

**THERMODYNAMICS
(MECHANICAL ENGINEERING)****Time: 3 Hours****Max Marks: 70**

Answer ONE Question from each Unit

All Questions Carry Equal Marks

All parts of the Question must be answered at one place

UNIT-I

- | | Marks | CO | BTL |
|--|-----------|-----|-----|
| 1. a) Distinguish between closed system, open system and isolated system with suitable examples. | 6M | CO1 | L3 |
| b) A mass of 1.5 kg of air is compressed in a quasi - static process from 0.1 MPa to 0.7 MPa for which $p v = \text{constant}$. The initial density of air is 1.16 kg/m^3 . Find the work done by the piston to compress the air. | 8M | CO1 | L3 |

(OR)

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|---|-----------|-----|----|
| 2. a) Define thermodynamic system, surroundings, and boundary. | 6M | CO1 | L3 |
| b) A gas undergoes an adiabatic expansion from 500 kPa and 2 m^3 to 100 kPa and 5 m^3 . Determine the work done during the process. | 8M | CO1 | L3 |

UNIT-II

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|---|-----------|-----|----|
| 3. a) Explain the limitations of first law of thermodynamics. | 6M | CO2 | L2 |
| b) To a closed system 150 KJ of work is supplied. If the initial volume is 0.6 m^3 and the pressure of the system changes as $p = 8 - 4V$ where p is in bar and V is in m^3 , determine the final volume and pressure of the system. | 8M | CO2 | L3 |

(OR)

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|---|-----------|-----|----|
| 4. a) Write the steady flow energy equation for a single stream entering and a single stream leaving a control volume and explain the various terms in it | 6M | CO2 | L2 |
| b) In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW . The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively, calculate the rate at which heat is rejected to the turbine. | 8M | CO2 | L3 |

UNIT-III

5. a) State Kelvin-Planck statement and Clausius statement. **4M** CO3 L2
b) A reversible heat engine operates between two thermal reservoirs at temperatures of 800°C and 60°C . The engine drives a reversible refrigerator that operates between reservoirs at temperatures of 60°C and -15°C . The heat supplied to the heat engine is 3000 kJ, and the net work output of the combined heat engine–refrigerator system is 500 kJ.
Determine: **10M** CO3 L3
(i) The heat extracted by the refrigerator from the low-temperature reservoir. The net heat transferred to the reservoir at 60°C .
(ii) Recalculate the answers in part (a) assuming that: The efficiency of the heat engine is 50% of the maximum (Carnot) efficiency. The COP of the refrigerator is 50% of the maximum (Carnot) COP.

(OR)

6. a) Prove the equivalence of Kelvin Planck and Clausius Statements of second law of thermodynamics. **6M** CO3 L2
b) An engine operating on a Carnot cycle works with in temperature limits of 600 K and 300 K. If the engine receives 2000 KJ of heat, evaluate the work done and thermal efficiency of the engine. **8M** CO3 L3

UNIT-IV

7. a) State and prove the Inequality of Clausius. **6M** CO4 L2
b) A lump of steel of mass 8 kg at 1000 K is dropped in 80 kg of oil at 300 K. Calculate the entropy change of steel, oil, and the universe. **8M** CO4 L3

(OR)

8. a) Derive an expression for the decrease in available energy when heat is transferred through a finite temperature difference **6M** CO4 L2
b) 0.25 kg of air at constant pressure and a temperature of 250°C receives 300 kJ of heat reversibly. Determine the available and unavailable energy if the temperature of the surroundings is 27°C . Take c_p of air as 1.005 kJ/kg K. **8M** CO4 L3

UNIT-V

9. a) Define enthalpy of formation and explain its significance. **6M** CO5 L2
b) Calculate the theoretical air required for the complete combustion of 1 kmol of methane (CH_4). **8M** CO5 L3

(OR)

10. A gas mixture consists of 3 kmol of CO_2 , 2 kmol of O_2 , and 7 kmol of N_2 . Determine: (i) Mole fraction of each constituent. (ii) Mass fraction of each constituent & (iii) Molecular weight of the mixture. **14M** CO5 L3

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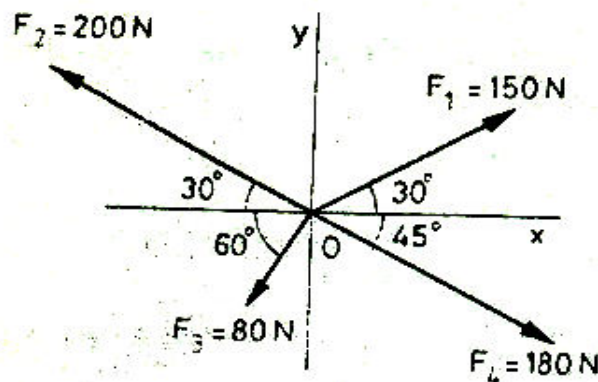
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UNIT-I

- | | | Marks | CO | BTL |
|----|---|-------|----|-----|
| 1. | a) State and explain the parallelogram law of forces with a neat sketch. | 4 | 1 | L1 |
| | b) Determine the resultant, both in magnitude and direction, of the coplanar concurrent forces acting on the body as shown in figure. | 10 | 1 | L1 |

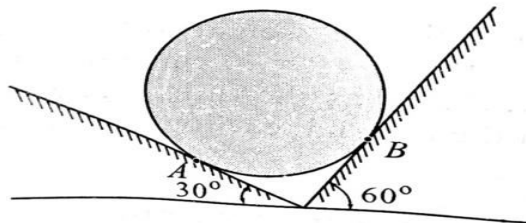


(OR)

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|----|---|---|---|----|
| 2. | a) Define the moment of a force. State its SI unit and significance. | 6 | 1 | L1 |
| | b) Calculate the magnitude of resultant when two forces of magnitude 56 N and 67 N act at an angle of 38° to each other. | 8 | 1 | L2 |

UNIT-II

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|----|---|----|---|----|
| 3. | a) Explain the procedure for drawing a Free Body Diagram (FBD). | 4 | 2 | L2 |
| | b) A cylinder of mass 50 kg is resting on a smooth surface which is inclined at 30° and 60° to horizontal as shown in Fig. Determine the reaction at contact A and B. | 10 | 2 | L2 |

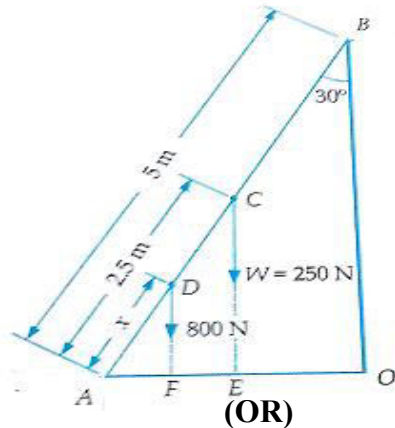


(OR)

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|----|--|---|---|----|
| 4. | a) State the equations of equilibrium for a planar force system. | 7 | 2 | L1 |
| | b) Differentiate between static and kinetic friction. | 7 | 2 | L1 |

UNIT-III

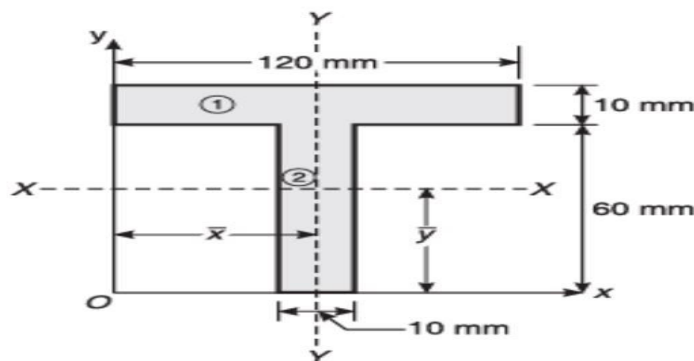
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|----|---|----|---|----|
| 5. | a) Explain the concept of Equilibrium. | 4 | 3 | L1 |
| | b) A uniform ladder of weight 250 N and length 5m is placed against a vertical wall in a position where its inclination to the vertical is 30° . A man weighting 800 N climbs the ladder. At what position will he induce slipping? Take coefficient of friction $\mu=0.2$ at both the contact surface of the ladder | 10 | 3 | L2 |



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|----|---|---|---|----|
| 6. | a) Explain wedge friction and its applications. | 6 | 3 | L1 |
| | b) Define i) Limiting friction ii) Coefficient of friction iii) Angle of friction
iv) Cone of friction | 8 | 3 | L1 |

UNIT-IV

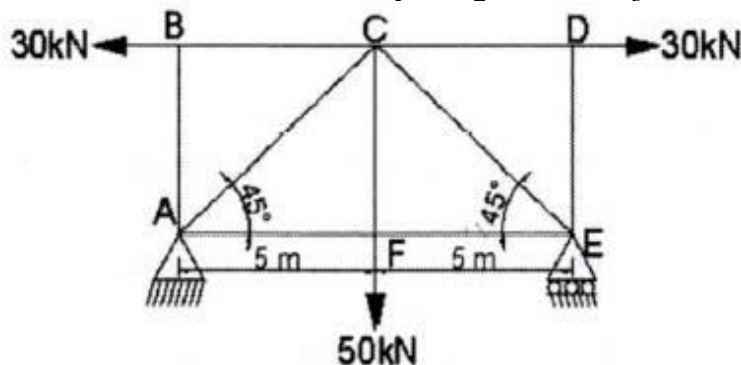
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| 7. | a) Define centroid and explain its significance. | 4 | 4 | L1 |
| | b) Find the centroid of the T-Section about the reference axes | 10 | 4 | L2 |



- | | | | | |
|----|--|---|---|----|
| 8. | a) Derive the centroid of a Triangle using method of integration. | 6 | 4 | L2 |
| | b) Derive the moment of inertia of a Triangle using method of integration. | 8 | 4 | L2 |

UNIT-V

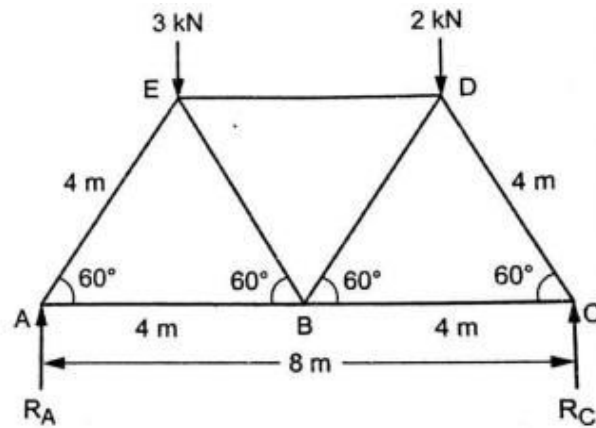
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| 9. | a) Differentiate between perfect, deficient and redundant trusses. | 6 | 5 | L1 |
| | b) Determine the forces in the members by using method of joints. | 8 | 5 | L2 |



(OR)

10. a) Discuss the advantages and limitations of the method of joints.
b) Calculate the force in each member of the loaded truss shown in Fig.

4	5	L1
10	5	L2



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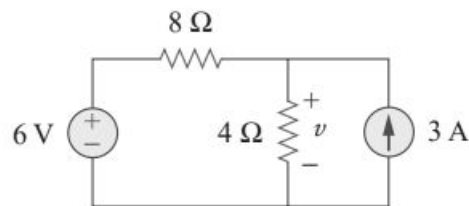
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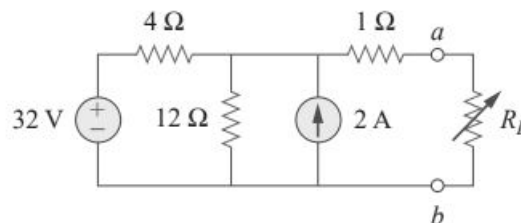
UNIT-I

- | | | Marks | CO | BTL |
|-------|---|-------|-----|-----|
| 1. a) | State and discuss maximum power transfer theorem? | 6M | CO1 | 3 |
| b) | Determine the voltage 'v' in the circuit using superposition theorem? | 8M | CO1 | 4 |

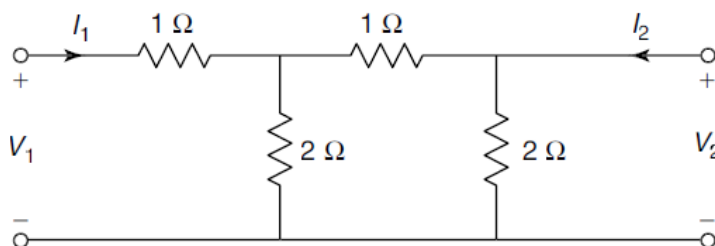


(OR)

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|-------|--|----|-----|---|
| 2. a) | State and explain substitution theorem with an example? | 7M | CO1 | 2 |
| b) | Determine the thevenin's equivalent circuit across the load resistance R_L ? | 7M | CO1 | 3 |

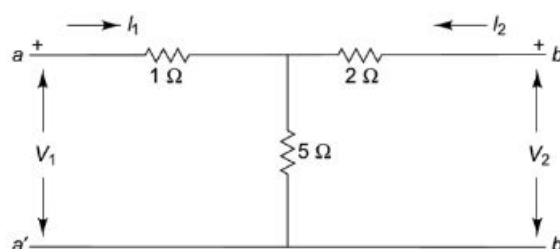
**UNIT-II**

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|-------|--|----|-----|---|
| 3. a) | Derive the h parameters in terms of Z-parameters? | 7M | CO2 | 3 |
| b) | Find Z-parameters for the network shown in figure? | 7M | CO2 | 4 |



(OR)

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|-------|---|----|-----|---|
| 4. a) | Derive the ABCD parameters in terms of Z-parameters? | 7M | CO2 | 4 |
| b) | Find the ABCD parameters for the network shown in the figure? | 7M | CO2 | 4 |

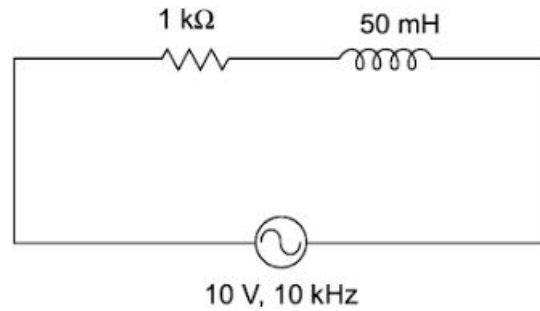


UNIT-III

5. a) Derive the impedance equation of a series R-L circuit? 6M CO3 4
 b) An alternating current is given by $i = 14.14 \sin(370 t)$. Find 8M CO3 4
 (a) rms value of the current (b) frequency (c) instantaneous value of the current at $t = 4 \text{ ms}$ (d) time taken by the current to reach 10 A for first time after passing through zero?

(OR)

6. a) Derive the impedance equation of a series R-C circuit? 6M CO3 2
 b) To the circuit shown in figure consisting of a $1 \text{ K } \Omega$ resistor connected in series with a 50 mH coil, a 10 V rms , 10 KHz signal is applied. Find i) impedance ii) current iii) Phase angle θ & iv) voltage across R & L? 8M CO3 4



UNIT-IV

7. a) Derive the expression for current at anti (RL & RC parallel) resonance? 7M CO4 4
 b) An RLC series circuit has a resistance of 10Ω , a capacitance of $100 \mu \text{ F}$ and a variable inductance. The applied voltage is 230 V , 50 Hz . (a) find the value of the inductance for which the voltage across the resistance is maximum (b) Q factor (c) voltage drop across R, L & C? 7M CO4 4

(OR)

8. a) Outline the significance of half power frequencies in series resonance? 4M CO4 2
 b) An ac series circuit consists of a coil connected in series with a capacitance. The circuit draws a maximum current of 10 A , when connected to 200 V , 50 Hz supply. If the voltage across the capacitor is 500 V at resonance, find the values of R, L, C and Q factor? 10M CO4 4

UNIT-V

9. Derive the transient response of a series R-L circuit for DC excitation and explain current growth and decay characteristics? 14M CO5 4
 (OR)
 10. a) Illustrate the natural response, forced response, and complete response with suitable equations and waveforms? 7M CO5 2
 b) Distinguish between DC and AC transient responses? 7M CO5 2

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<u>UNIT-I</u>		Marks	CO	Blooms Level
1.	a) Explain the classification of stones along with their engineering properties.	7	1	Remember
	b) Explain the classification and properties of bricks.	7	1	Remember
(OR)				
2.	a) Describe the manufacturing process of bricks with the help of neat sketch.	7	1	Understanding
	b) Describe the bulking of sand and its significance.	7	1	Analysis
<u>UNIT-II</u>				
3.	a) Explain the procedure for determining the consistency test of cement using Vicat apparatus.	7	2	Analysis
	b) Discuss the different special types of cement.	7	2	Analysis
(OR)				
4.	a) Explain how the hydration process takes place in cement	7	2	Remember
	b) Explain the fineness test and specific gravity test of cement.	7	2	Understanding
<u>UNIT-III</u>				
5.	a) Explain the importance of using sustainable materials in construction	7	3	Remember
	b) What is Metakaolin and its applications in construction.	7	3	Understanding
(OR)				
6.	a) Discuss in detail the properties and uses of GGBS and Rice Husk Ash	7	3	Analysis
	b) What are the advantages of sustainable construction materials.	7	3	Understanding
<u>UNIT-IV</u>				
7.	a) Explain the objectives of building bye-laws in detail.	7	4	Understanding
	b) What are the lighting requirements in buildings.	7	4	Remember
(OR)				
8.	a) Discuss the requirements open space and proper ventilation in buildings.	7	4	Remember
	b) Classify various types of buildings and explain them briefly.	7	4	Analysis
<u>UNIT-V</u>				
9.	a) Explain the orientation of buildings and the factors affecting it.	7	5	Understanding
	b) Explain how flexibility and elegance are important principles of planning.	7	5	Remember
(OR)				
10.	a) List out the various software tools in building planning and explain them briefly.	7	5	Remember
	b) Describe the minimum standards required for residential buildings.	7	5	Remember