B. E. PROD. ENGG. 2ND YEAR 1ST SEMESTER SUPPLEMENTARY EXAM.- 2018

Sub: **THERMAL ENGINEERING** Time: **Three hours** Full Marks: **100**

All parts of a question *(a, b, c* etc) should be answered at one place.
Assume any missing data with proper justification.

Answer any **FIVE** questions.

1.(a) What is thermal conductivity?

(b) Derive an expression for critical radius of insulation on sphere.

(c) A hollow sphere with inner and outer radii of 7.5 cm and 12.5 cm respectively is made of a material of thermal conductivity 52 W/m-K and carrying saturated steam. If the heat conducted out from the sphere is 2165 W and the inside temperature of the sphere is 425° C then determine the outside wall temperature of the sphere. Estimate the critical thickness of insulation when the sphere is insulated with a thickness of asbestos of thermal conductivity of 2 W/m-K and the convective heat transfer co-efficient from the surface of asbestos to the ambient air is 12 W/m^2-K. Also, calculate the outside temperature of insulation. Neglect radiation.

3+5+12=20

2.(a) Explain the importance of use of a fin. What are the different types of fins?

(b) Define the fin effectiveness.

(c) Aluminium fins of rectangular profile are attached on a plate wall with 5 mm spacing. The fins have thickness of 1 mm, length of 10 cm and thermal conductivity of 200 W/m-K. The wall is maintained at a temperature of 200° C and the fins dissipates heat by convection into the ambient air at 40° C with heat transfer co-efficient 50 W/m^2-K. Estimate the heat loos per m^2 of wall surface.

(4+5)+3+8=20

3.(a) Explain about the free and forced convections.

(b) Explain the importance of Grasoff's No. in convection?

(c) Why the dimensional analysis is important in solving the problems of convective heat transfer?-Explain.

(d) A steel plate 1 m x 1 m x 1 mm in size is placed vertically in a tank of water at 20° C. The initial temperature of the plate is 90° C. Estimate the average heat transfer coefficient. Take properties of water at 55° C as $\rho = 985.5$ kg/m^3; $\beta = 0.49 \times 10^{-3}$ K^{-1}; $\mu = 0.503 \times 10^{-3}$ kg/ms; k = 0.648 W/m-K; Pr = 3.24.

3+4+5+8=20

4.(a) State the Stefan-Boltzman law of radiation heat transfer.

(b) What do you mean by radiation shield and refractory surface?

(c) What do you understand by the following terms with respect to radiation heat transfer?
(i) Black body surface and (ii) Opaque body surface

(d) Two parallel, infinite gray surfaces are maintained at temperatures of 127° C and 227° C respectively. If the temperature of the hot surface is increased to 327° C, by what factor is the net radiation exchange per unit area increased? Assume the emissivity for the colder and hotter surfaces to be 0.9 and 0.7 respectively.

3+(3+3)+4+7=20

5.(a) What is effectiveness of a heat exchanger?

(b) Sketch the temperature distribution curves for working fluids in boiler and condenser type heat exchangers.

(c) An oil cooler for a lubricating system has to cool 1000 kg/hr oil (c_p = 2.09 kJ/ kg-K) in a counter flow heat exchanger from 80°C to 40°C by using a cooling water flow of 1000 kg/hr available at 30°C. Estimate the surface area of heat exchanger if the overall heat transfer co-efficient is 30 W/m^2-K and also calculate NTU of the heat exchanger. Take c_p= 4.18 kJ/kg-K for water.

2+6+12=20

6.(a) Discuss briefly the working principle of 2-stroke diesel engine with the aid of sectional view and the valve timing diagram.

(b) An ideal Otto cycle has a compression ratio of 8. The minimum and maximum temperatures of the cycle are 27° C and 1327° C respectively. The pressure of air at the beginning of compression process is 100 kPa. Determine the power developed and mean effective pressure for Otto cycle if mass flow rate is 1200 kg/h. Assume c_p and c_v values as 1.005 kJ/kg-K and 0.718 kJ/kg-K respectively.

10+10=20

7.(a) Define Octane and Cetane numbers. Give example of two alternative fuels.

(b) Describe the dry exhaust gases analysis done by Orsat Apparatus.

(c) The ultimate analysis by mass of a sample of petrol was 85.5% C and 14.5% H. Calculate (i) the stoichiometric air-fuel ratio, (ii) actual air-fuel ratio when the mixture strength is 90%.

(2+2)+8+8=20

8.(a) Compare the fire tube boiler and water tube boiler.

(b) Differentiate between the boiler accessories and mountings with examples?

(c) Describe the working of Cochran boiler with neat sketch.

5+5+10=20

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