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Reg. No															

B.Tech Degree Examination, DECEMBER 2023

Fourth Semester

18MEC107T - APPLIED THERMAL ENGINEERING

(For the candidates admitted during the academic year 2018-19 to 2021-22)

OPEN BOOK EXAMINATION

18MEC107TO

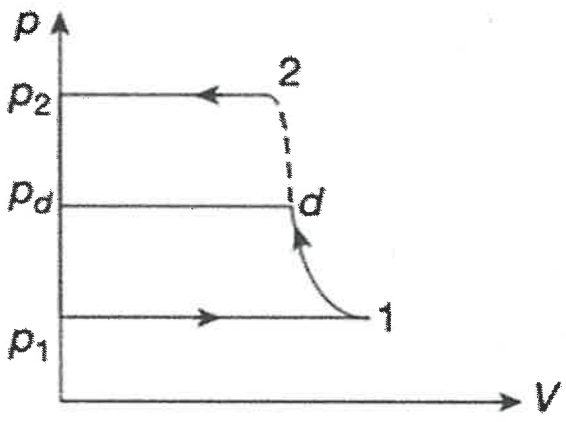
Note:

i. Specific approved THREE text books (Printed or photocopy) recommended for the course.
ii. Handwritten class notes (certified by the faculty handling the course / Head of the Department).

Time: 3 Hours **Max. Marks: 100**

Answer **FIVE** Questions
(Question No. 1 is compulsory)

			Marks	BL	CO
1 a.	i.	An air standard limited pressure cycle has a compression ratio of 15 and compression begins at 0.1MPa, 313K. The maximum pressure is limited to 6MPa and the heat added is 1.675MJ/kg. Compute a) the heat supplied at constant volume per kg of air, b) the heat supplied at constant pressure per kg of air, c)the work done per kg of air, d) the cycle efficiency, e)the temperature at the end of the constant volume heating process, f) the cut-off ratio and g) the mep of the cycle. (Take γ=1.4, Cp = 1.005 kJ/kg K, R= 0.287 kJ/kg K)	18	3	1
b.	ii.	What is the effect of regeneration on Brayton cycle? (A) net work output decreases because of regeneration (B) net work output increases because of regeneration (C) net work output is not affected by use of regeneration (D) regeneration is not advisable for Brayton cycle	1	1	1
c.	iii.	For the same maximum pressure and temperature of the Otto, Diesel and Dual air standard cycles, ---------- will be the same. (A) Compression ratio (B) Heat supplied (C) Thermal efficiency (D) Heat rejected	1	1	1
2 a.	i.	The gravimetric analysis of coal gives 79% of carbon, 9% of hydrogen, 4% of moisture and 8% of ash. Actual air supplied is 19 kg per kg of coal. Calculate the theoretical amount of air required, if 80% of carbon is burned to CO_2 and the remaining to CO. Also determine the volumetric composition of dry products of combustion	18	5	2
b.	ii.	The presence of nitrogen in the products of combustion ensures that (A) complete combustion of fuel takes place (B) incomplete combustion of fuel occurs (C) dry products of combustion are analyzed (D) air is used for combustion	1	1	2
c.	iii.	The calorific value determined by the bomb calorimeter is (A) lower calorific value at constant pressure (B) higher calorific value at constant pressure (C) lower calorific value at constant volume (D) higher calorific value at constant volume	1	1	2

3	i.	In a test of an oil engine under full load condition the following results were obtained. Indicated Power = 32 kW Brake power = 28 kW Fuel used = 7 kg/h Rate of flow of water through gas calorimeter = 14 kg/min Cooling water flow rate = 9 kg/min Calorific value of fuel = 43 MJ/kg Inlet temperature of cooling water = 20°C Outlet temperature of cooling water = 45°C Inlet temperature of water to exhaust gas calorimeter = 20°C Outlet temperature of water to exhaust gas calorimeter = 75°C Final temperature of the exhaust gases = 210°C Room temperature = 24°C Air-fuel ratio on mass basis = 21 Mean specific heat of exhaust gas = 1 kJ/kg K Specific heat of water = 4.18 J/kg K Draw up a heat balance sheet in kJ/hr. Estimate the specific fuel consumption in g/kW-hr and Thermal and Mechanical efficiencies.	18	5	3
	ii.	The bore and stroke of a single cylinder four-stroke engine are 100 mm and 160 mm respectively. If the brake torque is 50 Nm, the bmep is (A) 15 bar (B) 10 bar (C) 5 bar (D) 7.6 bar	1	1	3
	iii.	Volumetric efficiency is a measure of (A) speed of the engine (B) power of the engine (C) breathing capacity of the engine (D) pressure rise in the cylinder	1	1	3
4	i.	A single-acting, two-stage reciprocating compressor with complete intercooling delivers 12 kg per minute of air at 16 bar. The suction occurs at 1.01 bar and 27°C. The compression and expansion processes are reversible with polytrophic index n = 1.3. The compressor runs at 500 rpm. Assuming the density of air as 1.2 kg/m^3, Calculate the following: (a) The power required to drive the compressor. (b) The isothermal efficiency. (c) The free air delivered. (d) The heat transferred in intercooler. (e) The swept and clearance volumes for each cylinder if the clearance ratios for L.P. and H.P. cylinders are 0.04 and 0.06, respectively.	18	1	4
	ii.	 The above pV diagram is for (A) Roots blower (B) Vanes blower (C) Centrifugal compressor (D) Reciprocating compressor	1	1	4
	iii.	Roots blower is an example of (A) Reciprocating (positive displacement) compressor (B) Rotary (positive displacement) compressor (C) Centrifugal compressor (D) Axial flow compressor	1	1	4

5	i.	A food storage locker requires a refrigeration system of 40 kW capacity at an evaporator temperature of −5°C and a condenser temperature of 40°C. The refrigerant, R-12, is sub-cooled 6°C before entering the expansion valve, and the vapour is superheated 5°C before leaving the evaporator coil. The compression of the refrigerant is reversible adiabatic. A two-cylinder vertical single acting compressor with stroke equal to 1.5 times the bore is to be used operating at 900 rpm. Determine (a) the refrigerating effect/kg, (b) the mass of refrigerant to be circulated per minute, (c) the theoretical piston displacement per minute, (d) the theoretical power, (e) the co-efficient of performance, (f) The heat removed through condenser/kg and (g) The theoretical bore and stroke of compressor.	18	5	5
	ii.	A Carnot refrigerator requires 70 kJ/min of work to produce one ton of refrigeration at -40°C. The COP of this refrigerator is (A) 4 (B) 3 (C) 5 (D) 1/70	1	1	5
	iii.	Name the Psychometric processes involved in designing an air conditioner for seashore cities like Chennai, Mumbai etc (A) (a) Cooling and humidification (B) (b) Cooling and dehumidification (C) (c) Heating and humidification (D) (d) Heating and dehumidification	1	1	5
6	i.	During the trial of a single-cylinder, four-stroke oil engine, the following results were obtained. Cylinder diameter = 200 mm Stroke = 400 mm Mean effective pressure = 6 bar Torque = 407 Nm Speed = 250 rpm Oil consumption = 4 kg/h Calorific value of fuel = 43 MJ/kg Cooling water flow rate = 4.5 kg/min Air used per kg of fuel = 30 kg Rise in cooling water temperature = 45°C Temperature of exhaust gases = 420°C Room temperature = 20°C Mean specific heat of exhaust gas = 1 kJ/kg K Specific heat of water = 4.18 kJ/kg K Find the IP, BP and draw up a heat balance sheet for the test in kJ/h	18	5	3
	ii.	If N is the rpm, number of power strokes/min in a four-stroke engine is (A) 2N (B) N/2 (C) N (D) 4N	1	1	3
	iii.	Indicated power is directly proportional to (A) torque (B) air consumption (C) cylinder peak pressure (D) none of the above	1	1	3
7	i.	a) In a simple vapour compression cycle, following are the properties of the refrigerant R-12 at various points. Compressor inlet: h_1 = 183.2 kJ/kg, v_1 = 0.0767 m^3/kg, Compressor discharge: h_2 = 222.6 kJ/kg, v_2 = 0.0164 m^3/kg Condenser exit: h_3 = 84.9 kJ/kg, v_3 = 0.0083 m^3/kg, The piston displacement volume for the compressor is 1.5 litres per stroke and its volumetric efficiency is 80%. The speed of the compressor is 1600 rpm. Find (a) the power rating of the compressor (kW), (b) the refrigerating effect (kW). (10 marks)	18	1	5
	ii.	b) In a 5 kW cooling capacity refrigeration system operating on a simple vapour compression cycle, the refrigerant enters the evaporator with an enthalpy of 75 kJ/kg and leaves with an enthalpy of 183 kJ/kg. The enthalpy of the refrigerant after compression is 210 kJ/kg. Show the cycle on T-s and p-h diagrams. Calculate the following: (a) COP, (b) power input to compressor, and (c) rate of heat transfer at the condenser. (8 marks)			

D.	ii.	One tonne refrigerating machine means that (A) one tonne is the total mass of the machine (B) one tonne of refrigerant is used (C) one tonne of water can be converted into ice (D) one tonne of ice when melts from and at 0°C in 24 hours, the refrigeration effect produced is equivalent to 210 kJ/min.	1	1	5
E.	iii.	In an ideal vapour compression refrigeration cycle, which process is irreversible? (A) Compression (B) Heat rejection (C) Throttling (D) Heat absorption	1	1	5

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