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B.Tech. DEGREE EXAMINATION, JANUARY 2024
OPEN BOOK EXAMINATION
 Fourth Semester

18MEC107T – APPLIED THERMAL ENGINEERING
(For the candidates admitted from the academic year 2020 – 2021)

- Specific approved THREE text books (Printed or photocopy) recommended for the course
- 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

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| <p>1.a. In a test of an oil engine under full load condition, the following results were obtained. IP=35 kW, BP=29 kW, fuel used=9 kg/hr, rate of flow of water through gas calorimeter = 14 kg/min, Cooling water flow rate = 8 kg/min. Calorific value of the fuel = 42,500 kJ/kg, Inlet temperature of cooling Water = 22°C, Outlet temperature of cooling water = 68°C, Inlet temperature of water to exhaust gas calorimeter = 22°C, Outlet temperature of water from Exhaust gas calorimeter = 60°C, final temperature of exhaust gases = 132°C, Room temperature = 25°C, Air fuel ratio on mass basis = 20, Mean specific heat of exhaust gas = 1.2 kJ/kg K, Specific heat of water = 4.18 kJ/kg K. Draw up a heat balance sheet and estimate the thermal and mechanical efficiencies.</p> | <p>18 4 3</p> |
| <p>b. Brake Mean Effective Pressure is</p> <p>(A) The mean pressure of the air at the start of combustion</p> <p>(B) The mean pressure of the fuel injected</p> <p>(C) The mean pressure of that should act on the piston for a given brake power output</p> <p>(D) The mean pressure of the exhaust gas leaving the engine</p> | <p>1 1 3</p> |
| <p>c. An IC Engine gives an output of 3.7 kW, when the heat input is 12,000 J/s. The Brake thermal efficiency of the engine is</p> <p>(A) 29.8% (B) 31.8%</p> <p>(C) 30.8% (D) 28.8%</p> | <p>1 2 3</p> |
| <p>2.a. The compression and expansion ratio of an oil engine working an air standard Dual cycle are 7 and 5. The initial pressure and temperature are 1 bar and 28°C respectively. The heat liberated at constant pressure is twice the heat liberated at constant volume. The expansion and compression follow the law $PV^{1.3} = \text{Constant}$. Determine:</p> <p>i. Pressure, temperature at all salient points.</p> <p>ii. The mean effective pressure of the cycle</p> <p>iii. Thermal efficiency of the cycle</p> <p>iv. Power developed by the engine, if 6 cycles are executed in a second. Take cylinder bore = 250mm and stroke = 300mm</p> | <p>18 3 3</p> |

- b. Otto cycle efficiency is higher than diesel cycle efficiency for the same compression ratio and heat input, because in Otto cycle _____ 1 2 1
 (A) Heat addition is at constant Volume (B) Expansion and compression are isentropic.
 (C) Maximum temperature is higher (D) Heat rejection is lower
- c. The Brayton cycle used in aircraft, automotive is _____ 1 2 1
 (A) A closed cycle (B) An open Cycle
 (C) Either closed or open cycle (D) Air impossible cycle
- 3.a. A steam boiler uses pulverized coal in the furnace. The ultimate analysis by mass is given as C = 76%, H₂ = 4%, O₂ = 31%, S = 1%, Ash = 12%, Moisture = 4%. Excess air supplied is 25%. Calculate the mass of air to be supplied and mass of products of combustion per kg of coal burnt. 18 3 2
- b. The lower and higher caloric values of the fuel are related by 1 2 2
 (A) HCV : LCV + Specific Enthalpy of vaporization of water (B) HCV = LCV + Enthalpy of vaporization of water
 (C) HCV : LCV + Specific Entropy of vaporization of water (D) HCV = LCV + Entropy of vaporization of water
- c. Find the air fuel ratio for the complete combustion of fuel C₁₂H₂₆? 1 2 2
 (A) 14.14 (B) 15.14
 (C) 16.14 (D) 13.14
- 4.a. A single cylinder four stroke diesel engine works on the following data: 18 3 3
 Cylinder bore = 14cm
 Stroke = 21cm
 Speed = 300rpm
 Area of indicator diagram = 8cm²
 Length of indicator diagram = 9cm
 Spring constant = 7.5 bar/cm.
 Brake specific fuel consumption = 0.25 kg / kW hr.
 CV of the fuel = 42,500 kJ/kg
 Diameter of brake wheel = 60 cm.
 Rope diameter = 8 cm
 Brake load = 40 kg.
 Calculate:
 i. Brake Power ii. Indicated mean effective pressure
 iii. Indicated Power iv. Mechanical Efficiency
 v. Indicated Thermal Efficiency
- b. In an IC Engine operation, the pump work is required in 1 2 3
 (A) Compression stroke (B) Power stroke
 (C) Exhaust stroke (D) Suction and Exhaust stroke
- c. A four stroke engine completes _____ no. of complete cycles in one second, if its rpm is 1800. 1 2 3
 (A) 12.5 (B) 15
 (C) 18 (D) 21

5.a. A single stage, double acting reciprocating compressor has a FAD of 15 m³/min measured at 1.013 bar and 27°C. The pressure and temperature of the cylinder during induction are 0.95 bar and 48°C. The delivery pressure is 7 bar and the index of compression and expansion is 1.25. Calculate indicated power required and volumetric efficiency, the clearance volume is 6% of the swept volume. 18 4 4

- b. The effective volume of air handled by the reciprocating compressor in each cycle is less than its stroke volume. Some of the probable reasons are: 1 2 4
- Hot inlet valve restricts the flow as the air flow pasts the valve.
 - Mixing with residual air in the cylinder
 - Hot Cylinder walls
 - Cooling system reduces the volume of air

The correct reasons are:

- (A) (i), (ii), (iii) (B) (ii), (iii), (iv)
(C) (i), (iii), (iv) (D) (i), (ii), (iv)

- c. Two stage reciprocating compressors involve a high pressure and a low pressure stage. There are two cylinder of volume 180cc and 120cc. spot the high pressure stage cylinder volume 1 2 4
- (A) 180 cc (B) 120 cc
(C) 260 cc (D) 300 cc

6.a. A vapour compression refrigerator cycle works between the temperature limits of 30°C and -5°C. The vapour at the end of isentropic compression is dry saturated. Assuming there is no subcooling, find the COP of the system. Also find the capacity of the refrigerator, if the mass flow rate of refrigerator is 7 kg/min. The properties are: 18 4 5

Temp (K)	Enthalpy kJ/kg		Entropy (kJ/kg K)
	hf	hfg	
303	298.9	1465.84	1.1242
268	135.37	1433.05	0.5443

- b. The flow path of refrigerant through a vertical condenser, used in home refrigerator is 1 2 5

- (A) Bottom to Top (B) Top to Bottom
(C) Horizontal (D) Refrigerant flow does not take place

- c. _____ is the load centre of a refrigerator system 1 2 5
- (A) Compressor (B) Condenser
(C) Evaporator (D) Throttle Valve

7.a.i. Air at 50°C DBT and 60% RH is cooled to 20°C DBT. It is achieved by cooling and dehumidification. Air flow rate is 40 m³/min. Using Psychometric chart, calculate: 9 3 5

- DPT
- Mass of water drained out per hour
- Capacity of cooling coil

- ii. 130 m³/min of moist air at 10° DBT and 0.006 kJ/kg of dry air specific humidity is mixed adiabatically with 400 m³/min of moist air stream at 30° DBT, and 50% RH. If the pressure is constant at 1 bar, determine for the mixture stream
- (i) Humidity ratio
 - (ii) The Temperature
- b. The psychometric process adopted for hot and humid summer is
- (A) Cooling and Humidification
 - (B) Cooling and Dehumidification
 - (C) Heating and Humidification
 - (D) Heating and Dehumidification
- c. DBT, WBT and Dew Point Temperature (DPT) will be same for
- (A) 100% Saturated Air
 - (B) 0% saturated air
 - (C) 50% saturated air
 - (D) All unsaturated air

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