Exam No: _____

GANPAT UNIVERSITY

B. TECH SEM- III MECHATRONICS ENGINEERING REGULAR EXAMINATION– NOV-DEC 2015

2MC302: THERMAL ENGINEERING

TIME: 3 HRS **TOTAL MARKS: 60**

Instructions: (1) This Question paper has two sections. Attempt each section in separate answer book.

(2) Figures on right indicate marks.

(3) Be precise and to the point in answering the descriptive questions.

SECTION: I

Q.1 (A) What is meant by intensive and extensive property? State the differences between Microscopic approach and Macroscopic approach. (05)

(B) A fluid is confined in a cylinder by a spring loaded frictionless piston so that the pressure in the fluid is a linear function of the volume (p=a +bV). The internal energy of the fluid is given by the following equation: (05)

$$U = 34 + 3.15\ pV,$$

where, U is in KJ, p in KPa, V in cubic meter. If the fluid changes from an initial state of 170 KPa, 0.03m^3 to a final state of 400 KPa, 0.06m^3, with no work other than that done on the piston, find the direction and magnitude of work and heat transfer.

OR

Q. 1 (A) State the first law of thermodynamics, its applications and limitations. (05)

(B) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 KPa pressure, and 0.95 m^3/ kg volume, and leaving at 5m/s, 700 KPa, and 0.19 m^3/ kg. The internal energy of air leaving is 90 KJ / kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 KW. (a) Compute the rate of shaft work input to the air in KW. (b) Find the ratio of inlet pipe diameter to outlet pipe diameter. (05)

Q.2 (A) What is irreversibility? State various types of irreversibilities and explain them. (05)

(B) (a). 1 kg of water at 273 K is brought into contact with a heat reservoir at 373 K. When the water has reached 373 K, find the entropy change of the water, of the heat reservoir and of the universe. (05)

(b). If water is heated from 273 to 373 K by first bringing it in contact with a reservoir at 323 K and then with a reservoir at 373 K, what will the entropy change of the universe be?

OR

Q.2 (A) State Kelvin-Plank Statement of Second Law of thermodynamics and show that violation of Kelvin-Plank statement leading to violation of Clausius statement (05)

(B) A cyclic heat engine operates between a source temperature of 800^0C and a sink temperature of 30^0C. What is the least rate of heat rejection per KW net output of the engine? (05)

Q.3 **Attempt any two.** (10)

(A) Justify the statement "Entropy is a property of the system". With usual notations prove that $\oint \frac{\delta Q}{T} = 0$.

(B) Explain heat balance sheet with diagram.

(C) Give the classification of IC Engine. Briefly describe the engine performance parameter.

SECTION: II

Q.4 (A) What is the Isotropic material? Derive general heat conduction equation for Isotropic material. (05)

(B) A surface having an area of 1.5 m^2 maintained at 300 °C exchanges heat by radiation with another surface at 40 °C, The value of factor due to the geometric location and emissivity is 0.52. Determine: (a) Heat lost by radiation, (b) value of thermal resistance and, (c) value of equivalent convection coefficient. (05)

OR

Q.4 (A) What do you understand by critical thickness of insulation? Derive the expression of the critical radius of insulation for cylinder. (05)

(B) Calculate the rate of heat flow per m^2 through a furnace wall consisting of 200 mm thick inner layer of chrome brick, a centre layer of kaolin brick 100 mm thick and an outer layer of masonry brick 100 mm thick. The unit surface conductance at the inner surface is 74W/m^2 °C and the outer surface temperature is 70 °C. The temperature of gases inside the furnace is 1670 °C. What temperature prevails at the inner and outer surfaces of the centre layer? Take thermal conductivity of the chrome brick, kaolin brick and masonry brick are 1.25, 0.074 and 0.555 W/m°C respectively. Assume steady heat flow. (05)

Q.5 (A) Define the following terms: (05)

(1). Reynolds Number, (2). Nusselt Number, (3). Relative humidity,

(4). Degree of saturation, (5). Dew point temperature.

(B) An oil cooler for a lubrication system has to cool 1000 kg/h of oil (C_p = 2.09 KJ/ kg°C) (05) from 80 °C to 40 °C by using a cooling water flow of 1000 kg / h at 30 °C. Give your choice for a parallel flow or counter flow heat exchanger, with reasons. Calculate the surface area of the heat exchanger, if the overall heat transfer coefficient is 24 W/m^2 °C. Take C_p of water = 4.18 KJ / kg °C.

OR

Q.5 (A) Define the Logarithmic Mean Temperature Difference. Derive the expression of the Logarithmic Mean Temperature Difference for "Parallel flow" heat exchanger. (05)

(B) In a counter flow double pipe heat exchanger; water is heated from 25 °C to 65 °C by oil with a specific heat of 1.45 KJ/kg K and mass flow rate of 0.9 kg/s. The oil is cooled from 230 °C to 160 °C. If the overall heat transfer coefficient is 420 W/m^2 °C, Determine: (a) rate of heat transfer, (b) mass flow rate of water, and (c) surface area of the heat exchanger. (05)

Q.6 **Attempt any two.** (10)

(A) Explain Vapour Compression Refrigeration System with the schematic diagram. Also draw the T-S and p-h diagram for the V.C.R. cycle with dry vapour after compression.

(B) What is the advance in the Simple Vapour Absorption Refrigeration System?

(C) A vapour compression refrigerator works between the pressure limits of 60 bar and 25 bar. The working fluid is just dry at the end of compression and there is no under cooling of the liquid before the expansion valve. Determine: (a). C.O.P. of the cycle; and (b). Capacity of the refrigerator if the fluid flow is at the rate of 5 kg/ min.

Pressure (bar)	Saturation temperature (K)	Enthalpy (KJ/kg)		Entropy (KJ/ kg K)	
		Liquid	Vapour	Liquid	Vapour
60	295	151.96	293.29	0.554	1.0332
25	261	56.32	322.58	0.226	1.2464

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