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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 19ME4DCATD **Max Marks: 100**
Course: Applied Thermodynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	***CO***	***PO***	**Marks**
1	a)	With the help of P-V and T-S diagrams, obtain the expression for thermal efficiency of an air standard otto cycle in terms of compression ratio 'γ'.	*CO1*	*PO1*	**06**
	b)	An air-standard Otto cycle has a compression ratio of 8 with a low temperature of 288.7 K and a low pressure of 1.013 bar. If the energy addition during the combustion is 1850 kJ/kg. Determine the work output and maximum pressure.	*CO1*	*PO1*	**06**
	c)	A dual cycle, which operates on air with a compression ratio of 16, has a low pressure of 200 kPa and a low temperature of 200°C. If the cut-off ratio is 2 and the pressure ratio is 1.3, calculate the thermal efficiency, heat input, work output and the mean effective pressure.	*CO1*	*PO1*	**08**
		OR			
2	a)	Compare the Otto, Diesel and Dual combustion cycle in terms of efficiency for the same compression ratio and heat addition.	*CO2*	*PO1*	**08**
	b)	Explain the significance of the compression ratio in the Otto cycle and how it influences the thermal efficiency. Discuss the practical limitations in increasing the compression ratio in actual gasoline engines.	*CO2*	*PO1*	**06**
	c)	A gas turbine engine operates on an ideal Brayton cycle with the following specifications: • Inlet air temperature: 300 K • Inlet air pressure: 100 kPa • Maximum cycle temperature: 1200 K • Pressure ratio: 10	*CO2*	*PO2*	**06**
		UNIT - II			
3	a)	With the help of p-θ diagram, explain the stages of combustion in a compression ignition engine.	*CO2*	*PO1*	**06**
	b)	With the help of a graph, explain how the frictional power of an internal combustion engine can be determined using the Willan's line method.	*CO2*	*PO1*	**04**

		c)	A four-stroke gas engine has a cylinder diameter of 25 cm and stroke 45 cm. The effective diameter of the brake is 1.6 m. The observations made in a test of the engine were as follows: Duration of test = 40 min; Total number of revolutions = 8080 ; Total number of explosions = 3230; Net load on the brake = 80 kg ; mean effective pressure = 5.8 bar; Volume of gas used = 7.5m^3; Pressure of gas indicated in meter = 136 mm of water (gauge); Atmospheric temperature=17^{o}C; Calorific value of gas=19 MJ/m^3 at NTP; Temperature rise of cooling water = 45 ^{o}C; Cooling water supplied = 180 kg. Draw up a heat balance sheet and find the indicated thermal efficiency and brake thermal efficiency. Assume atmospheric pressure to be 760 mm of mercury.	*CO2*	*PO2*	**10**
			OR			
	4	a)	Discuss the key stages in the cycle (intake, compression, power, and exhaust), the role of each component (piston, crankshaft, valve mechanism), and how the fuel-air mixture is ignited in SI Engine.	*CO2*	*PO1*	**06**
		b)	A 4-cylinder four-stroke petrol engine has a bore of 80 mm and a stroke length of 90 mm. The engine runs at 2000 rpm, and the air-fuel ratio is 14:1. Calculate the engine displacement volume and the volumetric efficiency. If the intake air is 80% of the total displacement.	*CO2*	*PO1*	**08**
		c)	An internal combustion engine operates with an indicated mean effective pressure (IMEP) of 8 bar. The engine has a displacement volume of 0.6 liters and a mechanical efficiency of 80%. Calculate the brake power of the engine in kW. and the indicated power of the engine in kW.	*CO2*	*PO2*	**06**
			UNIT - III			
	5	a)	Obtain the work done expression for a single stage single acting reciprocating compressor with a clearance volume.	*CO3*	*PO1*	**06**
		b)	A certain mass of air is compressed from 1 bar, 0.1 m^3 to 6 bar in a compressor according to $PV^{1.4}$=C. Find the work done by the compressor. If the compression is carried out hyperbolically between the same initial state and the same final pressure as above, what would be the work done on air?	*CO3*	*PO1*	**06**
		c)	A single-stage single-acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke is 30^{o}C and 1 bar. The bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance volume is 3% of the swept volume. Assuming the index of compression and expansion to be 1.3, find: (i)Volumetric efficiency of the compressor, (ii) Power required if the mechanical efficiency is 85%, and (iii) Speed of the compressor in r.p.m.	*CO3*	*PO2*	**08**
			OR			
	6	a)	Explain the working principle of a multi-stage centrifugal compressor with inter cooling.	*CO3*	*PO1*	**06**

		b)	Explain the variation of pressure ratio, volumetric flow rate, and efficiency with respect to the mass flow rate and rotational speed. Include a discussion on surge and choke points.	*CO3*	*PO1*	**06**
		c)	A centrifugal compressor has an inlet temperature of 25°C and an inlet pressure of 1 bar. The air enters the compressor at a flow rate of 10 kg/s, and the isentropic efficiency is 80%. The exit pressure is 6 bar. Calculate the work done per unit mass of air and the temperature at the compressor exit. Assume air behaves as an ideal gas with R=287 J/kg-K and γ=1.4.	*CO3*	*PO2*	**08**
			UNIT - IV			
	7	a)	Explain the following terms with respect to pure substance: (i) Saturated heat, (ii) Latent heat, and (iii) Dryness fraction.	*CO1*	*PO1*	**06**
		b)	Steam expands isentropically from 70 bar and 500°C to 20 kPa in a steam turbine. Calculate the dryness fraction and the enthalpy of the steam after expansion if the steam flows steadily through the turbine with a mass flow rate of 150 kg/min. Determine the turbine work. Draw T-S diagram and show the above process on it.	*CO1*	*PO1*	**06**
		c)	Steam at 10 bar and 200°C undergoes a polytropic process to 1 bar according to the law $PV^{1.15}$= C. Determine the following: (i) Final condition of the steam, (ii) Work transfer for the process (iii) Magnitude and direction of heat transfer, and (iv) Change in entropy.	*CO4*	*PO2*	**08**
			OR			
	8	a)	With the help of the T-S diagram, discuss the effect of increase in boiler pressure and decrease in condenser pressure on the Rankine cycle for the same turbine inlet temperature.	*CO1*	*PO1*	**04**
		b)	With the help of a line and T-S diagram explain the working of reheat Rankine cycle. Obtain the expression for thermal efficiency working on reheat cycle.	*CO1*	*PO1*	**08**
		c)	Steam enters the turbine at a pressure of 20 bar and the corresponding thermometer reading as 360°C. If the condenser pressure is 0.08 bar and 84% dry. The steam after entering the condenser, is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming ideal Rankine cycle, determine net work done and cycle efficiency.	*CO4*	*PO2*	**08**
			UNIT - V			
	9	a)	Can water be used as refrigerant in place of R22 in a domestic air-conditioning system, where the lower temperature never falls below the freezing point. Explain, can this proposal work?	*CO1*	*PO1*	**02**
		b)	Explain the working of a vapour absorption refrigeration system and write the expression for COP of the refrigerator with suitable notations.	*CO1*	*PO1*	**08**
		c)	A refrigerator is to produce ice 0^0 C from water at 20^0 C. It has a condenser temperature of 298 K while the evaporator temperature is 268 K. The relative efficiency of the machine is	*CO4*	*PO2*	**10**

50% and 6 kg of R-12 refrigerant is circulated per min. The refrigerant enters the compressor with a dryness fraction of 0.6. The specific heat of water is 4.18 kJ/kg-K. Latent heat of ice is 335 kJ/kg. Determine the amount of ice produced in 24 hours. The properties of refrigerant are provided in the table below:

Temperature (K)	Liquid Heat (kJ/kg)	Latent Heat (kJ/kg)	Liquid Entropy (kJ/kg-k)
298	59.7	138	0.22
268	31.4	154	0.12

OR

10	a)	Define the following terms: (i) Dry Air, (ii) Dry Bulb Temperature, (iii) Dew Point Temperature, (iv) Specific humidity, (v) Relative humidity, and (vi) Dew point depression.	*CO1*	*PO1*	**06**
	b)	Obtain the expression for the heat removed ‘Q_{1-2} ‘for the cooling and dehumidification psychrometric process and represent the same on a psychrometric chart.	*CO1*	*PO1*	**04**
	c)	The atmospheric air at $20^{o}C$ and with a specific humidity of 0.0095 kJ/kg of dry air is provided for a psychrometric process. Without using Psychrometric chart, Calculate the following (i) Partial pressure of vapour (ii) Relative humidity (iii) Dew point temperature	*CO3*	*PO1*	**04**
	d)	A cinema theatre with a seating capacity of 1500 people is operating in winter. The average rate of heat generation from a person seated in the theatre is 105 W, of which 70 W is in sensible heat form and 35 W is in latent heat form. The combined heat losses through the walls, windows, and the roof are estimated to be 30 kW. Determine, if the auditorium needs to be heated or cooled. What will happen if the cinema theatres are filled to 1/4th of its capacity?	*CO4*	*PO2*	**06**

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