GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma in Engineering

Level: Diploma

Branch: Environmental Engineering

Course / Subject Code : DI01C13021(Only for C to D Students)

Course / Subject Name : Basics of Mechanical and Electrical Engineering

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	ESC - Engineering Science Courses

Prerequisite:	Basic Science Knowledge
Rationale:	Integrating mechanical and electrical engineering knowledge into environmental engineering education equips students with a comprehensive understanding of how mechanical and electrical systems interact with and impact the environment. Many environmental engineering projects require the design and optimization of mechanical systems, such as water treatment plants, air pollution control devices, and renewable energy systems. Electrical engineering principles are crucial in the design, implementation, and management of renewable energy systems such as solar, wind, and hydroelectric power. Therefore this course is important for Environmental engineering students as this interdisciplinary approach equips future environmental engineers with the skills and knowledge needed to develop sustainable, efficient, and innovative solutions to environmental problems.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Use relevant mechanical power and hand tools in real life applications.	R,U,A
02	Identify different components of various thermal systems.	R,U,A
03	Identify various hydro-pneumatic devices/equipment.	R,U,A
04	Apply fundamentals of DC circuits and batteries in relevant engineering discipline.	R,U,A
05	Apply fundamental of AC circuits in relevant engineering discipline.	R,U,A
06	Distinguish various electrical machines based on their working and applications.	R,U,A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
0	1	4	3	0	0	20	30	50

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Basic Mechanical Tools and Components** Introduction of mechanical engineering, Use of mechanical engineering-In day to day life and Interdisciplinary use Items in general use-identification criteria, major types, specifications and uses such as bolts, nuts, washers, bearings, valves, bushes, springs, levers, rivets, keys, o'rings, oil seals, shafts, axles. Pipes and pipe fittings- Types,specifications and uses. Hand and power tools: Types, specifications and uses of spanners (such as fix,ring, box, pipe, Allen, adjustable). Types, specifications and uses of hand tools (such as,Pliers, Screw drives, Chisel,Hand hacksaw, Hammers). Types, specifications and uses of power tools (Portable Drilling and grinding machine, Electric power saw,portable electric cutter, electric demolition hammer, power screw driver) Introduction to lathe, drill, milling and grinding machines. Types of operations / jobs which can be performed on machine tools listed above. Various process like Carpentry, welding, Foundry, Bending, rolling, forging and extrusion – concept and its application	2	20
2.	**Thermal systems** Steam generation, Steam formation process.	2	20

	Boilers: Introduction, Classification, Construction and working of Cochran, Lancashire, and Babcock and Wilcox boiler, Functioning of different mountings and accessories. Prime movers: Definition, Classifications. Steam turbine -working and applications, Refrigeration: Definition, Major components of refrigeration systems, Ton of refrigeration, Applications. Air Conditioning: Definition, Properties of air, Types of air conditioning systems. (Window, Package, Central air conditioning system)		
3.	**Hydraulic and Pneumatic Devices** Concept of theory of fluid flow, General properties of fluids. Pump: Working principle, Types, Construction and Working of centrifugal and reciprocating pumps. Water turbines: Working principle, Types, Application. Air compressor: Working principle, Types, Application. Other hydraulic/pneumatic/ hydro-pneumatic equipment. Principle of working- hydraulic lift, hydraulic pump, hydraulic power pack, hydraulic jack, Application.	3	10
4.	**DC Circuits** Concept of Electric Potential, EMF, Current, Power and Energy Resistor, Inductor and Capacitor Effect of temperature on resistance of conductor Ohm's law: Applications and limitations Kirchhoff's voltage law and Kirchhoff's current law Types of connections: series and parallel connections of resistors Battery: Concept of cell and battery, Rating of battery, Series and parallel connection of batteries, Applications	2	20
5.	**AC Circuits and Wiring** Basic Terminology: Cycle. Time- period, Amplitude, Frequency, RMS value. Average value, Form factor, Peak factor Pure resistor, inductor and capacitor with AC supply Power triangle and power factor Domestic wiring: Types of AC supply, Concealed and conduit wiring, Power rating of domestic appliances, fitting and fixtures, Sample example of one room electrification, Staircase wiring and godown wiring, electrical unit consumption and billing, Basic concept of energy audit	3	20

	Electrical Safety: Fuse, MCB, ELCB, RCCB, Need of Earthing, First aid against electrical shock		
6.	**Electrical Machines** Types of electrical machines: Static and Rotating, AC and DC. Basic construction and applications of DC machines: DC motor and generator. Basic construction and principle of working: Transformer ,Auto transformer Basic construction and applications of AC machines: , Single phase and three phase induction motor, Alternator Construction and applications of BLDC motor Use of DG set as emergency supply Solar energy: PV cell, Panel and Arrays, Block diagram of solar powersystem Wind energy: Block diagram of windpower system	3	10
	Total	**15**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
Not Applicable					

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

References/Suggested Learning Resources:
(a) Books:

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Theory of machine	R S Khurmi & J K Gupta	Eurasia Publishing House (Pvt.) Ltd. New Delhi,2020 ISBN: 9788121925242
2	Elements of workshop Technology (Vol. 1,2)	S.K. Hajra chaudhary A.K. Hajra chaudhary	Media promoters & publishers Pvt.Ltd. Mumbai,2010 ISBN:9788185099156
3	Fluid mechanics and hydraulic machines	R.K.Bansal	Laxmi publication Pvt.Ltd. New Delhi,2018 ISBN: 9788131808153

4	Thermal Engineering	R.K.Rajput	Laxmi Publication Pvt.Ltd. New Delhi,2018 ISBN:9788131808047
5	A Textbook of thermal Engineering	R. S. Khurmi & J. K. Gupta	S.chand Limited, New Delhi,2020, ISBN:9788121925730
6	Basic Mechanical Engineering	Pravin Kumar	Pearson Education ,India, 2018 ISBN: 9789386873293
7	Basic Mechanical Engineering	S. C. Sharma & M.P. Poonia	Khanna Publishing,2018 ISBN:9789386173331
8	A text book of Electrical Technology-Vol.1,2,4	Theraja B. L. Theraja A.K.	S.Chand Publication
9	Non-Conventional Energy Sources	Rai G. D.	Khanna Publications ISBN:978-8174090737

(b) Open source software and website:

- http:/nptel.iitm.ac.in/
- https://www.khanacademy.org/
- http://learnerstv.in/
- https://www.youtube.com/watch?v=DGST2NvATKI (Basic Mechanical tools)
- https://www.youtube.com/watch?v=eRfTZpEmnys&t=6s (Hand Tools)
- https://www.youtube.com/watch?v=RdipnvBPOKU (Power Tools)
- https://www.youtube.com/watch?v=dVBoZ4PfZmE (Boiler)
- https://www.youtube.com/watch?v=h5wQoA15OnQ (Refrigeration)
- https://www.youtube.com/watch?v=gVLhrLTF878 (Air Conditioning)
- https://www.youtube.com/watch?v=BaEHVpKc-1Q (Pump)
- https://www.youtube.com/watch?v=7uI7G8csJSM (Pump)
- https://www.youtube.com/watch?v=VoUtTjtA5vE (Compressor)
- https://www.youtube.com/watch?v=M08LCcVAuUY (Material Handling equipment)
- www.nptel.iitm.ac.in
- https://ndl.iitkgp.ac.in
- www.electronicsforu.com
- www.electrical4u.com
- www.vlab.co.in

Suggested Course Practical List:

S. No.	Practical Outcomes (Mechanical)(PrOs)	Unit No.	Approx. Hrs. required
1	Use different hand, power tools and pipe fitting tools for the given application	I	02
2	Make simple pipe layouts using pipes and pipe fittings as per given drawing.	I	02
3	Prepare a job using arc and gas welding operation.	I	02
4	Perform soldering/brazing operation on the given job.	I	02
5	Prepare a wooden joint as per the given drawing	I	02
6	Prepare a simple sheet metal product such as (Funnel or Box)	I	02
7	Attach/detach different mountings and accessories on steam boiler model.	II	02
8	Assemble/dismantle impulse turbine model.	II	02
9	Assemble/dismantle reaction turbine model.	II	02
10	Determine properties of air (Dry bulb temperature, Wet bulb temperature, Humidity).	II	02
11	Assemble/dismantle centrifugal and reciprocating pump. (Any one)	III	02
12	Assemble/dismantle water turbines models.	III	02
13	Assemble/dismantle centrifugal, reciprocating and screw compressor model.(Any one)	III	03
14	Design and assemble a hydraulic circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given training kit.	III	03
	Total		**30Hrs**

S. No.	Practical Outcomes (Electrical) (PrOs)	Unit No.	Approx.Hrs required
1	Identify resistors, inductors and capacitors.	IV	02
2	Verify Ohm's law in the given electric circuit.	IV	02

3	Verify Kirchhoff's current law in the given electric circuit.	IV	02
4	Verify Kirchhoff's voltage law in the given electric circuit.	IV	02
5	Measure voltage, current and power in the given DC circuit.	IV	02
6	Measure voltage, current and power and power factor in single phase AC circuit.	V	02
7	Carry out following wiring: (1) Staircase (2) Godown.	V	02
8	Calculate unit consumption for given electrical load.	V	02
9	Test the operation of protective devices like Fuse, MCB and ELCB.	V	02
10	Identify various parts of DC machines stating its function	VI	02
11	Identify various parts of AC machines stating its function	VI	02
12	Measure output voltage of the given single-phase transformer.	VI	02
13	Identify components of solar power system stating its function.	VI	03
14	Identify components of wind power system stating its function.	VI	03
	Total		**30 Hrs.**

List of Laboratory/Learning Resources Required:

S. No.	Equipment Name with Broad Specifications (Mechanical)
1	Plumbing tools- Coupling, Elbow, Bends, Tee, Plug, Cap, Nipple,Union, Reducer, Cross, Flanges.
2	Hand tools- Different spanners (Wrench), Pliers, Screw drives,Chisel, Hand hacksaw, Hammers.
3	Power tools- Portable Drilling and grinding machine, Electric powersaw, portable electric cutter, electric demolition hammer, power, screw driver.
4	Plastic Pipes and Metal pipes of different diameters and connectors, different types of pipe fittings, different types of pipe joints.
5	Pipe wrench, pipe vice, hacksaw , plumb bob, dies, pipe cutter, files and rasps
6	Center lathe machine(length between centers:1200mm)
7	Arc Welding machine welding current 20-400A.
8	Arc welding tools-electrode holder, cable connector, cable lugs,earthing clamp, wire brush.
9	Oxygen and acetylene gas welding and cutting kit with cylinders and regulators.
	Gas welding tools- welding torch, welding tip, spark lighters.

10	
11	Brazing and soldering kit. (Brazing kit with suitable silver and copper brazing alloy rods for ¼ '' to 7/8'' tubes- cu to cu, cu to steel, cu to brass and appropriate flux.)
12	Wood working tools- carpentry vice 150mm, marking and measuringtools, saws, claw hammer, mallet, chisel, squares.
13	Sheet metal material - Black iron, Galvanized iron, Stainless steel , Copper, Aluminum, Tin plate
14	Hand tools for sheet metal work - Trammers, Wire Gauge, Snips,Hammers, Stakes, Steel Metal Joints.
15	Models/cut section (Wooden/Plastic/Metallic) of fire and water tube boilers.
16	Models (Wooden/Plastic/Metallic) of different mountings and accessories for boilers.
17	Models/cut section (Wooden/Plastic/Metallic) of impulse andreaction turbine (suitable for dismantling)
18	Sling psychomotor and thermometer.(Digital temperature and humidity measurement, temperature range of -25° C to 60° C orhigher)
19	Centrifugal pump (suitable for dismantling)
20	Reciprocating pump. (suitable for dismantling)
21	Model/cut section (Wooden/Plastic/Metallic) Pelton wheel, Francis and Kaplan turbine. (suitable for dismantling)
22	Centrifugal compressor (suitable for dismantling)
23	Reciprocating compressor (suitable for dismantling)
24	Screw compressor(suitable for dismantling)
25	Hydraulic and Pneumatic trainer
S. No.	**Equipment Name with Broad Specifications (Electrical)**
1	Variable DC power supply: 0- 30V, 2A, Short Circuit protection, display for voltage and current
2	Discrete Component Trainer/ Analog Component Trainer: Fixed and variable D.C. Supplies, AC Supplies, Actual Components like transistors, SCR, LDR, photo diode, resistors, capacitors, inductors, diodes, LED's, transformers, 2 mm patch cords for interconnecting components

3	Auto-transformer: Single phase, 0- 230 V ,0-260 V, 8A
4	Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: Vac, Vdc (1000V max) , Adc, Aac (10 amp max), Resistance (0 - 100 M□) , Capacitance and Temperature measurement
5	Demonstration model for staircase and godown wiring.
6	Demonstration model for operation of fuse, MCB, ELCB and RCCB.
7	Clamp on meter: AC/DC current up to 40 A, 600 V
8	Cut section of AC and DC rotating machines
9	Solar Energy demonstration Kit (Meters, Chargeable Batteries,with sample load)
10	Wind Energy demonstration kit or Wind turbine working Model (Small capacity)

Suggested Project List:

Mechanical:

a) **Boilers**: Build model of different mountings with suitable material.
b) **Casting**: Prepare cast product with wax material.
c) **Pump:** Collect leaflets of pump from market, analyze and compare specifications.
d) **Air conditioning and Refrigeration Controls :** Make models of controls demonstrating their functions at least 3 under guidance of instructor/teacher in lab/ workshop.

Electrical:

a) **Extension board:** Prepare Extension board few sockets and switches.
b) **Electricity bill:** Calculate power consumption of your home and check your energy bill.
c) **Working Model** making for wind /solar power plant: Search on internet video/animation preferably dynamic animation which demonstrates the parts and working of a solar and wind power system and prepare a report.
d) **Solar/Wind power generation in India**: Prepare a report on current installed capacity of RES with emphasis on solar

Suggested Activities for Students:

Mechanical:

a) Student will visit the respective discipline industry / site and will prepare the list of mechanical engineering related equipment/machineries used by that industry / site.
b) Prepare a seminar on casting Processes.
c) Prepare a power point presentation on metal forming process.
d) Prepare a list of household items which are made by joining processes.
e) Prepare a chart on construction and working of various boilers.
f) Prepare property table for different types of refrigerants/alternate fuels.
g) Collect videos, animation showing working of various hydro/pneumatic devices.
h) Students will visit the industry and collect the specification and features of different water turbine and submit the report.

Electrical:

a) Prepare specification of some electrical components.
b) Calculate total installed electrical load of any premises.
c) Prepare a chart for different types of electrical machines and their applications.
d) Give seminar on innovation in renewable energy sources.

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