii. For a wind power plant, collect the data of electrical power generated and corresponding wind speed, and draw power output versus wind speed characteristics.
- **Mini Project:**

i. Visit a wind power plant and prepare a report on wind speed availability, installed capacity and generated power for the plant.
ii. Build a model of small wind turbine to charge given battery.

- **Other Activities (Specify):**
  i. On the map mark the wind energy sites of India.
  ii. During visit of a wind power plant, observe the blade design of the turbine and also observe the various other parts.

CO-3 Maintain wind power plants.

(Approx. Hrs: L+ T+P+SL=19)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain the working of the given type of wind power plant. SO3.2 Describe the procedure of scheduled and preventive maintenance of the given type of wind power system. SO3.3 Describe the procedure to troubleshoot the faults of the given type of wind power system.	LE3.1 Identify the power electronic devices and circuits in the small wind turbine. LE3.2 Test functioning of the power electronic devices used in given wind turbine. LE3.3 Perform minor repairs of given wind power Plant. LE3.4 Draw the plot of generated power versus wind speed for a small wind power trainer.	**Unit3.0 Wind Power Generation** 3.6 Introduction- block diagram of wind energy conversion systems (WECS). 3.7 Wind Turbines – Types (based on power generation capacity and based on horizontal or vertical rotor axis). 3.8 Horizontal Axis Wind Turbine(HAWT) – (a) Main Components and diagram- Turbine blades, Hub, Nacelle, Yaw Control Mechanism & Tower) (b) Types of Rotors-single or multiple blades, Teetering of Rotor, Upwind and downwind machines. (c) Yaw Control and Pitch control of Rotor. 3.9 Vertical Axis Wind Turbine(VAWT) – (a) Main Components-Tower, Blades, Support structure (b) Rotors-types & construction in brief. 3.10 HAWT versus VAWT - Advantages and disadvantages 3.11 Speed Control strategies for wind turbines - Yaw and tilt control, pitch control and stall control. 3.12 Power speed	• power electronics controllers used in wind power plants

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
		characteristics in various speed region 3.13 Generators Suitable for Wind Power Generation-DC, Synchronous and Induction generators, advantages and disadvantages. 3.14 Fixed speed drive scheme – power output versus wind speed characteristics 3.15 Variable speed drive scheme – (a) Variable speed drive using power electronics (b) Scherbius Variable speed drive – block diagram (c) Variable speed direct drive – advantages and disadvantages. 3.16 System integration – Effect of wind speed and grid condition. 3.17 Wind energy storage – Major problems and remedies 3.18 Environmental aspects of wind power	

SW-3 Suggested Sectional Work (SW):

- **Assignments:**
  i. Make a report on availability of wind power plants in India.
- **Mini Project:**
  i. Make a survey of a wind power plant for its installed capacity, variation of power generated over the year and also units generated
  ii. Make a report on suitability of various types generators used in wind power plants.
  iii. Build a mini wind turbine to charge the given battery.
- **Other Activities (Specify):**
  i. Study the operating principle of Double Armature AC Generator and its uses in wind power generation.

CO-4 Analyze the working of series and parallel connection of PV cells.

(Approx. Hrs: CI+ LI+SW+SL=22)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Describe the VI characteristics of a PV cell. SO4.2 Explain the effect of temperature on the open circuit voltage and short circuit current of a PV cell. SO4.3 Justify the need of connecting PV cells in series and parallel. SO4.4 Describe the limitation in load sharing when non identical PV cells are connected in series. SO4.5 Describe the limitation in load sharing when non identical PV cells are connected in parallel SO4.6 Describe the need of protection and the protection scheme used when PV cells are connected in series and parallel to modules.	LE4.1 Measure the I-V and P-V characteristics of a given PV module. LE4.2 Experimentally investigate short circuit current, OC voltage, fill factor, maximum power and efficiency of the given PV module. LE4.3 Measure the I-V characteristics of two PV modules connected in (i) Series (ii) Parallel LE4.4 Measure the solar irradiance level of a given locality for a given time duration using pyranometer.	**Unit4.0 PV cell** 4.1 PV cell characteristics and its equivalent circuit. Types of material used for PV cells 4.2 Data sheet of PV cell with emphasis on short circuit current, open circuit voltage, peak power, cell efficiency parameters. 4.3 Effect of temperature on PV cell. 4.4 Connection of Identical and non-identical PV cells in series. 5.5 Connection of Identical and non-identical PV cells in parallel. 6.5 Protecting series and parallel connected PV cells 7.5 Interconnection of modules in series and parallel	• Major solar power generation utilities in Chhattisgarh • Solar irradiance level of your locality for a given time span

SW-4 Suggested Sectional Work (SW):

- **Assignments:**
  i. Prepare a report on the use of solar energy for various applications.

- **Mini Project:**
  i. Determine the maximum power extracted from a given PV module and solar insolation.
  ii. Collect information of the major solar power generation utilities in Chhattisgarh and submit report on it.
  iii. Survey the maximum and minimum solar irradiance level of your locality for a given time span

- **Other Activities (Specify):**
  i. Prepare bill of material for a given solar installation in your region
  ii. Survey and prepare a report on the manufacturers of solar energy measurement

CO-5 Implement PV Modules with Battery for Domestic/Commercial Applications.

(Approx. Hrs: CI+ LI+SW+SL=22)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Describe the insolation and irradiance and its variation with time. SO5.2 Describe the earth centric view point and energy incident ona horizontal flat surface SO5.3 Explain types of battery and the battery parameters SO5.4 Evaluate PV sizing for a given load profile without battery SO5.5 Evaluate PV sizing for a given load with battery	LE5.1 Determine the maximum power generated by a PV module placed on a horizontal flat surface. LE5.2 Verify the healthiness of a battery for a PV application. LE5.3 Connect a given solar module, solar battery, charge controller and inverter to a given and measure the Electrical parameters under normal solar insolation. LE5.4 Connect a given solar module, solar battery, charge controller and inverter to a given and measure the Electrical parameters under partial shading condition.	**Unit5.0 Energy from sun and sizing of PV** 5.1 Insolation and irradiance and Insolation variation with time of a day 5.2 Insolation and energy on a horizontal flat plate. 5.3 Atmospheric effects. 5.4 Introduction to batteries, Battery capacity, Battery C rate, Battery efficiency, Energy and power densities. 5.5 Battery selection, Battery and PV sizing for a domestic/commercial application considering days of autonomy	• Collect information of the specification details of the charge controllers • Collect information on the battery terminology and battery parameters considered for a Solar PV application.

Legend:CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sectional Work (SW):

- **Assignments:**
  i. Read the safety manual on maintenance of Solar PV Plant, and write important safety measures to be observed while operating a solar power plant.
  ii. Draw the block diagram of a standalone PV system with battery feeding a load and write the specification details and function of the variousequipment's /system used.
- **Mini Project:**
  i. Experimentally investigate the optimum tilt angle of a given PV module for delivering maximum power to the load.
  ii. Develop a solar powered LED street light.
- **Other Activities (Specify):**
  i. Design a solar PV system to fulfill a load requirement of two CFL (9W) and Fan (60W).
  ii. Prepare a report on the charging procedures and the safety precautions to be observed during battery charging.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Renewable Energy Sources	4	4	2	10
II	Wind Energy	5	4	5	14
III	Wind Power Generation	5	4	5	14
IV	PV cell	5	6	5	16
V	Energy from sun and sizing of PV	5	6	5	16
Total		**24**	**23**	**23**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESA of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Make a list of various non-conventional energy sources with its specifications, available in lab and explain its working using suitable diagram.	50	40	10
LE1.2	Enlist applications of various non- conventional energy sources available in lab.	50	40	10
LE 2.1	List the various parts of a small wind power training system.	50	40	10
LE2.2	Dismantle the given small wind turbine and write the name of different parts.	50	40	10
LE2.3	Assemble an already dismantled wind turbine and check its proper working.	50	40	10
LE3.1	Identify the power electronic devices and circuits in the small wind turbine.	50	40	10
LE3.2	Test functioning of the power electronic devices used in given wind turbine.	50	40	10
LE3.3	Perform minor repairs of given wind power plant.	50	40	10
LE3.4	Draw the plot of generated power versus wind speed for a small wind power trainer.	50	40	10
LE4.1	Measure the I-V and P-V characteristics of a given PV module.	50	40	10
LE4.2	Experimentally investigate short circuit current, OC voltage, fill factor, maximum power and efficiency of given PV module.	50	40	10
LE4.3	Measure the I-V characteristics of two PV modules connected in (i) series (ii) parallel	50	40	10
LE4.4	Measure the solar irradiance level of a given locality for a given time duration using *pyranometer*.	50	40	10
LE5.1	Determine the maximum power generated by a PV module placed on a horizontal flat surface.	50	40	10
LE5.2	Verify the healthiness of a battery for a PV	50	40	10

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	application.			
LE5.3	Connect a given solar module, solar battery, charge controller and inverter to a given and measure the Electrical parameters under normal solar insolation	30	20	10
LE5.4	Connect a given solar module, solar battery, charge controller and inverter to a given and measure the Electrical parameters under partial shading condition.	30	20	10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend:PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture Method
2. Tutorial
3. Group Discussion
4. Industrial visits
5. Industrial Training
6. Field Trips
7. Portfolio Based Learning
8. Demonstration
9. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)

L) Suggested Learning Resources:

(b) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Non-Conventional Energy Resources	B H Khan	Mc Graw Hill Education (India) Pvt. Ltd.	Latest Edition
2.	Non-Conventional Energy Sources	G D Rai	Khanna Publication	Latest Edition
3.	Non-conventional sources of Energy (Hindi)	V K Jain	Deepak Prakashan	Latest Edition
4.	Non-Conventional Energy Sources and Utilisation	R K Rajput	S.Chand and company Pvt. Ltd. ISBN:9788121939713	Latest Edition
5.	Wind Energy	Siraj Ahmed	PHI Learning, New Delhi	Latest Edition
6.	Wind Power Plants and Project Development	Earnest, Joshua and Wizelius Tore	PHI Learning, New Delhi, 2015 ISBN: 978-8120351271	Latest Edition
7.	Wind Power Technology	Earnest Joshua	PHI Learning, New Delhi, 2015 ISBN: 9788120347786	Latest Edition
8.	Wind Energy Basics	Gipe, Paul	Chelsea Green Publishing	Latest Edition

S. No.	Titles	Author	Publisher	Edition & Year
9.	Wind and Solar Power Systems: Design, Analysis, and Operation	Mukund R. Patel	CRC Press ISBN 9780849315701	
10.	ENERGY SWARAJ: My Experiments with Solar Truth.	Solanki, Chetan Singh	NOTION PRESS, 2019 ISBN: 9781646509454	
11.	Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers	Solanki, Chetan Singh	PHI Learning, New Delhi, 2015 ISBN: 9788120347113	
12.	Solar Photovoltaic's: Fundamentals, Technologies and Applications	Solanki, Chetan Singh	PHI	Latest Edition
13.	Solar Electric Handbook: Photovoltaic Fundamentals and Applications	Boxwell Michael	Media Bundle,Greenstream Publishing ISBN -1256701661	Latest Edition
14.	Technology of Solar	Brahmpal Bhardwaj	Engineers India Research Institute ISBN: 9789380772547	Latest Edition
15.	Solar Photovoltaics: A Lab training Manual	Chetan S Solanki,BrijM.Arora, JuzerVasi, Mahesh B Patil	Cambridge University Press India Ltd.	Latest Edition

(b) Open source software and website address:

1. https:/www.youtube.com/watch/?v=FSB8_pb88P8 ; How Wind Turbines Generate Electricity
2. https://www.youtube.com/watch?v=P9SyZvHrJvc ; Wind Turbine Terminology and Components
3. http://www.solarmaxx.co.in ; Solar Products- Solar Maxx
4. https://energypedia.info/wiki/Solar_Energy
5. http//www.seia.org
6. http://www.solarpowerworldonline.com/category/industry-news/
7. http://niwe.res.in/
8. http://mnre.gov.in
9. www.ireda.gov.in
10. www.mahadiscom.in/SolarRoofTopNetMetering.shtm
11. www.indianwindpower.com/
12. www.nptel.ac.in
13. https://www.pvmagazine.com

(c) Others:

1. Learning Packages
2. BIS standards
3. Manufacturers' Manual
4. User's Guide

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1.	Cathode Ray Oscilloscope (CRO)	30 MHZ Dual Trace with isolated channels	LE3.2
2.	Digital Multimeter	3 ½ Digit Display	LE3.2
3.	Digital Multimeter	4 ½ Digit Display	LE3.2
4.	Two channel Digital storage Oscilloscope (CRO) with channel isolated	50 MHz	LE3.2
5.	Digital Multimeter	4 ½ Digit Display	LE3.2
6.	DC Voltmeter	iii. Range 0-50 V iv. Range 0-100V	LE3.4
7.	DC Ammeter	iii. Range 0-2 Amp iv. Range 0-5 Amp	LE3.4
8.	Rheostat	0-200 Ohm, 2.5 Ampere	LE3.4
9.	Function Generator	Variable Voltage up to +-10 volt up to 1 MHz with DC offset	LE 3.1, LE 3.2
10.	Wind Energy Trainer Kit	0-10 V, 3 blades, Max Output voltage 3 V, Short Circuit Current 250 mA, Ammeter 0-500 mA, Potentiometer 5KO1AA	LE2.1, LE 2.2, LE2.3, LE 3.3, LE 3.4
11.	Wind Energy Turbine Emulator		LE2.1, LE 2.2, LE2.3, LE 3.3, LE 3.4
12.	1 phase inverter	DC supply 12V,7 Ah, Output 230 Volt with fuses for protection from short circuit. Provisions for display of Inverter ON, Low battery voltage. Over load	LE 3.1, LE 3.2
13.	Small wind turbine with gearbox and induction generator	10 kW to 15 kW	LE 3.4
14.	Anemometer		LE 3.3, LE 3.4
15.	Solar Cell	c-Si 4cmX4cm	LE 4.1
16.	Solar photovoltaic module	4X20 Watt	LE 4.1, LE4.2, LE4.3, LE5.1, LE 5.2
17.	*Pyranometer*		LE4.4
18.	Photometer measure light digital Lux meter.	Measuring range: 0Lux~200,000Lux/0Fc~185806Fc. Accuracy: +/-3% rdg+/-0.5%f.s. (<10,000Lux), +/-4% rdg+/-10dgs (>10,000Lux).	LE4.4
19.	Four Quadrant DC power supply	Voltage 0 to +-10 V Current 0 to +-2 Amp	LE5.3, LE5.4
20.	Solar Simulator kit	Solar Simulator kit with Temperature controller, Digital ammeters and voltmeters, and provision for four quadrant power supply	LE5.3, LE5.4

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1 Electrical Equipment	PSO-2 Electrical power Systems
CO-1 Use renewable sources of energy.	3	2	1	1	3	3	2	1	1	3	3	2
CO-2 Analyze the working of various components of wind power plants.	3	3	2	3	2	2	2	2	1	3	2	3
CO-3 Maintain wind power plants.	3	3	3	3	2	1	2	3	1	2	3	3
CO-4 Analyze the working of series and parallel connection of PV cells.	3	3	3	3	3	3	2	2	1	3	3	3
CO-5 Implement PV modules with battery for domestic/commercial applications.	3	3	3	3	3	3	3	2	1	3	3	3

Legend:1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-1 Use renewable sources of energy.	SO1.1 SO1.2 SO1.3 SO1.4	LE1.1 LE1.2	Unit-1.0 0 Renewable Energy Sources 1.1 , 1.2, 1.3, 1.4, 1.5.1.6	As mentioned
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-2 Analyze the working of various components of wind power plants.	SO2.1 SO2.2 SO2.3 SO2.4	LE2.1 LE2.2 LE2.3	Unit-2.0 Wind Energy 2.1, 2.2, 2.3, 2.4., 2.5, 2.6, 2.7, 2.8	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-3 Maintain wind power plants.	SO3.1 SO3.2 SO3.3	LE3.1 - LE3.4	Unit-3.0 Wind Power Generation 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-4 Analyze the working of series and parallel connection of PV cells.	SO4.1 - SO4.6	LE4.1 LE4.2 LE4.3 LE4.4	Unit-4.0 PV cell 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-5 Implement PV modules with battery for domestic/commercial applications.	SO5.1 - SO5.5	LE5.1 - LE5.4	Unit-5.0 Energy from sun and sizing of PV 5.1, 5.2, 5.3, 5.4, 5.5.	

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

PSO-1 Use various tools to simulate, implement and test simple Electrical & Electronics Engineering related circuits and systems.

PSO-2 Apply Electrical & Electronics Engineering knowledge to maintain various Electrical & Electronics Engineering related systems

A) Course Code : 2000673(037)
B) Course Title : Entrepreneurship Development and Management
C) Pre- requisite Course Code and Title :
D) Rationale :

Our fast growing economy provides ample opportunities for diploma engineers to succeed in entrepreneurship. Diploma engineers can be their own masters and job provider to others by starting their service industry/assembly/marketing/consultancy/manufacturing enterprises. As entrepreneurship requires distinct set of skills which may not be developed while undergoing technical subjects. Hence a separate course has been introduced for developing such skills set amongst diploma students. This course aims at developing competencies in the diploma engineer for becoming an intrapreneur or a successful entrepreneur. After successfully completing this course students who develop qualities of successful entrepreneur can set up their own manufacturing industry/service industry/business/startup or be self employed and those who prefer job can become intrapreneur and share profits with their company.

E) Course Outcomes

CO-1 Demonstrate traits of a successful intrapreneur/entrepreneur

CO-2 Analyze the level of achievement motivation by preparing one's own portfolio.

CO-3 Innovate products and services using creativity techniques.

CO-4 Manage critical resources from support institutions.

CO-5 Prepare sustainable small business plans.

F) Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)					
			L	P	T	SL	Total Study Hours (L+P+T+SL)	Total Credits (L+T+P/2)
Mechanical Engineering	2000673 (037)	Entrepreneurship Development & Management	2	-	1	1	4	3

Lecture (L) L Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.) Practical (P) Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Tutorial Includes sessional work (SW) (assignment, seminar, mini project etc),

Self-Learning (SL) includes self-study, group study and learning from subject teacher or use of multi media

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Title	Scheme of Examinations					
			Theory			Practical		Total Marks
			ESE	CT	TA	ESE	TA	
Mechanical Engineering	2000673 (037)	Entrepreneurship Development & Management	70	20	30	-	-	120

Legend:

ESE: End semester exam CT: Class Test TA: Teachers Assessment

Note:

i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30% weightage of total respectively.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Demonstratetraits of a successful intrapreneur/entrepreneur

(Approx. Hrs:CI+LI+SW+SL=11)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Select intrapreneurship orentrepreneurship as acareer based on the qualities possessed by an individual. SO1.2 Identify various avenues of entrepreneurship for diploma engineers. SO1.3 Demonstrate qualities of successful intrapreneur /entrepreneur. SO1.4 Explain various steps in establishment of enterprise. SO1.5 Select an area of business opportunity as per your interest.		**Unit 1.0 Characteristics of entrepreneurs** 1.1 Concept of entrepreneur and intrapreneur 1.2 Benefits of becoming an intrapreneur/ entrepreneur. 1.3 Scope of entrepreneurship in local and global market. 1.4 Planning for establishment of an enterprise. 1.5 Traits of successful intrapreneur/ entrepreneur and passion, initiative, independent decision making, team work, assertiveness, persuasion, persistence, information seeking, commitment to work contract etc. SW analysis. Team work simulation. 1.6 Trait of successful entrepreneur: calculated risk taking. Risk taking simulation exercise. 1.7 Business opportunity Guidance	• History of entrepreneurship . • Definition of entrepreneurship • Social entrepreneurship

SW-1 Suggested Sessional Work (SW):

- **Assignments:**
  i. Identify existing needs of the institute/college and convert them into business opportunity.
  ii. Enumerate characteristics of assigned first generation successful entrepreneurs, intrapreneurs, managers by preparing a presentation.
  iii. Analyze the reasons for success and failure of the assigned entrepreneurs by preparingppt on the basis of news, articles, reviews, video etc.

- **Mini project:**

i. Interviewing few local entrepreneurs and prepare a collage on "Traits of successful entrepreneurs".
ii. Identify traits to be developed in you for becoming a successful entrepreneur based on your strength and weakness analysis and submit an action plan to develop the same.
iii. Organize "best from waste" competition.

- **Other Activities:**
  i. Identify your hobbies and interests and convert them into business idea.
  ii. Organize seminar on history of entrepreneurship, Definition and selected case studies of social entrepreneurship.

CO-2 Analyze the level of achievement motivation by preparing one'sown portfolio.

(Approx. Hrs: CI+LI+SW+SL= 11)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain the concept of achievement motivation. SO4.2 Assess level of need for Achievement in the individual through different tools. SO4.3 Prepare an action plan for enhancing need for achievement.		**Unit 2.0 Motivation Management** 2.1 Motives, motivation and motivational cycle. 2.2 Concept of Need for Achievement. 2.3 Need for Achievement assessment through various tools. • Ring toss game • Boat making exercise • Building block exercise • TAT stories • Who am I? 2.4 Interpretation and action plan for self development.	• Kakinada experiment Techno-preneurship.

SW-2 Suggested Sessional Work (SW):

- **Assignments:**
  i. Prepare a portfolio based on achievement motivation exercise and tasks.

- **Mini project:**
  i. Prepare a report on need for achievement exercises.
  ii. Develop achievement motivation field exercises.

- **Other Activities:**
  i. Prepare a plan for development of achievement motivation and execute it.
  ii. Develop case studies on Techno-preneurship.
  iii. Prepare a report on Kakinada experiment.

CO-3 Innovate products using creativity techniques.

(Approx. Hrs: CI+LI+SW+SL= 16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Elucidatethe use creativity techniques for entrepreneurs. SO3.2 Improve a chosen product using brainstorming technique. SO3.3 Differentiate between creativity and innovation. SO3.4 Apply concept of product life cycle for conceiving a project. SO3.5 Design a product using new product development process.		**Unit 3.0 Management of Creativity.** 3.1 Creativity: Divergent thinking, creativity techniques. 3.2 Innovation, types and applications 3.3 Product life cycle, New product development process. Product development and innovation through creativity and innovation.	• Check list of questions. • Six thinking hats. • Case study of innovative first generation entrepreneur. • Schemes and incentives for innovation. • Innovative solutions for social problems.

SW-3 Suggested Sessional Work (SW):

- **Assignments:**
  i. Use the assigned creativity technique for improvement of product characteristic.
  ii. Use the assigned creativity technique for improvement of service process characteristic.

- **Mini project:**
  i. Apply innovative practices in different process of an enterprise.

- **Other Activities:**
  i. Prepare a prototype of a creative solution to industrial/ social problem.
  ii. Organise seminar on Schemes and incentives for innovation, Innovative solutions for social problems and Kakinada experiment.

CO-4 Manage critical resources from support institutions.

(Approx. Hrs: CI+LI+SW+SL= 11)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Select appropriate form of business organization for enterprise SO4.2 Identify entrepreneurship support institutions for technical/		**Unit 4.0 Critical Resources** 4.1 Forms of business organization: Proprietorship, Partnership, Cooperative, Private, Public Ltd Company, Section 8 company, LLP 4.2 Institutional Support for entrepreneurship:	• Establishment procedure of Proprietorship, LLP, Cooperative, Section 8 company,LLPFactory Act, Labour Laws, GST,

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
marketing and finance. SO4.3 Explain salient features of entrepreneurship promotion schemes of centre and state. SO4.4 Prepare a marketing mix plan for identified industry. SO4.5 Develop a materials management plan. SO4.6 Develop a human resource plan.		MSMESI, CED, DTIC, CITCON, CSIDC, LUN, NSIC, KVIC, NABARD, Banks, SIDBI 4.3 Entrepreneurship promotion schemes of centre and state. 4.4 Marketing Mix, Market survey for project identification 4.5 Inventory control, vendor development, material movement, store management. 4.6 Manpower plan, hiring process, compensation, performance appraisal.	

SW-4 Suggested Sessional Work (SW):

- **Assignments:**
  i. Examine suitability of different forms of business organization for the given project and prepare a presentation for the same.
  ii. Conduct a market survey and prepare a report along with marketing mix plan for the given project.
  iii. Prepare materials management strategy for a business or manufacturing unit and submit as areport.
  iv. Prepare a man power plan chart and job specifications for identified positions.

- **Mini project:**
  i. Explore facilities extended by support institutions to entrepreneurs for marketing of the given situation.
  ii. Investigate facilities extended by support institutions to entrepreneurs for technical support of the given situation.
  iii. Identifyfacilities extended by support institutions to entrepreneurs for financial support of the given situation

- **Other Activities:**
  i. Visit the assigned agencies engaged in institutional support for entrepreneurship and make a report.
  ii. For your selected project decide a unique name of the enterprise, logo, signboard, letterhead andpamphlet.
  iii. Organise a seminar on establishment procedure of proprietorship, LLP, cooperative, section 8 company, factory act, labour laws and GST.

CO-5 Prepare sustainable small business plans.

(Approx. Hrs: CI+LI+SW+SL= 12)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Prepare business plan/techno economic feasibility report. SO5.2 Calculate and comment on breakeven point for given project. SO5.3 Explain financing of startups.		**Unit 3.0 Sustainable business plan** 5.1 Format of business plan/techno-economic feasibility report. 5.2 Demand and annual production target based on market survey. 5.3 Outline production/service process. 5.4 Land, building and machinery requirement. 5.5 Power,utilities and raw material requirement. 5.6 Fixed capital, Working capital, Subsidy and Cost of Project. 5.7 Means of finance, calculation of interest. 5.8 Profitability analysis, Break-even point.	• Techno-economic feasibility report of MSME. • Startup process. • Angel Investors. • Venture capitalist. • Incubators.

SW-5 Suggested Sessional Work (SW):

- **Assignments:**
  i. Describe the procedure of registration and availing of facilities from the assigned support institution.
  ii. Prepare a process plan for the selected project.

- **Mini project:**
  i. Prepare a marketing plan for the assigned project.
  ii. Prepare a financial plan for the assigned project.
  iii. Prepare a technical feasibility plan for the assigned project.
  iv. Prepare a techno-economical feasibility report of the assigned project.

- **Other Activities:**
  i. Analyse a case study on startups focusing on financing from angel investor and venture capitalist.
  ii. Organise seminar on Starup process, Angel investors, Venture Capitalist and Incubators

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Characteristics of entrepreneurs	2	4	8	14
II	Motivation Management	2	2	6	10
III	Management of Creativity and Innovation	2	4	8	14
IV	Resource Management	2	4	10	16
V	Sustainable Business Plan	2	4	10	16
	Total	**10**	**18**	**42**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESA of Laboratory Instruction*):Not Applicable

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Field Trips
6. Portfolio Based Learning
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
9. Brainstorming

L) Suggested Learning Resources:

(c) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Entrepreneurial Development	Desai Vasant	Himalaya Publishing House	Mumbai/2017 ISBN 978 93 5097 383 7
2	Starting your own business, step by step Blue print for the First – time Entrepreneur	Harper Stephen C.	Mc Craw-Hill	2003 ISBN13: 9780071410120
3.	The Business Planning GUIDE	H.Bangs David	Upstart Publishing Company in Chicago	978-0793154098
4	Entrepreneurship Development in India	Gupta Dr.C.B. Shriniwasa NP	Sultan Chand & Sons	9788180548185
5	Entrepreneurship Development	Khanka Dr.S.S.	S.Chand New Delhi	ISBN 81 219 1801 4
6	Entrepreneurship Development and small Business Enterprises	Charantimath M.	Pearson Edu.Soc. INDIA	2013/ISBN 13 978 8131 762264
7.	Entrepreneurship Development	Sharma Sangita	PHI, DELHI	ISBN 978 81 203 5270 4

(b) Open source software and website address:

1. Free e books: https://www.free-ebooks.net/book-list/entrepreneurship

2. Startups:https://inc42.com/startups/?utm_source=top-menu&utm_medium=website&utm_campaign=menu
3. Indian Tech Startup funding report: https://pages.inc42.com/annual-indian-tech-startup-funding-report-2017/?utm_source=top-menu&utm_medium=website&utm_campaign=menu
4. Project profile: https://my.msme.gov.in/MyMsmeMob/MsmeProjectProfile/Home.htm
5. Project profile: http://www.dcmsme.gov.in/publications/pmryprof/pjseries.html
6. Project profile http://www.dcmsme.gov.in/reports/ProjectProfile.htm

M) List of Major Laboratory Equipment and Tools: Not Applicable

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Demonstrate traits of a successful intrapreneur/entrepreneur.	-	3	-	-	2	2	2	2	2	2	-	-
CO-2 Analyse the level of achievement motivation by preparing one's own portfolio.	-	3	-	-	2	2	2	2	2	2	-	-
CO-3 Innovate products using creativity techniques.	-	3	-	-	2	2	2	2	2	2	-	-
CO-4 Manage critical resources from support institutions.	-	3	-	-	2	2	2	2	2	2	-	-
CO-5 Prepare sustainable small business plans.	-	3	-	-	2	2	2	2	2	2	-	-

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Title	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-2,5,6,7,8, 9,10	CO-1 Demonstrate traits of a successful intrapreneur/entrepreneur.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit 1.0 Characteristics of entrepreneurs 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	As mentioned in page number 325 to 330
PO-2,5,6,7,8, 9,10	CO-2 Analyse the level of achievement motivation by preparing one's own portfolio.	SO2.1 SO2.2 SO2.3		Unit 2.0 Motivation Management 2.1, 2.2, 2.3, 2.4	
PO-2,5,6,7,8, 9,10	CO-3 Innovate products using creativity techniques.	SO.3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit 3.0 Management of Creativity and Innovation 3.1, 3.2, 3.3	
PO-2,5,6,7,8, 9,10	CO-4 Manage critical resources from support institutions.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6		Unit 4.0 Resource Management 4.1, 4.2, 4.3, 4.4,4.5,4.6	
PO-2,5,6,7,8, 9,10	CO-5 Prepare sustainable small business plans.	SO5.1 SO5.2 SO5.3		Unit 5.0 Sustainable Business Plan 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8	

Legend:CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

A) Course Code : 2024681(024)

B) Course Title : Industrial Automation

C) Pre-requisite Course Code and Title : DC Machines and Transformers, AC Rotating Machines, Basic Electronics, Digital Electronics and Basic Programming Skills

D) Rationale :

The aim of this course is to introduce students with present Industrial Automation scenario in India. The essential components of present industrial automation Industry such as Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) are discussed here. The important topics on sensors, transducer and actuators, microprocessor and microcontroller and electric drives which are prerequisite to take up this elective subject are not included in this course as they are already discussed in the other courses. This course will provide essential knowledge and skills about the industrial automation, its components and robotic systems used in the present industry.

E) Course Outcomes:

CO-1 Interpret the working of a simple industrial automation and robotic system.

CO-2 Test a given PLC for its functionality.

CO-3 Test the output of ladder logic programs.

CO-4 Maintain PLC based systems.

CO-5 Use SCADA based PLC system for supervisory control and data acquisition of a specified application.

F) Scheme of Studies :

Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)					
			L	P	T	SL	Total Study Hours (L+P+T+SL)	Total Credits (L+T+P/2)
Electrical Engineering	2024681 (024)	Industrial Automation	2	-	1	1	6	3
	2024691 (024)	Industrial Automation (Lab)	-	2	-	-	-	1

Lecture (L) L Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.) Practical (P) Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Tutorial Includes sessional work (SW) (assignment, seminar, mini project etc),

Self-Learning (SL) includes self-study, group study and learning from subject teacher or use of multi media

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Title	Scheme of Examinations					
			Theory			Practical		Total Marks
			ESE	CT	TA	ESE	TA	
Electrical Engineering	2024681 (024)	Industrial Automation	70	20	30	---	----	120
	2024691 (024)	Industrial Automation (Lab)	---	----	-----	40	60	100

Legend:

ESE: End semester exam CT: Class Test TA: Teachers Assessment
PRA: Process Assessment, PDA: Product Assessment

Note:

i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30% weightage of total respectively.
ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.
iii. Minimum two experiment from each unit is mandatory.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Interpret building blocks of basic instrumentation system and its characteristics.

(Approx.Hrs:CI+LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Describe the working of a simple given industrial automation system along with a block diagram. SO1.2 Select the type of automation system in the given situation with justification. SO1.3 Describe the working of fundamental blocks of a given robot along with a neat block diagram. SO1.4 Describe the function of basic components of a robot. SO1.5 Describe the working of given types of robots based on its working envelope and control.	LE1.1 Identify the various building blocks of a simple given automation system. LE1.2 Identify the important components of a simple given robotic system.	**Unit-1.0Industrial Automation and Robotics** 1.1 Definition of industrial automation, block diagram, working of each building block 1.2 Types of Automation: fixed, programmable, flexible, hard and soft automation. 1.3 Benefits, limitations and applications of automation. 1.4 Definition of Robotics, block diagram, working of each building block 1.5 Basic components of robot -Manipulator linkage, **ac**tuators, transmission, sensors, controller, user Interface and power conversion 1.6 Classification of robots based on working envelope/ control - Cartesian/Rectilinear,Cylindrical,Spherical,Jointed arm and SCARA(Selective Compliance arm for robotic assembly 1.7 Benefits, limitations and applications of robotics	• Merits and demerits of Automation in industry • Application of Robotics

SW-1 Suggested Sessional Work (SW):

- **Assignments:**
  iii. List various applications in our daily life where automation is used.
  iv. Prepare a report on components of robot and types of robot (Internet activity – Download a video).
- **Mini Project:**
  i. Develop a simple automatic water level controller using magnetic float switch.
  ii. Develop a simple automatic door system using optical sensor and linear actuator.
- **Other Activities (Specify):**
  i. Develop a closed loop control system for monitoring the temperature.

CO-2 Test the given PLC for its functionality.

(Approx. Hrs: CI+LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Describe the working of each building block of a simple given PLC system using block diagram. SO2.2 Describe the steps to interface the input analog and digital devices to given PLC. SO2.3 Describe the steps to interface the output analog and digital devices to given PLC. SO2.4 Describe the program scan cycle of a given PLC. SO2.5 List the advantages and applications of a given PLC.	LE2.1 Identify the various parts and front panel status indicators of the given PLC. LE2.2 Identify different input and output devices that can be connected to a given PLC LE2.3 Test the analog input and output lines of the given PLC. LE2.4 Test the digital input and output lines of the given PLC.	**Unit-2.0 Basics of PLC** 2.1 Definition, Block diagram 2.2 Parts of PLC, Principles of Operation, functions of various blocks 2.3 I/O modules: analog & digital, I/O Specifications 2.4 PLC scan cycle 2.5 Advantages & Applications of PLC.	• Advantages that PLCs offer over conventional relay-based control systems. • Different types of PLC based on size and make.

SW-2 Suggested Sessional Work (SW):

- **Assignments:**
  iii. Compare the PLC and PC with regard to:
  a. Physical hardware differences
  b. Operating environment
  c. Method of programming
  d. Execution of program
  iv. Compare discrete and analog I/O modules with respect to the type of input or output devices withwhich they can be used.
- **Mini Project:**
  iii. Develop a simulation to connect analog and digital input to the PLC.
  iv. Develop a simulation to connect analog and digital output to the PLC.
- **Other Activities (Specify) :**
  iii. Present the seminar on the types of PLCavailable in the market.

iv. Prepare the comparative technical specifications of any one type of PLC (Micro or Mini) of different manufacturer (Internet based activity).

CO-3 Test the output of ladder logic programs.

(Approx. Hrs: CI+LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain the "if close", "if open" and "normally open", "normally closed" concepts with example. SO3.2 List the five types programming of a given PLC. SO3.3 Develop a ladder logic programs for the specified application using arithmetic instructions. SO3.4 Analyze PLC up/down counter ladder logic programs for the given simple application. SO3.5 Analyze PLC on, off and reset delay timer ladder logic programs for the simple given application.	LE3.1 Develop/Execute ladder diagram for different arithmetic operations. LE3.2 Develop/Execute ladder diagram of AND, OR, NOT, NAND, NOR, X-OR, X-NOR gate along with truth table. . LE3.3 Check the UP/DOWN COUNTER operation of the given PLC. LE3.4 Check the on, off and reset delay timer operation of the given PLC. LE3.5 Develop/test ladder program to put LED/lamp in the blinking mode. LE3.6 Develop ladder program for traffic light control system. LE3.7 Develop / test ladder program for rotating stepper motor in forward and reverse direction at constant speed. LE3.8 Develop /test ladder program for tank water level control.	**Unit 3.0PLC programming** 3.1 Programming basics,Program Scan, port addressing 3.2 PLC Programming languages –, Instruction list, , Structured text Functional Block diagram, Ladder logic and sequential function chart 3.3 Basics of ladder logic - rung,rails, Programming execution, If Closed and If Open Instructions, normally open and normally close operation 3.4 Ladder logic and diagram, relay logic 3.5 Arithmetic instructions: addition, subtraction, multiplication 3.6 Logical operations: AND, OR,NOR, NAND,EX-OR,EX_NOR 3.7 Programming Timer – On, Off and reset 3.8 Programming Counter- Up, down 3.9 Develop ladder logic for various simple applications.	• PLCs available in the market. • Various open source softwares of PLC available. • Download and install any one open source PLC software (eg.Logixpro) and execute some simple ladder logic programming.

SW-3 Suggested Sectional Work (SW):

- **Assignments:**
  i. State three advantages of using programmed PLC timer over mechanical timing relay.
  ii. It is required to have a pilot light glow, meeting all of thecircuit requirements given below:
    a. All four circuit pressure switches must be closed.
    b. At least two out of three circuit limit switches must be closed.
    c. The reset switch must not be closed.

  Using AND, OR, and NOT gates, design a logic circuit that will solve this hypothetical problem.
- **Mini Project:**
  i. Develop the ladder logic that will turn on an output light, 15 seconds after switch A has been turned on.

ii. The ladder logic that will turn on a light, after switch *A* has beenClosed 10 times. Push button *B* will reset the counters.
iii. Develop arelay based motor control automation such that the motor reverses its direction when the limit switches are activated.

- **Other Activities (Specify):**
  i. Present a seminar on basics of ladder logic programming of PLC.

CO-4 Maintain PLC based systems.

(Approx. Hrs: CI+LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Describe the requirements for a given PLC enclosure. SO4.2 Describe proper grounding procedure and preventive maintenance steps associated with given PLC systems. SO4.3 Describe the common procedure to interface the PLC with other given hardware.	LE4.1 Test the ground connections of the given PLC. LE4.2 Interface the given PLC with a PC or a Laptop.	**Unit-4.0Installation and Troubleshooting of PLC** 4.1 PLC enclosures, electrical noise, Leaky inputs and outputs, grounding, voltage variations and surges 4.2 Common Preventive Maintenance procedure and troubleshooting steps of PLC 4.3 Interfacing of Programmable Logic Controller with other hardware	• Difference between PC and PLC • Interfacing of the electronic hardware with PLC.

SW-4 Suggested Sectional Work (SW):

- **Assignments:**
  ii. Summarize the basic grounding requirements for a PLC system.
  iii. State two ways in which electrical noise may be coupled into a PLC control system.
  iv. List five preventive maintenance tasks that should be carried out on the PLC installation regularly.

- **Mini Project:**
  i. Troubleshoot the faulty equipment/kit available in automation laboratory.
  ii. Troubleshoot the faulty in a given PLC system and prepare a report.

- **Other Activities (Specify):**
  i. Give seminar on different types of PLC and their industrial applications

CO-5 Use SCADA based PLC system for supervisory control and data acquisition of a specified application.

(Approx. Hrs: CI+LI+SW+SL=20)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Describe the function of givenelement of a SCADA system. SO5.2 Interfacethe given PLC with SCADA system using the given Open Platform Communications (OPC). SO5.3 Describe the steps to develop a simple SCADA screen for the given industrial application. SO5.4 Describe the procedure to maintain the SCADA based PLC system for the given application.	LE5.1 Test the given parameters of SCADA. LE5.2 Set up a SCADA configuration. LE5.3 Develop following simple SCADA applications using any one open source SCADA software, create tags, trends – historical and real time and apply dynamic properties i. Turn on and off a tube light using a switch ii. Apply filling and object size properties to a rectangle, square and round object iii. Move the object, fill the object using slider and meter reading. iv. Apply orientation property to a fan and control its direction using a slider. v. Move a square object horizontally first, then vertically and again horizontally by applying visibility property.	**Unit-5.0 Supervisory Control and Data Acquisition System(SCADA)** 5.1 SCADA: Introduction, need benefits and typical applications of SCADA 5.2 SCADA Architecture - Remote Terminal Units (RTUs), Master Terminal Units, Various SCADA editors, Communication protocols for SCADA 5.3 Interfacing SCADA system with PLC- Typical connection diagram, Object Linking and Embedding for Process Control(OPC) architecture 5.4 Creating SCADA Screen for simple object, Steps for Linking SCADA object (defining Tags and items, creating trends etc.,) with PLC ladder program using OPC,Configuring simple applications using SCADA:Traffic light control, water distribution, pipeline control, Power generation, transmission and distribution etc. 5.5 Procedure to maintain the SCADA based PLC system	• Difference between PLC, DCS and SCADA • HMI and SCADA softwares • Open source softwares of SCADA

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sectional Work (SW):

- **Assignments:**
  i. Prepare a list of open source SCADA software.
  ii. List the practical applications of SCADA system.

- **Mini Project:**
  i. Develop a PLC and SCADA based simple application and prepare the report.

ii. Simulate on an open source SCADA software-Move a container for some distance on a conveyor belt, bring it below a tank which is full, fill the container to half and move it away from that position on the conveyor belt.

- **Other Activities (Specify):**
  i. Prepare a power point presentation and give seminar on a SCADA system.
  ii. Prepare a power point presentation and give seminar on creating tags and trends for a given industrial application.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Industrial automation and robotics	4	6	4	14
II	Basics of PLC	2	6	6	14
III	PLC programming	2	4	8	14
IV	Installation and Troubleshooting of PLC	2	4	6	12
V	Supervisory Control and Data Acquisition(SCADA)	4	6	6	16
Total		**14**	**25**	**31**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESA of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Identify the various building blocks of a simple given automation system and its function.	50	40	10
LE1.2	Identify the important components of a simple given robotic system and its function.	50	40	10
LE2.1	Identify the various parts and front panel status indicators of the given PLC.	50	40	10
LE2.2	Identify different input and output devices that can be connected to a given PLC.	50	40	10
LE2.3	Test the analog input and output lines of the given PLC.	50	40	10
LE2.4	Test the digital input and output lines of the given PLC.	50	40	10
LE2.5	Use PLC to test the START STOP logic for two inputs and one output system.	50	40	10
LE 2.6	Use PLC to control the following devices : lamp, motor, push button switches, proximity sensor.	50	40	10
LE3.1	Develop/Execute ladder diagram for different arithmetic operations.	50	40	10
LE3.2	Develop/Execute ladder diagram of AND, OR,	50	40	10

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	NOT, NAND, NOR, X-OR, X-NOR gate along with truth table.			
LE3.3	Check the UP/DOWN COUNTERoperation of the given PLC.	50	40	10
LE3.4	Check the on, off and reset delay timer simple operation of the given PLC.	50	40	10
LE3.5	Develop/test ladder program to put LED/lamp in the blinking mode.	50	40	10
LE3.6	Develop ladder program for traffic light control system.	50	40	10
LE3.7	Develop / test ladder program for rotating stepper motor in forward and reverse direction at constant speed.	50	40	10
LE3.8	Develop /test ladder program for tank water level control.	50	40	10
LE4.1	Test the ground connections of the given PLC.	50	40	10
LE4.2	Interface the given PLC with a PC and a Laptop	50	40	10
LE5.1	Test the given parameters of SCADA.	50	40	10
LE5.2	Set up a SCADA configuration.	50	40	10
LE5.3	Develop following simple SCADA HMI applications using any one open source SCADA software by applying the dynamic properties: (i) Turn on and off a tube light using a switch. (ii) Apply filling and object size properties to a rectangle, square and round object. (III) Create an application using alarm. (iv) Move the object, fill the object using slider and meter reading. (v)Apply orientation property to a fan and control its direction using a slider. (vi) Move a square object horizontally first, then vertically and again horizontally by applying visibility property. (vii) Move a container on a conveyor belt from left to right, fill it fully from an inverted tank which is fully filled and move the container from left to right again. (viii) Create historical trend for a given simple application. (ix) Create real time trend for a given simple application.	50 50 50 50 50	40 40 40 40 40	10 10 10 10 10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend:PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Field Trips
6. Demonstration
7. ICT Based Teaching Learning (Video Demonstration, Mobile)

L) Suggested Learning Resources:

(d) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Introduction to Programmable Logic controllers	Gary Dunning	Delmar Cengage Learning	3rd edition, 2009 ISBN 10: 813150302X ISBN 13: 9788131503027
2.	Programmable Logic Controllers	Frank D. Petruzella	Tata Mc Graw Hill publications, New Delhi	5th edition, 2017 ISBN 10: 0071067388 ISBN 13: 9780071067386
3.	PLCs & SCADA: Theory and Practice	Rajesh Mehra and Vikrant Vij	Laxmi Publications, New Delhi	Latest edition ISBN-13: 9780073510880 ISBN-10: 0073510882
4.	Programmable Logic Controllers	W. Bolton	Elsevier	6th Edition, ISBN 10: 9351073386 ISBN 13: 9789351073383
5.	Programmable Logic Controllers Principles and applications 2.	Webb John W. and Reis A. Ronald	PHI ,New Delhi,	Latest edition, ISBN 10: 8120323084 ISBN 13: 9788120323087
6.	Programmable Logic Controllers	John R Hackworth	Pearson education, New Delhi	Latest edition, ISBN 10: 8177587714 ISBN 13: 9788177587715
7.	Programmable Logic Controllers and Industrial Automation an Introduction	Mitra, Madhuchanda; Gupta, Samarjit Sen	Param International Publishing (India) Pvt. Ltd., New Delhi,	Latest edition ISBN: 9788187972631, 8187972637
8.	Programmable logic controllers: principles and applications	Webb, John W.; Reis, Ronald A.	PHI Learning Pvt. Ltd. New Delhi,	Latest edition. ISBN 10: 0024249807 ISBN 13: 9780024249807
9.	SCADA: Supervisory Control and Data Acquisition	Stuart A Boyer	International Society of Automation	4th Edition, Kindle Edition
10.	PLC & SCADA: Theory and practice	Rajesh Mehta, Vikrant Vij	Lakshmi Publications	Latest edition ISBN-13:9789381159118

(b) Open source software and website address:

1. Process Automation Control- online Tutorial: www.pacontrol.com
2. PLC product: www.seimens.com
3. www.ab.rockwellautomation.com
4. PLC product: www.abb.co.in
5. Different product of PLC and Peripherals, Smart Tile CPU Board, All in one lighting energy

controller, Classic PLC www.triplc.com

6. Simulation software:http://plc-training-rslogix-simulator.soft32.com/free-download/
7. Simulator : www.plcsimulator.net/

(c) Others:

1. Learning Packages
2. Lab Manuals
3. Manufacturers' operating Manual

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1.	PLC trainer kit	IEC 1131-3 compatible PLC with programming Software and interfacing hardware, user manual, (complete PLC Trainer system) of reputed make such as Allen-Bradley, Siemens, Mitsubishi, Modicon, and Micrologix etc.,	LE2.1,LE2.2,LE2.3, LE2.4,LE2.5,LE2.6, LE3.1,LE3.2,LE3.3, LE3.4,LE3.5,LE3.6, LE3.7, LE3.8, LE4.1,LE4.2
2.	Input and Output devices	Input and Output devices for PLC: like Lamp, DC Motor, Proximity sensors, Thermocouple/RTD, Red, green, yellow LEDs, Stepper Motor, limit switches, push button	LE1.1, LE2.1, LE2.2, LE2.3, LE2.4, LE2.5, LE2.6, LE3.1, LE3.2, LE3.3, LE3.4, LE3.4, LE3.5, LE3.6, LE3.7, LE3.8, LE4.1, LE4.2
3.	Output devices -motors	Servomotor, DC motor, AC motor, steeper motor, Conveyer Belt control by PLC, water level control etc.,	LE3.7
4.	Types of PLCs	Nano PLC, Mini PLC, Micro PLC with analog and Digital I/O, memory, peripheral interfaces	LE2.1,LE2.2,LE2.3, LE2.4,LE2.5,LE2.6, LE3.1,LE3.2,LE3.3, LE3.4,LE3.5,LE3.6, LE3.7, LE3.8, LE4.1,LE4.2
5.	Open source software	Ladder logic simulator, Pico soft Simulator, Logixpro simulator, Simple EDA tools(open source)	LE2.1,LE2.2,LE2.3, LE2.4,LE2.5,LE2.6, LE3.1,LE3.2,LE3.3, LE3.4,LE3.5,LE3.6, LE3.7, LE3.8
6.	Software	SCADA software: like Ellipse/FTVSE/Wonderware/ openSCADA React and respond in real-time, Real time monitoring. User friendly, secure, extensible. simplified maintenance, Communication with PLC	LE5.1, LE 5.2,LE 5.3
7.	Measuring instrument	Digital Multimeter (¾ Digital Multimeter): 4000 counts large LCD display with auto/manual range, No Power OFF under natural operation, Data Hold, Max/Min value Hold Capacitance, Frequency/Duty Cycle	LE2.1,LE2.2,LE2.3, LE2.4,LE2.5,LE2.6, LE3.1,LE3.2,LE3.3, LE3.4,LE3.5,LE3.6, LE3.7, LE3.8, LE4.1,LE4.2

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Interpret the working of a simple industrial automation and robotic system.	3	3	2	2	-	-	-	3	2	3	2	2
CO-2 Test the given PLC for its functionality.	3	3	3	3	3	-	2	3	3	3	2	2
CO-3 Test the output of ladder logic programs.	3	3	3	3	1	-	2	3	3	3	2	2
CO-4 Maintain PLC based systems.	3	3	3	3	2	1	2	3	3	3	2	2
CO-5 Use SCADA for supervisory control and data acquisition of a specified application.	3	3	3	3	2	1	2	2	2	3	3	2

Legend:1 – Low, 2 – Medium, 3 – High

Use various tools to simulate, implement and test simple Electrical & Electronics Engineering related circuits and systems
PSO2Apply electrical & Electronics Engineering knowledge to maintain various Electrical & Electronics Engineering related systems.

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4, 7,8,9,10 PSO-1,2	CO-1 Interpret the working of a simple industrial automation and robotic system.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	LE1.1, LE1.2	Unit 1.0 Introduction to Industrial automation and robotics 1.1, 1.2, 1.3, 1.4,1.5, 1.6, 1.7	As mentioned
PO-1,2,3,4,5, 7,8,9,10 PSO-1,2	CO-2 Test the given PLC for its functionality.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	LE. 2.1, LE. 2.2 LE 2.3, LE2.4	Unit 2.0 Basics of PLC 2.1,2.2,2.3,2.4, 2.5	
PO-1,2,3,4,5, 7,8,9,10 PSO-1,2	CO-3 Test the output of ladder logic programs.	SO.3.1 SO3.2 SO3.3 SO3.4 SO3.5	LE3.1, LE 3.2, LE3.3, LE3.4, LE3.5, LE3.6, LE3.7, LE3.8,	Unit 3.0 Basic PLC programming 3.1,3.2,3.3,3.4,3.5, 3.6, 3.7, 3.8,3.9	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-4 Maintain PLC based systems.	SO4.1, SO4.2 SO4.3	LE4.1, LE4.2	Unit 4.0 PLC Installation. and Troubleshooting 4.1,4.2,4.3	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-5 Use SCADA for supervisory control and data acquisition of a specified application.	SO5.1 SO5.2 SO5.3 SO5.4	LE5.1, LE5.2 LE5.3	Unit 5.0 DCS and SCADA 5.1, 5.2, 5.3,5.4,5.5,5.6	

Legend:CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2024682(024)

B) Course Title : Energy Conservation & Energy Audit

C) Pre-requisite Course Code and Title : Elements of electrical engineering Electrical Circuit, DC Machines and Transformers, AC rotating Machines, Utilization of Electrical Energy

D) Rationale :

The consumption of energy is increasing day-by-day. One way to cope up with the increaseinenergydemandistoincreasetheproductionofenergywhichdemandsmoreinvestmentand the other way is to conserve the energy because energy conserved is energy generated. Energy conservation means reduction in energy consumption but not compromising with the quality of the comfort. The solution primarily lies in tapping all possible renewable energy sources but also efficient use of available energy using energy efficient devices. This is not only one of the rapid emerging fields but also contribute towards national energy conservation program. This course will enable the diploma pass outs to apply different energy conservation measures in generation, transmission and distribution, in lighting, in electrical motors and also carry out different types of energy audit using different energy audit instruments.

E) Course Outcomes:

CO-1 Create awareness about the significance of energy conservation and management and also about other energy conservation measures.

CO-2 Conserve electrical energy by applying energy conservation measures in power System

CO-3 Conserve electrical energy by applying energy conservation measures in lighting.

CO-4 Conserve electrical energy by applying energy conservation measures in electrical motors and transformers

CO-5 Carry out electrical energy audit using energy audit equipment and meters.

F) Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)					
			L	P	T	SL	Total Study Hours (L+P+T+SL)	Total Credits (L+T+P/2)
Electrical Engineering	2024682 (024)	Energy Conservation & Energy Audit	2	----	1	1	6	3
	2024692 (024)	Energy Conservation & Energy Audit (Lab)	---	2	---	-----	------	1

Lecture (L) L Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.) Practical (P) Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Tutorial Includes sessional work (SW) (assignment, seminar, mini project etc),

Self-Learning (SL) includes self-study, group study and learning from subject teacher or use of multi media

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning

G) Scheme of Assessment:

Board of Study	Course Code	Course Title	Scheme of Examinations					
			Theory			Practical		Total Marks
			ESE	CT	TA	ESE	TA	
Electrical Engineering	2024682 (024)	Energy Conservation & Energy Audit	70	20	30	-	-	120
	2024692 (024)	Energy Conservation & Energy Audit (Lab)	-	-	-	40	60	100

Legend:

ESE: End semester exam CT: Class Test TA: Teachers Assessment

PRA: Process Assessment, PDA: Product Assessment

Note:

i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30% weightage of total respectively.
ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.
iii. Minimum two experiment from each unit is mandatory.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Apply basics of energy conservation and energy audit for conserving electrical energy.

(Approx.Hrs:Cl+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Explain the current energy scenario inIndia. SO1.2 State the need ofenergy conservation and itsbenefits. SO1.3 Identify the various renewable and non renewable energy sources of energy in brief. SO1.4 Explain the concept of energy management and its objectives. SO1.5 Differentiate between Energy management, energy conservation, energy audit and energy efficiency. SO1.6 Explain the role of Bureau of Energy Efficiency (BEE) and other energy saving	LE1.3 List various energy management systems prevailing in a particular industry/Organization LE1.4 Identify the energy management skills and strategies in the energy management system of a particular industry/Organization. LE1.5 Visit the web site of BEE and MEDA/CREDA and collect the information on energy conservation activities and	**Unit 1.0Energy conservation measures and Management** 1.1 Current energy scenario in India: Demand supply gap, need of electrical energy conservation. 1.2 Review of various sources of renewable and non renewable sources of energy. 1.3 Concept of energy management and its objectives 1.4 Difference between energy management, energy conservation, energy audit and energy efficiency. 1.5 Role of Bureau of Energy Efficiency (BEE) and Government Organizations such as NPC, MNRE, BEE,MEDA in energy conservation.	• Collect from market the catalogues of star labeling of domestic appliances and prepare a report on star labeling of equipment

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
promoting organizations. SO1.7 Explain Energy conservation Act 2001. SO1.8 Explain the significance of star labeling of a given equipment. SO1.9 Estimate the Pay back period, Internal Rate of Return, Depreciation cost for a given equipment SO1.10 Explain the role of Energy Service Companies(ESCO). SO1.11 Differentiate between ESCO and Energy Performance Contract(EPC).	prepare a report. LE1.6 Conduct an interview with the energy manager regarding energy conservation.	1.6 Functions of Energy rating: Star labeling of equipment. 1.7 Features of energy conservation act 2001 1.8 Energy Units and Conservations 1.9 Pay back period, Internal Rate of Return, Depreciation 1.10 Role of ESCO 1.11 Difference between ESCO and EPC	

SW-1 Suggested Sessional Work (SW):

- **Assignments:**
  i. Explain the difference between energy conservation and energy efficiency with suitable example.
  ii. Visit at least two nearby industries and administer questionnaire on energy conservation measures adopted by them and prepare a report based on responses.
- **Mini Project:**
  i. Prepare report on latest energy conservation policies of Chhattisgarh state.
- **Other Activities (Specify):**
  i. Carry out a survey on internet and prepare a report on energy conservation act and ECBC (Energy Conservation Building Code)
  ii. Prepare a report on "Bachat Lamp Yojana" Scheme.

CO-2 Conserve energy by applying energy conservation measures in power system.

(Approx. Hrs: CI+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain the scope ofenergy conservation ingeneration. SO2.2 Explain energyconservation measures tooptimize transmission anddistribution SO2.3 Explain demandside management and	LE2.1 Analyze the case study of energy conservation in generation by solar, wind, bio energy, cogeneration and fuel cell technology or any recent technology of generation estimating pay back period also. LE2.2 Collect the energy	**Unit 2.0 Energy Conservation in Power System** 2.1 Energy conservation in generation –Solar, wind, Bio energy, Cogeneration, Fuel cell technology(Case study) 2.2 Power factor, Causes and effects of low power factor, power factor improvement and its Importance,Methods of	• Calculate the payback period for a given energyconservation equipment in generation, transmissionand distributionsystem • Calculate the depreciation cost of a given

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
itssignificance in energyconservation. SO2.4 Explain the types of tariff andrestructuring of electrictariff SO2.5 Explain the causes and effect of low power factor SO2.6 Explain the Methods of power factor improvement SO2.7 Describe mosteconomical power factorand state importance ofimprovement. SO2.8 Describe the working a given energy conservation equipmentin T&D system.	bills of various electrical consumers and prepare a report on reduction of electricity bill. LE2.3 Visit to Automatic power factor correction unit in industrial/commercial utility and analyze its working. LE2.4 Estimate electrical energy savingby improving power factor and load factor for a given case study in terms of saving in units and cost .	power factor improvement(Numerical on above) 2.3 Most economical power factor,Selection and location of power factor correcting equipment 2.4 Assessment of Transmission and Distribution (T&D) losses in power system: Technical and commercial 2.5 Demand-Sidemanagement (DSM): objectives, methodology 2.6 Energy conservation equipment : ➢ Maximum Demand Controller ➢ kVAR Controller Automatic Power Factorcontroller. 2.7 Tariff, desirable characteristics of tariff 2.8 Types of tariff- Simple tariff, flat rate tariff, block rate tariff, two part tariff, M. D. tariff, power factor tariff, Time-off-day tariff, Peak-off day tariff, Load factor tariff Introduction to Availability Based Tariffs (ABT),Recent Chhattisgarh State Power Distribution Company Limited (CSPDCL) tariffs for different consumers. (Simple Numerical on above topic)	energyconservation equipment in generation, Transmissionand Distribution system

SW-2 Suggested Sessional Work (SW):

- **Assignments:**
  i. Explain demand side management and various techniques used for DSM. What are the benefits of DSM.
- **Mini Project:**
  i. Estimate the pay back period, depreciation cost, for the given energy saving equipment in the transmission and distribution system.

- **Other Activities (Specify):**
  i. Collect the catalogues of at least five star labeled equipment and prepare a report on star labeled equipment.

CO-3 Conserve energy by applying energy conservation measures in lighting.

(Approx. Hrs: CI+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 State the basics terms related to lightning/illumination. SO3.2 Analyze the energy assessment steps in lightning. SO3.3 Explain different energy conservations techniques in lightning scheme. SO3.4 Describe the inrush current phenomenon in transformer. SO3.5 Describe the energy conservation techniques lightning system. SO3.6 Identify the conservation technique in fan.	LE3.1 Collect information by market survey and prepare report on rating, luminous output, cost, list of manufacturers of various types of energy efficient luminaries (FTL, CFL, LED, Sodium Vapour, HPMV etc.) LE3.2 Case study on the energy conservation measures taken in street lighting. LE3.3 Determine the reduction in power consumption by replacement of FAN and regulators in class room/ laboratory. LE3.4 Compare the power consumption of different types of Tube-light with choke, electronic blast and LED lamps by direct measurement.	**Unit 3.0 Energy conservation in lighting system** 3.1 Basic parameters and terms used in lighting system (Illumination). 3.2 Recommended Luminance levels 3.3 Procedure for assessing existing lighting system in a facility. 3.4 Energy conservation techniques in lighting system. ➢ By replacing Lamp sources. ➢ Using energy efficient luminaries ➢ Using light controlled gears ➢ By using the advance technology ➢ By installation of ➢ separate Transformer / servo stabilizer for lighting. ➢ Periodic survey and adequate maintenance programs ➢ Lighting maintenance. ➢ Centralized Control Equipment (Microcontroller based). ➢ Occupancy sensors/Motion Detectors ➢ Control gears: Dimmers, Regulators and Stabilizers.	• Calculate the Calculate the payback period for a given energyconservation equipment in lighting system • Calculate the depreciation cost of a given energyconservation equipment in lighting system

SW-3 Suggested Sectional Work (SW):

- **Assignments:**
  i. Explain the principle of operation and features of LED lamps and metal halide lamps.
  ii. Analyze the maintenance procedure for improving efficiency of a given lighting scheme

- **Mini Project:**
  i. Make a comparative study of energy efficient control gears and ballasts used in lighting system on the basis of energy efficiency, cost,life, energy saving and saving in energy bill.

- **Other Activities (Specify):**
  i. State various energy saving opportunities in the municipal lighting system along with investment and simple playback for minimum three saving options.

CO-4 Conserve energy by applying energy conservation measures in electrical motors and transformers.

(Approx. Hrs: CI+ LI+SW+SL=16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Describe the need and significance of energy conservation in motors and transformers. SO4.2 Describe the features of Energy EfficientMotors SO4.3 Differentiate between energy efficient and standard motors. SO4.4 Describe the various techniques of energy conservation in a three phase induction motor SO4.5 Describe the working of various energy conservation equipment in electrical motors. SO4.6 Describe the working of various energy efficient transformer and also state their special features.	LE4.1 Case study on the energy conservation techniques implemented inelectrical motors. LE4.2 Determine the power saving in star mode operation of Induction motor compared to delta mode. LE4.3 Determine the '% loading' along with the related efficiency for different loads of given Induction motor. LE4.4 Control speed of a 3 phase inductionmotor using VFD LE4.5 Analyze the specifications of a energy efficient motor.	**Unit 4.0Energy conservation in electrical motors and Transformers** 4.1 Need and significance of energy conservation in motors and transformers. 4.2 Construction, working and advantages of Energy Efficient motors. 4.3 Difference between energy efficient and standard motors. 4.4 Energy conservation techniques in Induction motor, the work horse of the industry: ➢ By improving Power quality. ➢ By motor survey. ➢ By matching motor. ➢ By minimizing the idle andredundant running of motor. ➢ By operating in star mode. ➢ By rewinding of motor. ➢ By improving mechanical power and transmission efficiency 4.5 Function of Energy conservation equipment related to electrical motors: ➢ Soft starter: For inductionmotors ➢ Power Factor Controller ➢ Static capacitor ➢ Automatic star delta starter	• List the manufacturers of energy efficient electric motors and energy efficient transformers • List the suppliers of energy efficient electric motors and energy efficient transformers.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
		➢ Variable Frequency Drives. 4.6 Energy efficient transformer, its features amorphous transformer; epoxy Resin cast transformer/ Dry type of transformer	

SW-4 Suggested Sectional Work (SW):

- **Assignments:**
  i. Explain the reasons of not locating distribution transformer at load centre of secondary distribution system.
- **Mini Project:**
  i. Prepare a star rating plan for distribution transformers and corresponding losses specified by BEE.
- **Other Activities (Specify):**
  i. List the manufacturer and supplier of Energy conservation equipment related to electrical motors.

CO-5 Carry out energy audit using energy audit equipment and meters.

(Approx. Hrs: CI+ LI+SW+SL=20)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 State the Electricity act 2003 and IE rules for energy audit. SO5.2 Describe energy flow diagram and state its importance. SO5.3 Describe the use of various energy audit instruments for a given application. SO5.4 Prepare energy audit questionnaire SO5.5 Know the stepwise procedure of different energy audits. SO5.6 Calculate the payback period and return on investment of energy	LE5.1 Prepare a sample energy audit report of your workshop/ lab, by using various energy audit instruments. LE5.2 Prepare a sample energy auditquestionnaire for a educational institute, implement it and prepare a report. LE5.3 Visit to any one organization such as Hospitals, public library or any commercial building, prepare questionnaire for implementation energy conservation program.	**Unit 5.Energy Audit** 5.1 Electricity act 2003 (statement) 5.2 IE rules and regulations for energy audit. 5.3 Energy Flow Diagram and its significance. 5.4 Energy audit instruments and their use. 5.5 Questionnaires for the energy audit. 5.6 ABC analysis. 5.7 Internal energy audit checklist. 5.8 Procedure of Energy audit (walkthrough audit and detailed energy audit) 5.9 Simple payback period and return on investment 5.10 Examples on small Energy conservation projects. (Numerical). 5.11 Instruments for Audit - basic role and usage	• Collect the details of different Manufactures of energy audit instruments and prepare a report. • Collect the details of different suppliers of energy audit instruments • Develop 5S strategies for effective energy management plan.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
conservation measures.		guidelines for instruments like digital multi-meter,tong tester, Lux meter, power analyzer , flow meters, thermal imager, temperature indicators, digital pressure meter etc	

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sectional Work (SW):

- **Assignments:**
  iii. Describe the usage of different instruments used during energy audit.

- **Mini Project:**
  i. Analyze theenergy conservation act 2003 from IEA and prepare a brief summary.

- **Other Activities (Specify):**
  i. Analyze ISO50001- energy management systems standard and prepare a report on how it can work as a system to enhance energy efficiency.
  ii. Give a seminar on Energy Audit instruments and their working.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Energy conservation measures and Management	4	4	4	12
II	Energy Conservation in Power System	4	5	5	14
III	Energy Conservation in Lighting system	4	6	5	15
IV	Energy Conservation in electrical Motors and Transformers	4	6	4	14
V	Energy Audit	4	6	5	15
Total		**18**	**32**	**20**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESA of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	List various energy management systems prevailing in a particular industry/Organization.	50	40	10
LE1.2	Identify the energy management skills and strategies in the energy management system.	50	40	10
LE1.3	Visit the web site of BEE and MEDA /CREDA and collect the information on energy conservation activities.	50	40	10
LE1.4	Conduct an interview with the energy manager regarding energy conservation.	50	40	10
LE2.1	Analyze the case study of energy conservation in generation by solar, wind, bio energy, cogeneration and fuel cell technology or any recent technology of generation estimating pay back period also.	50	40	10
LE2.2	Collect the energy bills of various electrical consumers and prepare areport on reduction of electricity bill.	50	40	10
LE2.3	Visit to Automatic power factor correction unit in industrial/commercial utility understand its working.	50	40	10
LE2.5	Estimate electrical energy saving by improving power factor and load factor for a given case study in terms of savings in units and cost.	50	40	10
LE3.1	Collect information by market survey and prepare report on rating, luminous output, cost, list of manufacturers of various types of energy efficient luminaries (FTL, CFL, LED, Sodium Vapour, HPMV etc.)	50	40	10
LE3.2	Case study on the energy conservation measures taken in street lighting.	50	40	10
LE3.3	Determine the reduction in power consumption by replacement of FAN and regulators in class room/ laboratory.	50	40	10
LE3.4	Compare the power consumption of different types of Tube-light with choke, electronic blast and LED lamps by direct measurement.	50	40	10
LE4.1	Case study on the energy conservation techniques implemented inelectrical motors.	50	40	10
LE4.2	Determine the power saving in star mode operation of Induction motor compared to delta mode	50	40	10
LE4.3	Determine the '% loading' along with the related efficiency for different loads of given Induction motor.	50	40	10
LE4.4	Control speed of a 3 phase induction motor using VFD.	50	40	10
LE4.5	Analyze the specifications of a energy efficient motor.	50	40	10
LE5.1	Prepare a sample energy audit report of your workshop/ lab, by using various energy audit instruments.	50	40	10
LE5.2	Prepare a sample energy auditquestionnaire for a educational institute, administer it and prepare a report.	50	40	10

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE5.3	Visit to any one organization such as Hospitals, public library or any commercial building, prepare, administer andanalyze questionnaire for implementation energy conservation program.	50	40	10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend:PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Field Trips
6. Demonstration
7. ICT Based Teaching Learning (Video Demonstration, Mobile)

L) Suggested Learning Resources:

(e) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Fundamentals of electrical system	www.bee-india.com	Bureau of Energy Efficiency	Latest edition ISBN: 978-81-909025-3-3
2.	Guide Books no. 1 and 3 for National Certification Examination for Energy Managers and Energy Auditors (Fourth Edition 2015)	(BEE)	Bureau of Energy Efficiency (AStatutory body under Ministry ofPower, Government of India)	
3.	Energy Technology	O.P. Gupta	Khanna Publishing House, New Delhi	Latest edition ISBN: 9789386173683
4.	Efficient Use and Management of Electricity in Industry	Desai, B. G.; Rana, J. S.; A. Dinesh, V.; Paraman, R	Devki Energy Consultancy Pvt. Ltd.	Latest edition ISBN-13;9789350141014
5.	Principles of Power System	Mehta ,V. K	S. Chand &Co.New Delhi	2016, ISBN 9788121905947
6.	Energy Management	Singh, Sanjeev; Rathore, Umesh	S K Kataria & Sons, New Delhi	ISBN-13: 9789350141014
7.	Energymanagement	Paul OCallaghan	Mcgraw Hill, NewDelhi	2012 or latest edition ISBN-10: 0077076788 ISBN-13: 978-077076788
8.	Energy Management and	K. V. Sharma, P.	I K International	First Edition,

S. No.	Titles	Author	Publisher	Edition & Year
	Conservation	Venkataseshaiah	Publishing House Pvt. Ltd;	Edition-November 2011. ISBN-9789381141298
9.	Energy Management, Audit and Conservation	Barun Kumar	Vrinda Publications P Ltd.;	2e edition (28 April 2014 ISBN-10: 8182810930 ISBN-13: 978-8182810938
10.	Energy Engineering And Management	Chakrabarti, Aman	e-books Kindle Edition	
11.	India - The Energy Sector	P. H. Henderson	University Press,Delhi	2016 edition ISBN: 978-0195606539
12.	Energy Management Handbook	W. C. Turner	Fairmount Press	2012, ISBN 9781304520708
13.	Utilization Generation & Conservation Of Electrical Energy	Sunil S. Rao	Khanna Publishers (2007)	ISBN-13 978-81-7409-201-4

(b) Open source software and website address:

1. Website of bureau of energy and efficiency: www.bee-india.nic.in
2. Website of Akshay Urja News Bulletin: www.mnes.nic.in
3. Chattisgarh State Renewable Energy Development Agency:www.creda.in,www.credaom.com
4. Maharashtra Energy Development Agency (MEDA):www.mahaurja.com
5. Notes on energy management on: www.energymanagertraining.com
6. www.greenbusiness.com
7. www.worldenergy.org

(c) Others:

1. Learning Packages
2. Lab Manuals
3. Manufacturers' operating Manual
4. Manufacturer/supplier catalogues

M) List of Major Laboratory Equipment and Tools:

s

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Automatic power factor correction Equipment	-	LE2.2
2	Digital multi-meter	-	LE2.2, LE4.1
3	Tong tester	-	LE2.2, LE4.1
4	Lux meter	-	
5	Power analyzer	-	LE2.2, LE4.1, LE5.2, LE5.3
6	Flow meters	-	LE5.2, LE5.3
7	Thermal imager	-	LE4.1, LE5.2, LE5.3
8	Temperature Indicators	-	LE2.2, LE4.1, LE5.2, LE5.3

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
9	Digital Pressure Meter	-	LE5.2, LE5.3
10	Energy efficient motor	-	LE 4.5
11	Speedometer	-	LE4.4
12	smart energy meters	-	
13	FTL, CFL, LED	Different rating	LE3.1
14	Electric choke, Electronics ballast	Single-phase, 230V, 50Hz	LE3.4
15	Star-delta converter	3-phase, 415V, 25A	
16	Electric and electronic fan regulator	1-phase, 230V, 50Hz	
17	Three phase induction motor with VFD Drive	-	LE 4.4

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Create awareness about the significance of energy conservation and management and also about other energy conservation measures.	3	3	3	3	1	1	3	3	2	3	3	3
CO-2 Conserve energy by applying energy conservation measures in power System.	2	3	3	3	1	1	3	3	2	3	3	3
CO-3 Conserve energy by applying energy conservation measures in lighting.	3	3	3	3	1	1	3	3	2	3	3	3
CO-4 Conserve energy by applying energy conservation measures in electrical motors and transformers.	3	3	3	3	1	1	3	3	2	3	3	3
CO-5 Carry out energy audit using energy audit equipment and meters.	3	3	3	3	1	1	3	3	2	3	3	3

Legend : 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-1 Create awareness about the significance of energy conservation and management and also about other energy conservation measures.	SO1.1,SO1.2 SO1.3,SO1.4, SO1.5,SO1.6, SO1.7,SO1.8, SO1.9,SO1.10,So1.11	LE1.1, LE1.2, LE1.3, LE1.4,	Unit 1.0 Energy conservation measures and Management 1.1, 1.2, 1.3, 1.4,1.5,1.6, 1.7, 1.8,1.9,1.10,1.11	As mentioned
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-2 Conserve energy by applying energy conservation measures in power System.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5,SO2.6, SO2.7, SO2.8,	LE2.1,LE2.2, LE2.3,LE2.4	Unit 2.0 Conservation in Power System 2.1,2.2,2.3,2.4,2.5,2.6	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-3 Conserve energy by applying energy conservation measures in lighting.	SO3.1, SO3.2, SO3.3, SO3.4, SO3.5	LE3.1,LE3.2, LE3.3, LE3.4,	Unit 3.0 Energy conservation in lighting system 3.1,3.2,3.3,3.4	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-4 Conserve energy by applying energy conservation measures in electrical motors and transformers.	SO4.1,SO4.2, SO4.3,SO4.4, SO4.5,SO4.6	LE4.1, LE4.2, LE4.3, LE4.4, LE4.5	Unit 4.0 Energy conservation in motors and Transformers 4.1,4.2,4.3,4.4,4.5, 4.6	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-5 Carry out energy audit using energy audit equipment and meters.	SO5.1,SO5.2, SO5.3,SO5.4, SO5.5, SO5.6	LE5.1,LE5.2, LE5.3	Unit 5.0 Energy Audit 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 5.7, 5.8, 5.9,5.10,5.11	

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learnin

A) Course Code : 2024663(024)

B) Course Title : Major Project

C) Pre- requisite Course Code and Title :

D) Rationale :

Project work plays a very important role in engineering educations in developing core technical skills, soft skills and higher level of cognitive, psychomotor and affective domain skills. It encourages the thinking process in the students.

Project work is normally done when students have acquired sufficient knowledge, skills and attitude and are able to integrate all these, entirely in new situation or task to solve the problems of the industries.

Through project work, students get direct exposure to the world of work in their relevant field. They are intrinsically motivated to explore new things, new methods, new design and many more ideas.

They also develop many soft skills like confidence, communication skills, creative ability, inquisitiveness, learning to learn skills, lifelong learning skills, problem solving skills, management skills, positive attitude, ethics etc. through project work.

Normally in a curriculum document, there is a mention of project work in two different situations.

In situation one, Project work is reflected as Mini Project under each and every course curricular detailing, in the form of sessional work mentioned under different semesters. These projects are normally related to the developing skills in respective course of the specific programme.

In another situation, project work is reflected as a complete course or as a major project in the total programme structure, normally at higher semester either at 4^{th}, 5^{th} and 6^{th}, depending on the requirement of the programme Normally.

E) Course Outcomes: After completion of the project work of a course or full semester, the students will be able to -

CO-1 Integrate the Knowledge (K), Skills (S), Attitudes (A) developed in a new task or problem identified in the form of project work.

CO-2 Develop higher level of cognitive, psychomotor and affective domain skills relevant to the course/programme.

CO-3 Integrate the generic skills/soft skills/employable skills with relevant technical skills for successful completion of the project work.

CO-4 Develop the skills of innovativeness, creativity, resourcefulness, time management, problem solving abilities, interpersonal skills, pro-activeness, cost effectiveness, environment consideration and sustainability.

F) Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)					
			L	P	T	SL	Total Study Hours (L+P+T+SL)	Total Credits (L+T+P/2)
Electrical Engineering	2024663 (024)	Major Project	----	3	----	2	5	2

Lecture (L) L Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.) Practical (P) Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Tutorial Includes sessional work (SW) (assignment, seminar, mini project etc),

Self-Learning (SL) includes self-study, group study and learning from subject teacher or use of multi media

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

Board of Study	Course Code	Course Title	Scheme of Examinations					
			Theory			Practical		Total Marks
			ESE	CT	TA	ESE	TA	
Electrical Engineering	2024663(024)	Major Project	----	-----	-----	100	120	220

Legend:

ESE: End semester exam CT: Class Test TA: Teachers Assessment

PRA: Process Assessment, PDA: Product Assessment

Note:

i. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.

H) Guidelines to Teachers for Implementation of the Project Work :

Once the project is identified and allocated to students, teacher's role is very important. Teachers act as guide, facilitator, catalyser, motivator to promote brain storming, thinking, creatively, initiativeness and many other skills in the students. Teachers should help or guide continually to monitor whether the students are proceeding in the right direction as per outcomes to be attained.

It is also suggested that teachers are not supposed to guide and plan each and every step from the point of view of execution of the project, otherwise it will curb their creativity or thinking process. Teachers have to see that he or she is able to create think tank for this fast technological world of work for the growth of our country. Following points should be taken into consideration while planning and implementing the project work.

1. Identification of project and allocation methodology :

Though the teachers and students, both are involved in identification of project titles, but the prime responsibility of identification of project titles goes to the teachers involved in implementing the course or programme. Teachers are fully aware of course/programme curriculum. They are also aware of related industrial problems. They try to explore the possibility of identification of project titles through these problems.

These small industrial problems in the form of project titles may be brought into the laboratories or workshop of institutions of a specific programme, which are equipped with all necessary facilities and resources to carry out the project work. These labs or workshop can function as miniature industry to solve the industrial problems in the form of simulated industrial projects. These projects may be integrated problem of courses or programme.

The project identified may beapplication type, product type, Research type and review type.

1.1 Criteria for Identification and Implementation of Project Titles :

Identification of project title is planned to be done based on many considerations like :

- Cost effectiveness
- Safety considerations
- Ethical issues
- Environmental considerations
- Improvised process
- Improvised equipment
- Simulated industry's problem
- Application or utility in the world of work.
- Relevance to the Curriculum
- Mapping of Outcomes of Project with POs and PSOs
- Feasibility of implementation of theproject

2. Implementation and Evaluation of Project Work:

Once the identification of project titles and guide allocation process is over, quality of student's project, on different criteria including the report writing need to be continually monitored.

Projects planning, design, execution and report writing is done by the students under the guidance and feedback by respective teachers for attainment of courses specific outcomes, POs and PSOs.

Continual Monitoring, feedback and assessment mechanism on weekly progress/updates on action taken on different criteria and sub-criteria of the project work need to be planned for individual and team of students. Path breaking teachers who think out of the box are required to guide, monitor and evaluate the project work.

For objective, valid and reliable assessment, teachers should use different tools of assessment such as checklist, rating scale, assessment rubric, observation schedule, portfolio assessment, incidental records etc. Even the students may be encouraged to adopt self assessment techniques using the assessment rubrics.

2.1 Criteria of Evaluation of Project:

The different criteria of evaluation of project under different sub heads of project work completion are given below :

2.2.1 Project Planning :

Project planning, its action plan, steps of realizing the projects, may be specifically planned in advance based on feasibility, resources available, time allocation, finance and manpower requirement for each and every step or activity of project work.

Under project planning, many points need to be considered like -

- Selection of relevant industry based projects as per the requirement of curriculum
- Rationale/Application
- Objectives Set
- Literature survey
  Literature survey on the project title need to be done through abstract, journals, websites, open sources and other relevant sources available.
  It need to be ensured that objectives are written properly with clear specific, measurable and attainable statements. The sample size has to be delimited and

decided as per the time limit allotted, feasibility and many other considerations. Objectives formulated will decide the further course of action, depth and breadth of the project and implementation plan.

2.2.2 Design, Development and Execution of Project :

Following important characteristicfeatures of project are need to be given special emphasis during the implementation of the project work-

- Innovativeness
- Creativity
- Originality
- Pro-activeness
- Initiativeness
- Cost Effectiveness
- Resourcefulness
- Development of soft skills/generic skills

There may be deviation from planning, design and implementation of the project as per the requirement.

2.2.3 Quality of Report Writing :

Following points need to be taken care of for report writing-

- Report writing as per prescribed format
- Clarity of Objectives
- Presentation of Data
- Data Analysis, Interpretation and Result
- Quality of Product

2.2.4 Presentation & Discussion :

Quality of presentation of data need to be ensured using the following criteria -

- Clarity in Communication and Presentation
- Voice Audibility
- Use of Media and methods
- Satisfying the queries of audience
- Attainment of objectives set

2.2.5 Project's Potential :

Futuristic scope and recommendation for further studies related to project may be assessed from the following criteria -

- Papers published or award received
- Exhibition or Display or showcase of project in competition or exhibition or Tech Fest
- Evaluation of working of projects or prototype
- Relevance and Applications in the world of work
- Recognition in any form
- Related areas/sub areas for further studies

The students need to be assessed continuously based on the assessment rubric prepared by the implementing teachers on different stages of project work completion.