Lukhdhirji Engineering College, Morbi Mechanical Engineering Department

Basic Mechanical Engineering (BE01R00081)

Problem Based Learning Activities

Semester: 1st **AY: 2026-27**

Sr. No.	Name Of Activities	No. Of Hours	Chapter
1	Technical Video Learning Related To Topics On Basic Mechanical Engineering	Duration of Video = 05 Report Preparation = 05 **Total = 10 Hours** **(7 Marks)**	Steam Boilers Air compressors and pumps Refrigeration & Air Conditioning
2	Assignment With Theories & Numerical Related To Basic Mechanical Engineering	Assignments-1 of 06 Hours (**4 Marks)** Assignments-2 of 14 Hours **(8 Marks)** **Total = 20 Hours (12 Marks)**	Basic Terminology and Energy Properties of gases and Properties of Steam
3	To Solve Complex Problems on Basic Mechanical Engineering	Complex Problems To Be Solved By Students Assign During Lab Hours With Feasible Solution **Total = 10 Hours** **(7 Marks)**	Heat Engines And Internal Combustion Engines
4	Power Point Presentation	Allotted Activities to Be Prepared **Total = 05 hours** **(4 Marks)**	Couplings, Clutches Brakes and Transmission of Motion and Power Engineering Materials

Course Coordinator **Head of Department**

Activity-1

Technical Video Learning Related to Topics On Basic Mechanical Engineering

Students needs prepare a report (Min- 15 to Max-30 Pages) based on learning from these video for following chapters:

Chapter	Contents	Links
Steam Boiler	How does a Thermal power plant work?	https://www.youtube.com/watch?v=IdPTuwKEfmA
	How Electricity is Generated in one of the World's Largest Coal-Fired Power Stations - KUSILE	https://www.youtube.com/watch?v=13Pb7HlB-oE&t=3630s
	What is boiler?	https://www.youtube.com/watch?v=w8tQ9FSYzm0&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL
	Classification of Boiler	https://www.youtube.com/watch?v=PjsZGn4B6cw&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=2
	Important Term OR Basic Part of boiler	https://www.youtube.com/watch?v=-NuhDzM8xeU&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=4
	Boiler Steam Drum	https://www.youtube.com/watch?v=QHRi0xkidqg
	Comparison Between Fire Tube And Water Tube Boiler	https://www.youtube.com/watch?v=0fley-DLWyc&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=3
	Cochran Boiler Construction and Working With Animation	https://www.youtube.com/watch?v=493LPdMF1dE
	Lancashire Boiler	https://www.youtube.com/watch?v=px2URFsBPB4
	Babcock and Wilcox Boiler Animation Construction Working	https://www.youtube.com/watch?v=KdBjIepzW-A
	Boiler Mountings And Accessories	https://www.youtube.com/watch?v=rgg-shjBNzU&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=8
	Bourdon Tube Pressure Gauge	https://www.youtube.com/watch?v=5OFuBa85J_w&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=9
	Water Level Indicator	https://www.youtube.com/watch?v=0Py5qdlRyxs&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=10
	Feed Check Valve	https://www.youtube.com/watch?v=-1qlDZxC6vA&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=11
	Steam Stop Valve	https://www.youtube.com/watch?v=0ZH8VLueoBw&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=12
	Fusible Plug	https://www.youtube.com/watch?v=BmKCFmeZAUc&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=13
	Blow off Cock	https://www.youtube.com/watch?v=hTUfiF4H2Hg&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=14
	Air Preheater	https://www.youtube.com/watch?v=-LOTzt6GuRk&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=15
	Super Heater	https://www.youtube.com/watch?v=y5jsjBndgq8
	Economizer	https://www.youtube.com/watch?v=ULa3LjFB0os&list=PLdoIhVhbPQV6nmSlVMi7rk2za0y1jFjeL&index=17
	Classification of Pump	https://www.youtube.com/watch?v=mgw0-aHn44s&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=1
	Head of centrifugal pump	https://www.youtube.com/watch?v=4iWR7IS3QZY&list=PLdoIhVh

Air compressors and pumps		bPQV4081d07xc24qWnIR2QMI8O&index=2
	Reciprocating Pump Working Animation	https://www.youtube.com/watch?v=fHLkZV2_Cb4&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=3
	Double Acting Reciprocating Pump Animation	https://www.youtube.com/watch?v=a8_jk2XgdtU&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=4
	Air vessel Reciprocating Pump With Air Vessel	https://www.youtube.com/watch?v=okWG4KlUKUU&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=5
	Plunger Pump - How plunger pump work	https://www.youtube.com/watch?v=okWG4KlUKUU&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=5
	Bucket Pump Hand Pump how bucket pump work how hand pump work	https://www.youtube.com/watch?v=YCz6KJsGp8U&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=7
	classification of centrifugal Pump	https://www.youtube.com/watch?v=ULuB9fj1AvA&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=8
	Centrifugal Pump With Animation Construction and Working	https://www.youtube.com/watch?v=08gkwzYhL80&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=9
	Priming of centrifugal Pump introduction various method priming	https://www.youtube.com/watch?v=gQn4WhJZ2Gk&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=10
	Difference Between Centrifugal and Reciprocating Pump	https://www.youtube.com/watch?v=85xOm0FIcdc&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=11
	Efficiencies of Centrifugal Pump	https://www.youtube.com/watch?v=yqr13aQGW0Q&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=12
	Cavitation In Centrifugal Pump	https://www.youtube.com/watch?v=Ua-bR1j4gNA&list=PLdoIhVhbPQV4081d07xc24qWnIR2QMI8O&index=13
	Classification of Compressor	https://www.youtube.com/watch?v=hoP-BHCep6M&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G
	Single stage Reciprocating compressor without clearance	https://www.youtube.com/watch?v=e402VfVE7VE&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G&index=2
	Construction of Centrifugal Compressor	https://www.youtube.com/watch?v=xINBZP60uEY&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G&index=3
	Construction And Working of Axial Flow Compressor	https://www.youtube.com/watch?v=NBY9oqAX-rY&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G&index=4
	Vane Type Compressor	https://www.youtube.com/watch?v=NuApnXOxu1g&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G&index=5
	Root Blower Root Compressor	https://www.youtube.com/watch?v=v3gE4cA5_gg&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G&index=6
	Screw Compressor	https://www.youtube.com/watch?v=8qdr_-kyVeg&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G&index=7
	Scroll Compressor/ Spiral Compressor Construction And Working	https://www.youtube.com/watch?v=xIaKeaPcsEU&list=PLdoIhVhbPQV7-x5LoapgUthAPEJKJN83G&index=8
	Difference Between Heat Engine,Heat Pump,Refrigerator	https://www.youtube.com/watch?v=CmlBRzoCyMM&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A
	Designation Refrigerants	https://www.youtube.com/watch?v=FiD3QPWUjzs&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A&index=2
	Distinguish or Difference Between Primary and Secondary Refrigerant	https://www.youtube.com/watch?v=ngjDQoyxL30&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A&index=3

Refrigeration & Air Conditioning	Properties of Good Refrigerant	https://www.youtube.com/watch?v=jO1tHkoo4-Y&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A&index=4
	One ton of refrigeration.	https://www.youtube.com/watch?v=JQd1nwM5VpQ&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A&index=5
	Vapour Compression Refrigeration System	https://www.youtube.com/watch?v=JIKmawhXOFU
	PH Diagram	https://www.youtube.com/watch?v=9QyJ8DzRbWI&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A&index=7
	Vapour absorption refrigeration system	https://www.youtube.com/watch?v=oclgDmwEfZY&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A&index=8
	Difference between VCRS vs VARS	https://www.youtube.com/watch?v=YCkbRADU0nw&list=PLdoIhVhbPQV7pX_sncsJ5JKSPnwHNdS9A&index=10

Activity-2

Assignment with Theories & Numerical Related to Basic Mechanical Engineering

ASSIGNMENT-1 (CO-1)

Introduction

1. State and explain the Zeroth Law of Thermodynamics and the First Law of Thermodynamics.
2. Explain the terms melting point, boiling point, and the triple point of water with the help of Pressure–Volume (P–V) and Pressure–Temperature (P–T) diagrams.
3. Define the following terms:
4. Prime mover
5. Internal energy
6. Heat capacity
7. What are specific heats? Which type of specific heat is commonly used in practical applications?
8. Describe the different types of thermodynamic systems with suitable diagrams.
9. Differentiate between gauge pressure, vacuum pressure, and absolute pressure with the help of neat sketches.
10. State the sign conventions used for heat transfer and work in thermodynamics.

ASSIGNMENT-2 (CO-2)

Properties of Gases:

Q-1: Vessel of 1.8 m^3 capacity contains one kg –mole of nitrogen at 200°C. Calculate the specific volume and pressure if the gas is cooled to 40°C, calculate final pressure, change in specific internal energy and specific enthalpy

Q-2: A gas whose pressure, volume and temp are 4 bar, 0.16 m^3 and 180°C respectively has the state changed at constant pressure until the temperature becomes 16°C. Calculate (i) Heat transferred. (ii) Work done during the process. Take R = 0.29 kJ/kg K & Cp = 1.005 kJ/kg K

Q-3: One cubic meter of air at pressure of 1.8 bar and 90 °C is compressed to final pressure 7 bar and volume 0.36 m^3. Determine 1. Mass of air 2. Index of 'n' compression 3. Change in internal energy 4. Heat transfer during compression Take $\gamma = 1.4$ and R = 287 J/kg K.

Q-4: A cylinder contains 0.7 m^3 of gas at pressure of 1.04 bar and 92°C. The gas is compressed to a volume of 0.17 m^3 according to low $pv^n=C$. The final pressure is 6 bar. Assuming $\gamma = 1.4$ and R = 287 J/kg K. Calculate 1. The mass of gas. 2. The value of index 'n' for compression. 3. The change of internal energy of gas.

Q-5: 1 kg of gas is compressed polytropically from a pressure of 140 kPa and 260 K to 755 kPa. If the compression is according to load, $pv^{1.3}=C$, find 1. the initial volume, 2. the final temperature, 3. the work done, 4. the change in Internal Energy, 5. the heat received or rejected during the process, 6. the change in enthalpy. Take $\gamma = 1.4$ and R = 287 J/kg K.

Q-6: An ideal gas is heated from 20 °C to 55 °C. The mass of gas is 4 kg. Determine 1. Specific heat 2. Change in internal energy 3. Change in enthalpy. Take $\gamma = 1.4$ and R = 287 J/kg K.

Q-7: A gas whose pressure, volume, and temperatures are 2.75 bar, 0.09 m^3, and 185°C respectively, has the state changed at constant pressure until its temperature becomes 15°C.Calculate 1. Heat transfer. 2. Work done during the process. Take $\gamma = 1.4$ and R = 287 J/kg K.

Q-8: Determine the work done in compressing 1 kg of air from a volume of 0.16 m^3 at a pressure of 1 bar to a volume of 0.06 m^3, when the compression is 1. Adiabatic 2. Isothermal. Take $\gamma = 1.4$ and R = 287 J/kg K.

Q-9: 0.87 kg of gas at 1.5 bar and 280 °C is expanded to 4 times the original volume according to the law $pv^{1.3}$=C. Calculate 1. The original and final volume of the gas. 2. The final temperature of the gas. 3. The final pressure of the gas. Take $\gamma = 1.4$ and R = 287 J/kg K.

Q-10: 0.35 m^3 of air of mass 1 kg at initial pressure of 6.5 bar expands to a final volume of 0.45 m^3. If the expansion is according to the law $pv^{1.3}$=C, find the work done, the change in internal energy, and heat received or rejected during the process. Take $\gamma = 1.4$ and R = 287 J/kg K.

ASSIGNMENT-3 (CO-2)

Properties of Steam:

Q-1: 1.7 kg of steam at a pressure of 15 bar and temperature of 260°C is expanded until the pressure becomes 2.4 bar. The dryness fraction of steam is then 0.85. Calculate change in Internal Energy.

Q-2: Find the internal energy of 3 kg of steam at a pressure of 17 bar when 1. The steam is superheated with temperature of 450 °C 2. The steam is wet with dryness fraction = 0.85 Take C_{pS} = 2.1 kJ/kg K.

Q-3: Calculate the internal energy of 2 kg of superheated steam at a pressure of 12 bar and 270°C. If this steam is to be expanded to a pressure of 1.65 bar and 0.83 kg dry, determine the change in internal energy. Assume specific heat of superheated steam as 2.1 kJ /kg K.

Q-4: How much heat is needed to convert 5 kg of water at 25 °C into steam at 9 bar and 230 °C? Take Cp of superheated steam is 2.1 kJ /kg K and specific heat of water is 4.2 kJ /kg K.

Q-5: A rigid tank contains 12 kg of water at 110 °C. If 8 kg of water is in the liquid form and rest is in the vapor form, draw PV diagram and identify the point in PV diagram. Determine the pressure in the tank, the volume of liquid and water vapor, quality of steam, and volume of tank by using dryness fraction.

Q-6: Combined Separating and Throttling Calorimeter is used to find out dryness fraction of steam.

Following readings were taken.

Main pressure = 13 bar absolute.

Mass of water collected in separating calorimeter = 2 kg.

Mass of steam condensed in throttling calorimeter = 30 kg.

Temperature of steam after throttling =210°C.

Pressure of steam after throttling = 1.1 bar
absolute. Assume Cp of steam is = 2.1 kJ /kg K.
Calculate dryness fraction of steam.

Q-7: Determine dryness fraction of steam supplied to separating and throttling calorimeter.
Water separated in separating calorimeter = 0.47
kg. Steam discharged from throttling calorimeter
=7 kg. Steam pressure in main pipe =1.3 MPa.
Barometer reading = 760 mmHg.
Manometer reading = 190 mmHg.
Temperature of steam after throttling =142 °C.
Assume Cp of steam is = 2.1 kJ /kg K.

Q-8: Determine the quality of stream for the following cases.

1. P = 11 bar, V = 0.20 m^3/kg.
2. P = 13 bar. T = 250°C.
3. P = 15 bar. H = 2850 kJ /kg

Q-9: A boiler generates steam at a pressure of 11 bar with 80% dryness fraction from feed water at 20°C. It is superheated in a superheater up to a temperature of 260°C, determined per kg of steam.
A. Sensible heat in feed water.
B. Specific enthalpy of saturated water.
C. Latent heat of vaporization.
D. Enthalpy of wet steam.
E. Enthalpy of superheated steam.
F. Specific volume of wet and superheated steam.
G. Specific entropy of wet and superheated steam.

Q-10: In a throttling calorimeter, the following data is available.
The pressure before throttling = 15 bar absolute.
The pressure after throttling equal 1 bar absolute.
Temperature after throttling = 130 °C.
Calculate 1. Dryness fraction of steam before passing through the throttling calorimeter. 2. What is the minimum value of dryness fraction that can be determined assuming the same pressure before and after throttling? Assume Cp of steam is = 2.1 kJ /kg K.

Activity-3

To Solve Complex Problems on Basic Mechanical Engineering

Problem-1: A four-stroke, single-cylinder petrol engine operates on the air standard Otto cycle. At the beginning of the compression stroke, the pressure and temperature of air are 1 bar and 27°C, respectively. The air is compressed isentropically to a pressure of 18 bar. Heat is then supplied at constant volume until the pressure rises to 48 bar. The engine runs at 1500 rpm and develops a brake torque of 180 N·m.

The following data are available:

- Cylinder bore = 100 mm
- Stroke = 120 mm
- Mechanical efficiency = 82%
- Fuel consumption = 6 kg/h
- Calorific value of fuel = 44,000 kJ/kg
- Specific heat at constant volume, Cv=0.718 kJ/kg·K
- Universal gas constant, Ru=8.3143 kJ/kmol·K
- Molecular weight of air = 28.97 kg/kmol
- Ratio of specific heats, γ=1.4

Determine:

1. Compression ratio of the cycle.
2. Air standard thermal efficiency.
3. Temperatures at all four state points of the Otto cycle.
4. Heat supplied and heat rejected (kJ/kg of air).
5. Net work output per kg of air.
6. Brake Power (kW).
7. Indicated Power (kW).
8. Brake Thermal Efficiency.
9. Indicated Thermal Efficiency.
10. Brake Specific Fuel Consumption (BSFC) in kg/kWh.
11. Mean Effective Pressure (MEP) of the air standard cycle.

Problem-2: A heat engine operates between a high-temperature reservoir at 800°C and a low-temperature reservoir at 35°C. The engine receives heat at a rate of 3000 kJ/min. The actual thermal efficiency of the engine is 65% of the Carnot efficiency.
The engine drives a generator whose mechanical efficiency is 92%, and the electrical output obtained is 20 kW.
The rejected heat is absorbed by cooling water flowing through the condenser. Cooling water enters at 24°C and leaves at 36°C. Take the specific heat of water as 4.187 kJ/kg·K.
The following data are available:

- Source temperature: 800°C
- Sink temperature: 35°C

- Heat supplied: 3000 kJ/min
- Actual efficiency = 65% of Carnot efficiency
- Generator mechanical efficiency: 92%
- Electrical output: 20 kW
- Cooling water inlet temperature: 24°C
- Cooling water outlet temperature: 36°C
- Specific heat of water: 4.187 kJ/kg·K

Determine

- Carnot efficiency of the engine.
- Actual thermal efficiency of the engine.
- Brake power developed by the engine (kW).
- Indicated power supplied by the heat engine before generator losses (kW).
- Rate of heat rejected to the sink (kW).
- Mass flow rate of cooling water required (kg/min).
- Work produced per minute by the engine (kJ/min).
- If the heat supplied is increased by 15% while the actual thermal efficiency remains constant, determine:
    - ✓ New brake power,
    - ✓ New rate of heat rejection,
    - ✓ Percentage increase in cooling water requirement.

Activity-4

Power Point Presentation

Students needs prepare power point presentation of minimum 10 slides and max 20 slides for following topics:

- Couplings
- Clutches
- Brakes
- Transmission of Motion and Power
- Engineering Materials

Rubrics for the Activities

Task	Criteria	Marks			
Assignment	**Content Accuracy and Completion of assignment**	**(Exemplary) 12-10**	**(Satisfactory) 9-7**	**(Developing) 6-5**	**(Unsatisfactory) 0-4**
		• All examples/Questions are correct and Complete • All assignments nicely organized and neat	• Partially examples/ Questions are correct and Complete • All assignments partially organized and neat	• Less examples/Questions are correct and Complete • All assignments less organized and neat	• Examples/Questions are not correct and Complete • All assignments are not organized and neat
Report	**Technical Content & Concepts and Writing & Presentation**	**(Exemplary) 7-5**	**(Satisfactory) 4-3**	**(Developing) 2-1**	**(Unsatisfactory) 0**
		• The report shows a comprehensive understanding of the mechanical system, with a logical structure and professional writing. • It is free of errors and uses correct technical terms.	• The report demonstrates a good grasp of the basics and is generally well-organized. • It is mostly clear, with a few minor errors that don't hinder readability.	• The report shows a superficial understanding of the system, with significant errors and misconceptions. • Its structure is confusing, and multiple grammar and spelling errors make it difficult to read.	• The report demonstrates a fundamental misunderstanding of mechanical systems, with incorrect concepts and disorganized information. • Numerous errors make it difficult to read and comprehend.
Complex Problems solution	**Clarity and Detail of the Examples**	**(Exemplary) 7-5**	**(Satisfactory) 4-3**	**(Developing) 2-1**	**(Unsatisfactory) 0**
		• The examples are highly detailed and well-structured, with a clear scenario and a logical, step-by-step solution.	• The examples are clear and detailed, with understandable problem statements and logical solution steps. However, some minor details or assumptions may be missing.	• The examples are vague and incomplete, making the student's reasoning difficult to follow.	• The examples are confusing and lack key details, making them ineffective at illustrating the steam boiler concepts.
Power Point Presentation	**Technical Content and Accuracy and Presentation Structure ,Design, and Delivery and Communication**	**(Exemplary) 4**	**(Satisfactory) 3**	**(Developing) 2**	**(Unsatisfactory) 0**
		• Accurate, in-depth information with a clear, comprehensive understanding. • Clear, logical flow with professional, clutter-free slides. • Clear, confident speaker with great pacing and audience engagement.	• Mostly accurate with a solid grasp of core concepts. • Generally, well-organized with some minor inconsistencies. • Understandable delivery, but may lack energy or consistent eye contact.	• Few inaccuracies or a superficial understanding of the topic. • Some slides are disorganized, poor formatting, • Average audience interaction	• Significant inaccuracies or a superficial understanding of the topic. • Disorganized slides, poor formatting, or illegible visuals. • Mumbled, rushed, or disengaging delivery with poor audience interaction.