C 37076 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, JUNE 2004

EE 2K 403—MECHANICAL ENGINEERING—II

(New Scheme)

Time : Three Hours Maximum : 100 Marks

Use of heat and mass transfer data book is permitted.
Use of refrigeration and air-conditioning tables is permitted..
Any missing data may be assumed suitably by giving proper justification.

1. (a) Define the following :—
   (i) Newton's law of viscosity.
   (ii) Bulk modulus.
   (iii) Vapour pressure.
   (b) What is buoyancy force ? A cubical body of side 300 mm. and specific gravity 2.0 is immersed in water. What is the least force required to lift the body ?
   (c) Define the hydraulic, mechanical and volumetric efficiencies of a turbine.
   (d) Discuss the various losses in centrifugal pumps.
   (e) Discuss the physical mechanism of heat conduction in a solid, liquid and a gas.
   (f) What is solar radiation ? Explain.
   (g) Differentiate between relative humidity and humidity ratio.
   (h) What is construction cost of a power plant ? Explain

(8 × 5 = 40 marks)

2. (a) (i) Define Pressure. (2 marks)
   (ii) State and prove Pascal's law. (13 marks)

Or

   (b) (i) Write down the 3-D continuity equation and explain the terms in it. (3 marks)
   (ii) Water flows at a rate of 2.5 $m.^3$/min. through a pipe of 0.5 m. diameter. The pipe later reduces to 0.2 m. diameter. Calculate the flow velocities in the two pipes. (4 marks)
   (iii) Two velocity components are given in the following cases. Find the third component such that they satisfy the equation of continuity :

$$u = x^3 + y^2 + 2z^2 ; v = -x^2y - yz - xy \text{ and } u = \log\left(y^2 + z^2\right); v = \log\left(x^2 + z^2\right).$$

(8 marks)

Turn over

3. (a) With a neat sketch, explain the working of a reaction turbine. (15 marks)

Or

(b) What are the two methods of dimensional analysis ? Explain. (15 marks)

4. (a) Derive the general three dimensional heat conduction equation in Cartesian co-ordinates. (15 marks)

Or

(b) Steam in a heating system flows through tubes whose outer diameter is D_1 = 3 cm. and the walls are maintained at 120° C. Circular aluminum fins (k = 180 W/m. °C) of outer diameter D_2 = 6 cm. and constant thickness t = 2 mm. are attached to the tube. The space between the fins is 3 mm. and thus there are 200 fins per metre length of the tube. Heat is transferred to the surrounding air at T_∞ = 25° C with a combined heat transfer coefficient of h = 60 W/m.^{2} °C. Determine the increase in heat transfer from the tube per metre of its length as a result of adding fins. (15 marks)

5. (a) (i) What is dew point temperature ? Explain. (3 marks)

(ii) On a particular day the weather forecast states the relative humidity is 56 % while the atmospheric temperature and pressure are 27° C and 1.01 bar respectively. Determine the partial pressure of the water vapour in the atmosphere, the humidity ratio and the dew point temperature of the atmosphere. (12 marks)

Or

(b) Consider a power-generating unit of 15 MW capacity. The unit supplies the following loads :—

(i) Domestic constumers – maximum demand of 9 MW at a load factor of 20 %.

(ii) Small industrial load – maximum demand of 5.5 MW at a load factor of 40 %.

(iii) Street light load – maximum demand of 500 kW at a load factor of 25 %.

Capital cost of the plant—Rs. 10,000 per kW.

Total running cost—50 lakhs per year.

Annual rate of depreciation and interest on capital cost—10 %.

Find the overall cost of energy per kWh for each type of consumer. (15 marks)

[4 × 15 = 60 marks]