

Branch Name:	Mechanical Engineering
Program Code:	ET402
Course Title:	Basic Thermal Engineering
Course Code:	2ET4020401
Pre-requisite Course:	-----

Course Objectives:

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.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	0	2	5	60	40	20	30	150

Course Contents:

Unit No	Topic	Total Hours	Weightage (%)
1	Steam Formation and its Properties • Concept of two-phase system • 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. • Concept, definition and determination of dryness fraction and degree of superheat. • Concept, definition and determination of latent, sensible heat, enthalpy, entropy and specific volume of steam. • Use of steam table and Mollier chart (H-S diagram) • Numerical example based on above. • Throttling process • Methods of measurement of steam, quality, Calorimeter-Bucket, Separating, Throttling and Combined Calorimeters. (No numerical problems)	07	15
2	Steam Generators • Concept and layout of a thermal power Plant. • Steam Boiler-concept, definition as per Indian Boilers • Regulation (IBR), functions, features and classification.	10	20

	- Working of simple low-pressure boilers along with merits and demerits – Simple Vertical boiler, Lancashire boiler, Cochran boiler, Babcock and Wilcox water tube boiler, Packaged boiler, Waste heat recovery boiler. - Functions, working and location of Boiler mountings & accessories. - Boiler Draught System – concept and classification - Boiler performance – parameters, evaporative capacity, equivalent evaporation, efficiency, heat balance sheet, simple numerical examples - Concept of fluidized bed combustion boilers. - Maintenance, inspection and safety measures in boiler (as per IBR), check list in boilers.		
3	Steam Prime movers. - Concept and classification of prime movers. - Steam nozzles-types, working and applications. Mass and velocity of steam discharge through nozzle (no derivation). Simple examples. - Steam turbine – concept and classification. Impulse and reaction turbines (constructional and materials details) working and differences. - Compounding of steam turbine- need, pressure compounding, velocity compounding and pressure- velocity compounding.	06	15
4	Steam Condensers and Cooling Towers - Elements of a steam condensing plant, concept, function and classification of condensers. - Jet condensers and surface condensers – working and differences. - Vacuum efficiency and condenser efficiency of condensers- simple numerical example. - Classification, function and working of cooling towers.	03	10
5	Air Compressors - Concepts, functions, classification and application - Working of reciprocation air compressor and rotary air compressors - Working of single stage air compressor and multistage air compressor, Inter-cooling and after cooling. - Power required and efficiency of reciprocating air compressor-single and two stages, simple numerical examples. - Concept of screw compressors for oil free air.	08	20
6	Heat Transfer and HeatExchangers - Various modes of heat transfer - Conduction heat transfer – Fourier’s law (no Cartesian or other derivation of equations), thermal conductivity, heat transfer through plain wall, composite wall and cylinder. - Convection heat transfer, Newton’s law of convection, Free and force convection, coefficient of convection. - Radiation heat transfer, blackbody concept, emissivity, refractivity, absorptivity, Stefan and Boltzmann’s law. - Define thermal conductivity. - Need, types, properties and applications of insulating materials in various industries. - Difference between hot and cold insulation, Overall heat transfer coefficient - Heat exchanger- introduction, types and applications. Logarithmic Mean Temperature Difference (LMTD) Simple numerical examples	08	20

List of Practical:

1. Demonstration of low-pressure boilers.
2. Demonstration of Boiler mountings and accessories.
3. Boiler performance – Determination of boiler efficiency, equivalent evaporation and heat balance sheet. (Based on in-house performance or from data collected during industrial visit)
4. Demonstration of Steam prime movers – impulse and reaction turbines.
5. Demonstration Steam condensers and cooling towers.
6. Performance test to determine volumetric efficiency of reciprocating air compressor.
7. Performance test of Heat Exchanger to determine overall heat transfer coefficient and LMTD of heat exchanger.

Reference Books:

- 1 Heat Engines, Pandya and Shah, Charotar Publishing
- 2 Thermodynamics and HeatPower, Mathur and Mehta, Tata Mcgraw-hill
- 3 Thermal Engineering, P. L. Ballaney, Khanna Publications
- 4 Thermal Engineering, R K Rajput, Laxmi Publication
- 5 Practical Thermodynamics, G D Rai, Khanna Publication
- 6 Heat and Mass Transfer, D S Kumar, S K Publication

List of Open-Source Software/learning website:

1. <https://www.spiraxsarco.com/resources-and-design-tools/steam-tables/superheated-steam-region>
2. <https://virtuallabs.hkust.edu.hk/TubularHeatExchanger/VirtualExperiment>
3. https://www.youtube.com/watch?v=EGFDqqX_Iek&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=7
4. https://www.youtube.com/watch?v=h1Yt4ibYXfA&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=12
5. https://www.youtube.com/watch?v=DuLFDzQVTU4&list=PLLy_2iUCG87BT8H9uMufjrcPF5e6Qd2bz&index=16
6. <https://www.youtube.com/watch?v=mHcZdKnYtkY>
7. <https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=709&cnt=4>

Course Learning Outcomes (CLO):

1. Learn to calculate steam properties and dryness fraction.
2. Acquire the fundamentals of boilers, mountings and accessories. Able to find boiler performance.
3. Acquire fundamentals and translate the knowledge of steam prime movers which will enable them understanding real energy transfer system.
4. Identify the elements and processes of steam condensers and cooling towers.
5. Operate air compressors and observe the parameters affecting the performance.
6. Identify heat transfer mode and calculate heat transfer for given heat transfer system.

Mapping of CLO with PO and PSO

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1	H	M											L	L		
CLO2	M	H	L				H		L				H	M		
CLO3	L												M	L		
CLO4	M	L				L	L						M	L		
CLO5		M	L	M					L				M		M	
CLO6	M	M	L	L	L		M					L	M	M	L	

H: High, M: Medium, L: Low