GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: THERMAL ENGINEERING- I
Code: (3341902)

Diploma Programme in which this course is offered	Semester in which offered
MECHANICAL ENGINEERING	**4th Semester**

1. RATIONALE.

Well trained mechanical engineer should have a thorough grading in the basic knowledge of thermal engineering. The object of this course is to establish basic fundamental practical knowledge in the field of thermal engineering which includes boiler operations, boiler mountings and accessories, heat transfer, condensers, air compressor, two phase system etc. The course will provide a mature approach to the basic principles of thermal engineering which will function as foundation in applications in major fields of mechanical engineering and technology notably in steam and nuclear power plants, compressors, small package boiler plantain different devices, etc.

2. COMPETENCY.

- Apply basic concepts, laws and principles of thermal engineering to use equipment/devices/machines working on thermal systems.

3. COURSE OUTCOMES (CO's).

1. Determine steam properties and dryness fractions.
2. Classify and explain boilers, boiler mountings and accessories.
3. Determine boiler performance based on given specific parameters.
4. Explain working of steam prime movers.
5. Identify the elements and processes of steam condensers and cooling towers.
6. Operate air compressors and observe the parameters affecting the performance.
7. Identify heat transfer mode and calculate heat transfer for given heat transfer system.

4. TEACHING AND EXAMINATION SCHEME.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L -Lecture; **T -**Tutorial/Teacher Guided Student Activity; **P -**Practical; **C -** Credit; **ESE**-End Semester Examination; **PA** -Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Two phase system.**	1a. Describe steam formation process and terminology.	1.1 Concept of two phase system. 1.2 Formation of steam, its various phases, definition and representation of wet steam, dry steam, saturated steam and superheated steam on PV, T-s and H-s diagram. 1.3 Concept, definition and determination of dryness fraction and degree of superheat. 1.4 Concept, definition and determination of latent heat, sensible heat, enthalpy, entropy and specific volume of steam.
	1b. Use steam table and Mollier chart for determination of steam property.	1.5 Use of Steam tables and Mollier chart- (Heat Entropy Chart). 1.6 Numerical examples based on above.(1.1 to 1.5).
	1c. Determine dryness fraction of steam. 1d. Explain throttling process.	1.7 Throttling process. 1.8 Methods of measurement of steam quality, Calorimeters- Bucket, Separating, Throttling and Combined calorimeters. (No numerical Problems).
Unit – II **Boilers, mountings and accessories.**	2a. Explain the working of boilers, mountings and accessories.	2.1 Steam boiler-concept, definition as per Indian Boilers Regulation (IBR), functions, features and classification. 2.2 Working, merits and demerits of following low pressure steam boilers: i. Simple vertical boiler. ii. Lancashire boiler. iii. Cornish boiler. iv. Cochran boiler. v. Babcock and Wilcox water tube boiler. vi. Packaged boiler. vii. Waste heat recovery boiler. 2.3 Boiler mountings and accessories- functions, working and location on

Unit	Major Learning Outcomes	Topics and Sub-topics
		boilers. 2.4 Boiler draught system-concept and classification.
	2b.Determine boiler performance.	2.5 Boiler performance – parameters, evaporative capacity, equivalent evaporation, efficiency, heat balance sheet, simple numerical examples based on these. 2.6 Concept of fluidized bed combustion boilers. 2.7 Maintenance, inspection and safety precautions in boiler house (As per IBR), check list in boilers.
Unit – III **Steam prime movers.**	3a.Explain principle of working and construction of Steam turbine. 3b.Apply principle of steam nozzles to solve simple examples.	3.1 Concept and classification of prime movers. 3.2 Steam nozzles-types, working and applications. Mass and velocity of steam discharge through nozzle (No derivation). Simple examples. 3.3 Steam turbine – concept and classification. Impulse and reaction turbines (constructional and materials details.)-working and differences.
	3c. Describe compounding of steam turbine.	3.4 Compounding of steam turbine: i. Need. ii. Pressure compounding. iii. Velocity compounding. iv. Pressure velocity compounding.
Unit – IV **Steam condensers and cooling towers.**	4a.Describe working of condensers.	4.1 Elements of a steam condensing plant, concept, function and classification of condensers. 4.2 Jet condensers and surface condensers- constructional sketch, working and differences.
	4b.Determine efficiency of condensers.	4.3 Vacuum efficiency and condenser efficiency of condensers- simple numerical example.
	4c.Describe working of cooling towers.	4.4 Classification, function and working of cooling towers.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – IV **Air compressors.**	5a.Explain principle, construction and working of air compressors.	5.1 Air compressor-concepts, functions, classification and applications. 5.2 Working of reciprocating air compressor and rotary air compressors. 5.3 Single stage air compressor and multistage air compressor: i. Working. ii. Inter-cooling & after cooling.
	5b.Calculate power requirement and volumetric efficiency of reciprocating air compressor.	5.4 Power required and efficiency of reciprocating air compressors-single and two stages, simple numerical examples. 5.5 Concept of screw compressors for oil free air.
Unit – V **Heat transfer.**	6a.Explain modes of heat transfer. 6b.Determination of heat transfer through cylinder and wall.	6.1 Various modes of heat transfer. 6.2 Conduction heat transfer- Fourier's law- explanation (No Cartesian or other equation derivation), thermal conductivity, heat transfer through a plain wall, composite wall and cylinder. 6.3 Convection heat transfer, Newton's law of convection, Free and force convection, coefficient of convection. 6.4 Radiation heat transfer, Blackbody concept, emissivity, refractivity, absorptivity, Stefan and Boltzmann's law.
	6c.Explain types of insulations.	6.5 Define thermal conductivity. 6.6 Need, types, properties and applications of insulating materials in various industries. 6.7 Difference between hot and cold insulation.

Unit	Major Learning Outcomes	Topics and Sub-topics
	6d.Calculate overall heat transfer coefficient and LMTD.	6.8 Over all heat transfer coefficient. 6.9 Simple numerical examples based on above. 6.10Heat exchanger: introduction, types and applications- Logarithmic Mean Temperature Difference (LMTD) concept- (No derivation & no numerical examples).

6. SUGGESTED SPECIFICATIONTABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Two phase system.	7	2	4	4	10
II	Boilers, mountings and accessories.	10	7	4	4	15
III	Steam prime-movers.	6	4	4	2	10
IV	Steam condenser & cooling towers.	3	2	3	2	07
V	Air compressors.	8	3	6	5	14
VI	Heat transfer.	8	3	4	7	14
Total		**42**	**21**	**25**	**24**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy).

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

General Notes:

a. If midsem test is part of continuous evaluation, unit numbers I,II (UP TO 2.4 ONLY) and VI are to be considered.

b. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills **(Outcomes in cognitive, psychomotor and affective domain)** so that students are able to acquire the competencies. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.*

S. No.	Unit Number	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	**PREPARATORY ACTIVITY:** a. List and define thermodynamic properties. b. Tabulate thermodynamic SI units and their conversions. c. Explain thermodynamic processes and their examples. d. Given the data, determine properties of steam using steam table and Mollier chart.	02
2	II	**DEMONSTRATION:** (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.): a. Low pressure boilers. b. Boiler mountings and accessories.	04
3	II	**BOILER PERFORMANCE:** Boiler trial- determination of boiler efficiency, equivalent evaporation and Heat balance sheet. (Based on in-house performance or from the data collected during industrial visit.).	04
4	III	**DEMONSTRATION:** (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.): a. Steam prime movers-impulse and reaction turbines.	02

		b. Working of nozzles.	
5	IV	**DEMONSTRATION:** (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.): a. Steam condensers. b. Cooling towers.	02
6	V	**PERFORMANCE TEST OF AIR COMPRESSOR:** Performance test on a reciprocating air compressor and determine its volumetric efficiency.	04
7	VI	**PERFORMANCE TEST OF HEAT EXCHANGER:** Determine overall heat transfer coefficient and LMTD of heat exchanger.	02
8	ALL	**MINI PROJECT AND PRESENTATION:** (In the group of 3-5students- to be assigned in the beginning of the term). a. Identify any one thermal equipment/device/plant (which are included in syllabus) at nearby industry. Sketch the setup, write the specifications, and describe the working of that with process parameters and state applications of that. b. Downloaded photos/ videos, PPTs. Make one CD/DVD for a batch of students. Also prepare a chart or model on given topic. Prepare the seminar. Topics related to syllabus are to be given by teacher. Advancement in the topics areas may also be given. c. Present the seminar at least for 10 minutes for a and b above.This must include photographs / movies of group working on project.	08
		TOTAL	28

Notes:

a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.

b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. Term work report content of each experience should also include following.
    i. Experience set up sketch and specifications of boilers, mountings, accessories, condensers, cooling towers, air compressors, heat exchangers, etc (as applicable).
    ii. Working for demonstration type experiences.
    iii. Steps / process description to execute experience for performance type experience.
    iv. Observation table, calculation and graphs if necessary.
d. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 3 to 5students.
e. Student activities are compulsory and to be submitted along with term work.
e. For ESE, students are to be assessed for competencies achieved through suggested list of activities/ practical. They should be given following tasks:
    i. Identify the parts of equipment (Air compressor/ boiler/heat exchanger/ condenser).
    ii. Identify location and function of boiler mountings/ accessories (any two).
    iii. Use of steam table/ Mollier chart, determine properties of steam for given pressure and temperature (two problems).
    iv. Any one performance test (for one set of reading) on heat exchanger/ air compressor/ boiler (determine heat supplied and any one heat loss).

8. SUGGESTED LIST OF STUDENT ACTIVITIES.

Sr. No.	Activity.
1	Prepare Mollier charts and show different regions.
2	Collect/ download product catalogues with specification of various types of energy conservation equipment/ devices and heat exchanger of recent trends.
3	At least one visit of any power plant/ industry where various items like boiler, air compressor, heat exchanger, cooling tower, condenser etc. can be shown to students.
4	Identify and list at least 10 equipments/devices which require heat transfer and prevention of heat transfer. Also state mode of heat transfer and methods used to prevent heat transfer.

9. INSTRUCTIONAL STRATEGIES:

Sr. No.	Unit	Unit Title	Strategies
1	I	Two Phase system.	Charts, PPTs, demonstration of the process.
2	II	Boilers, mountings and accessories.	Models, Charts, Videos, PPTs, Industrial visit.
3	III	Steam prime-movers, condensers and cooling towers.	Models, Charts, Videos, Cut sections, Industrial visit.
4	IV	Air compressors.	Charts, Videos, PPTs.
5	V	Heat transfer.	Charts, Videos, PPTs.

10. SUGGESTED LEARNING RESOURCES

(A) List of Books:

Sr.No.	Title of Books	Author	Publication
1.	Heat Engines.	Pandya and Shah.	Charotar Publishing
2.	Thermodynamics and Heat power	Mathur and Mehta.	Tata Mcgraw-
3.	Heat Engines.	D. A. Wrangham.	Cambridge University Press.
4.	Heat and mass transfer.	D S Kumar.	S K
6.	Thermal Engineering.	P.L.Ballaney.	Khanna.
7.	Thermal Engineering.	A. S. Sarao.	SatyaPrakashan.
8.	Heat and mass transfer.	R K Rajput.	S. Chand.
9.	Basic Boiler Attendant.	M MDalchawal.	New Popular Prakashan.
10.	Thermal Engineering.	R K Rajput.	Laxmi.
11.	Practical Thermodynamics.	G D Rai.	Khanna
12.	A Text book of Thermal Engineering.	R S Khurmi& J K Gupta.	S Chand & Co.

(B) List of major equipment/materials:

1. Working non IBR steam boiler of package type.
2. Cut section/ models of boilers, boiler mountings and accessories.
3. Cut section/ models of steam prime movers.
4. Test rigs of condensers and cooling towers.
5. Test rig of reciprocating air compressor.
6. Experimental setup of heat exchanger.
7. Independently temperature and pressure measuring instruments.

(C) List of Software/Learning Websites

a. http://nptel.iitm.ac.in/courses/112101097/
b. http://nptel.iitm.ac.in/courses/112106155/

c. http://nptel.iitm.ac.in/courses/112101002/
d. http://www.thermaxindia.com/Large-Industrial-Boilers/Waste-Heat-Recovery-Boiler.aspx
e. http://www.thermaxindia.com/Packaged-Boilers/Shell-Boiler/Oil-Gas-Fired/Shellmax.aspx
f. http://www.thermaxindia.com/Large-Industrial-Boilers/solid-fuels-agro-wastes-biomass/Biomass-Fired-Boiler.aspx
g. http://www.bhel.com/product_services/range.php?rangeid=146&productid=106&categoryid=141
h. http://www.bhel.com/product_services/product.php?categoryid=62&link=Power

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics.

1. Prof. S. R. Pareek, Head of Department, Mechanical Engineering, Tolani F. G. Polytechnic, Adipur.
2. Prof.Patel RamanbhaiRevabhai, Lecturer in Mechanical Engineering, R. C. Technical Institute, Sola, Ahmedabad.
3. Dr.Shah Atul S., Lecturer in Mechanical Engineering, Government Polytechnic Waghai.
4. Prof. M. N. Patel, Lecturer in Mechanical Engg, Government Polytechnic, Chhotaudepur.
5. Prof.PatadiyaVirenkumarNatvarlal, Lecturer in Mechanical Engineering, Shree N. M. Gopani Polytechnic Institute, Ranpur.
6. Prof.Ms.PrajapatiKrutikaVinodchandra, Lecturer in Mechanical Engineering, Parul Institute Of Engineering & Technology (Diploma Studies), Limda, Waghodia.

Coordinator and Faculty Members from NITTTR Bhopal.

1. **Dr. Prof. C.K.Chugh.**