Program Name : **Electrical Engineering Program Group**
Program Code : **EE/EP/EU**
Semester : **Second**
Course Title : **Basic Mechanical Engineering**
Course Code : **22214**

1. RATIONALE

Electrical engineering is the basic engineering branch. Electric power supply is needed for running of mechanical and the chemical process equipment for which different electric motors are used. So in mechanical industry, the electrical engineer has to take care of various electrical installations with its maintenance. Knowledge of basic thermodynamics including steam engineering, boilers and refrigeration and air-conditioning will be useful for maintenance of related equipment. These equipment are used for generation of electrical power and maintenance of desired environment. Electrical engineer must have fundamental knowledge of fluid Mechanics and fluid machinery which is required in the operation of hydraulic power plants. Topics on air compressors and gas turbine also provide necessary guide lines for the maintenance of these equipment by electrical engineer. Further, this will help trouble free working of these equipment with saving in energy consumption.

2. COMPETENCY

The course should be taught and implemented with the aim to develop the course outcomes (COs) for the student to demonstrate the following competency needed by the industry:

- **Apply principles of Mechanical Engineering to solve broad-based engineering problems.**

3. COURSE OUTCOMES (COs)

The theory and practicals should be taught so that the student attains the cognitive, psychomotor and affective domain learning outcomes (LOs) at the respective and relevant taxonomy levels for the student to demonstrate the following COs required by the industry:

a. Check the broad based working of various types of boilers and steam turbines.
b. Check the broad based working of diesel engines and gas turbines.
c. Check the broad based working of Pelton replace Francis turbines.
d. Check the broad based working of air compressors.
e. Check the broad based working of refrigeration and air-conditioning systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

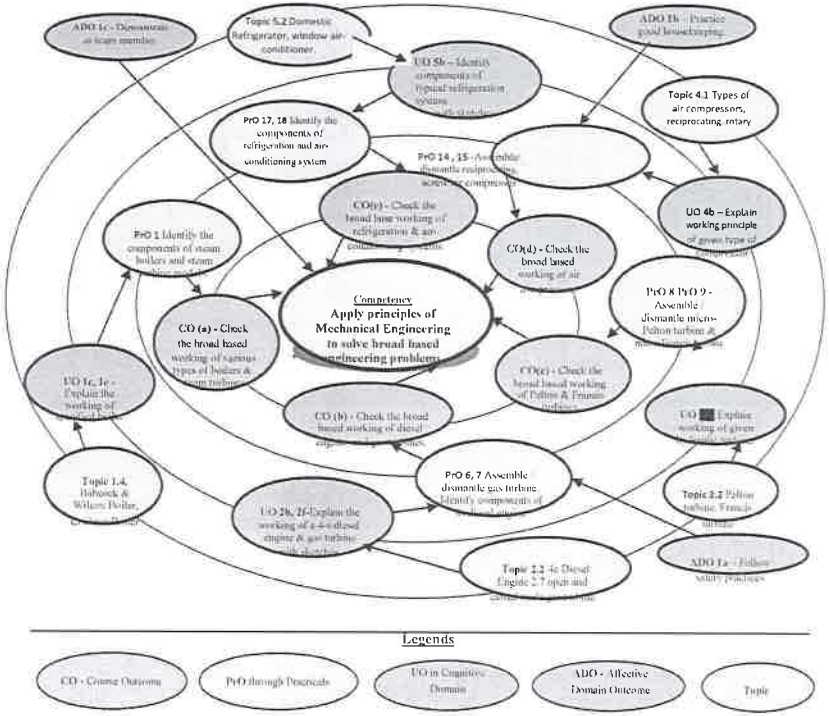

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practical in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Basic Mechanical Engineering		
1	Identify the components of steam boilers model.	I	02
2	Identify the components of impulse and reaction turbine models.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	Assemble / dismantle impulse turbine model.	I	02
4	Assemble / dismantle reaction turbine model.	I	02
5	Identify the components of gas turbine model.	II	02
6	Assemble / dismantle gas turbine model.	II	02
7	Identify components of 4-stroke diesel engine model.	II	02
8	Assemble / dismantle micro-Pelton turbine.	III	02
9	Assemble / dismantle micro-Francis turbine.	III	02
10	Assemble / dismantle hydraulic centrifugal pump.	III	02
11	Assemble / dismantle hydraulic jet pump.	III	02
12	Assemble / dismantle submersible pump.	III	02
13	Perform test on centrifugal pump to calculate overall efficiency.	III	02
14	Assemble / dismantle reciprocating air compressor.	IV	02
15	Assemble / dismantle screw compressor.	IV	02
16	Assemble / dismantle centrifugal compressor.	IV	02
17	Identify the components of refrigeration system (VCC).	V	02
18	Identify the components of air conditioning system (VCC).	V	02

Note

*i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences.

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of

practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organising Level' in 2nd year.
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Models of fire and water tube boilers.	1
2	Impulse and reaction turbine (Suitable for dismantling)	2,3,4
3	Model of Gas turbine. (Suitable for dismantling)	5,6
4	Single or multi cylinder 4-stroke diesel engine.	7
5	Micro-Pelton turbine.	8
6	Micro-Francis turbine.	9
7	Centrifugal pump. (Suitable for dismantling)	10
8	Hydraulic jet pump. (Suitable for dismantling)	11
9	Submersible pump. (Suitable for dismantling)	12
10	Test rig of centrifugal pump to find overall efficiency. (Compact test rig with digital display)	13
11	Two stage reciprocating air compressor. (Suitable for dismantling)	14
12	Screw air compressor. (Suitable for dismantling)	15
13	Centrifugal air compressor. (Suitable for dismantling)	16
14	Unitary refrigeration system. (VCC)	17
15	Unitary air-conditioning system. (VCC)	18

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Steam Boilers and Steam Turbines	1a. Describe given thermodynamic properties 1b. Interpret the specified thermodynamics law 1c. Explain the working of the specified boiler. 1d. Describe the function of the specified component of the	1.1 Specific volume, enthalpy, pressure, temperature, thermodynamic work 1.2 First and second law of thermodynamics 1.3 Basic concepts of wet steam, superheated steam, dryness fraction, degree of superheat. 1.4 Babcock and Wilcox boiler, Cochran boiler. 1.5 Various mountings and accessories (without construction details). 1.6 Layout of steam power plant. 1.7 Steam nozzles – continuity equation,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	steam power plant. 1e. Explain the working of the given type of turbine with sketches	types of nozzles, Mach number, applications of nozzles. 1.8 Impulse and reaction turbines, necessity of compounding. 1.9 Control of pollution due to steam boilers.
Unit– II IC Engines and Gas Turbines	2a. Using sketches identify the specified component of the given type of IC engine. 2b. Explain the working of a 4-stroke diesel engine using sketches. 2c. Calculate brake thermal efficiency for the given data of an IC engines. 2d. Identify simple faults for the given situation of an engine. 2e. Identify the specified component in the sketch of the given type of gas turbine . 2f. Explain with sketches the working of given gas turbine with its applications 2g. Explain with sketches the construction and working of a given gas turbine with its applications.	2.1 Types of IC engines, components of IC engines. 2.2 4 stroke diesel engines. 2.3 BP, heat supplied and brake thermal efficiency of IC engines. 2.4 Common faults in IC engines. 2.5 Remedial measures to rectify the faults. 2.6 Types of gas turbines, applications of gas turbines 2.7 Open and closed cycle gas turbines. 2.8 Control of pollution due to gas turbines and diesel engines.
Unit– III Fluid Machinery	3a. Identify the specified component in the sketch of the given type of hydraulic turbine. 3b. Explain with sketches the working of the given hydraulic turbine. 3c. Identify the specified component in the sketch of the given type of hydraulic pump. 3d. Explain with sketches the working of given type of hydraulic pump. 3e. Calculate the overall efficiency of the given centrifugal pump avoiding velocity diagram.	3.1 Hydraulic turbines, nozzle and diffuser. 3.2 Pelton turbine, Francis turbine. 3.3 Input power of Pelton wheel. 3.4 Reciprocating and Rotary pumps. 3.5 Centrifugal pumps, submersible and jet pumps.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-IV Air Compressors	4a. Identify the specified component in the sketch of the given type of compressor 4b. Explain with sketches the working principle of the given type of compressor. 4c. Select the relevant compressor to be used for the given application with justification. 4d. Suggest the method to reduce energy consumption with justification.	4.1 Types of Air compressors: two stage reciprocating air compressor, screw compressors, centrifugal compressors. 4.2 Methods to reduce power consumption of air compressors.
Unit –V Refrigeration and Air-conditioning	5a. State the HVAC requirement for the given situation. 5b. Identify components of typical refrigeration system in the given diagram with justification. 5c. Explain with sketches the working of specified refrigeration and/or air conditioning system. 5d. Identify the problem for the given failure of the component with justification. 5e. Suggest the solution for energy saving in the given simple situation with justification.	5.1 HVAC; Refrigeration, air-conditioning, ton of refrigeration, major components of vapour compression systems. 5.2 Domestic refrigerator and window air-conditioner. 5.3 OLP, thermostat, starting relay, defrost heaters used domestic in refrigerator and HP/LP cutouts. 5.4 Types of air-conditioning systems - window, package, central air-conditioning systems. 5.5 Basic fault finding in refrigerator and window air-conditioner. 5.6 Methods of energy saving in refrigeration and air-conditioning systems.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Steam Boilers and Steam Turbines	14	04	08	08	20
II	IC Engines and Gas Turbines	12	02	06	06	14
III	Fluid machinery	06	02	04	06	12
IV	Air Compressors	06	02	02	04	08
V	Refrigeration and Air-conditioning.	10	04	06	06	16
	Total	**48**	**14**	**26**	**30**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student -related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Prepare a seminar on boilers used in power plants.
c. Prepare a seminar on boilers control systems used in boiler.
d. Study circuit diagram for starting motor of IC engines and Battery Ignition system.
e. Prepare a power point presentation on hydraulic turbines.
f. Collect videos, animations showing working of different types of air compressors.
g. Make a troubleshooting chart for Domestic refrigerators.
h. Collect manufacturer's specifications for various refrigeration controls.

11. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet -based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Steam Boilers and Turbines** – Draw electrical lay out of any one power plant (08 to 10 hours).
b. **IC Engines** - Collect leaflets of Diesel engine generator sets from market. Analyze and compare the specifications. (At least 04 different manufacturers) (08 to 10 hours).
c. **Gas Turbines** - Collect data of gas turbines used for power plants of different capacities from internet and list features like type, power, speed, fuel used. (At least 04) (08 to 10 hours).
d. **Hydraulic Turbines** - Prepare charts showing parts of different types of commonly used hydraulic turbines from reference books. (08 to 10 hours).

e. **Air Compressors** - Prepare charts of wiring diagram for a 2-stage compressor having an auto cutoff solenoid valve available in laboratory or visiting an industry (8 to 10 hours).
f. **Refrigeration systems** - Students will make charts of wiring diagram of latest 02 each refrigerator / window air-conditioner available in market. (08 to 10 hours).
g. **Refrigeration controls** – Make models of refrigeration controls demonstrating their functioning (at-least 02) in institute workshop / laboratory under guidance of teacher.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Elements of Mechanical Engineering	Manglik, V. K.	PHI Learning Pvt. Ltd., New Delhi, 2013, ISBN: 9788120346291
2	Basic Mechanical Engineering	Agrawal, Basant; Agrawal, C. M.	WILEY India Pvt. Ltd., New Delhi, 2008, ISBN: 9788126518784

14. SOFTWARE/LEARNING WEBSITES

a. http://www.instrumentationengineers.org/2013/06/working-principle-of-impulse-turbines.html
b. https://www.youtube.com/watch?v=AyAd-gLO9CE
c. https://www.youtube.com/watch?v=s2WGFELXPNg
d. https://www.youtube.com/watch?v=gqNtoy2x5bU
e. https://www.grc.nasa.gov/www/k-12/airplane/engopt.html
f. https://powergen.gepower.com/resources/knowledge-base/what-is-a-gas-turbine.html
g. https://www.youtube.com/watch?v=Jd5BN7SPkqI
h. www.sakshat.ac.in