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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: III**
Branch: Industrial Engineering & Management **Duration: 3 hrs.**
Course Code: 19IM3DCEES **Max Marks: 100**
Course: Elements of Energy Systems **Date: 20.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably assumed.

UNIT - I

1 a) What do you understand by macroscopic and microscopic view points **4**

b) The readings t_A and t_B of two Celsius thermometers A and B agree at the ice point (0ºC) and steam point (100ºC), but elsewhere they are related by the equation **6**

$$t_A = l + mt_B + nt_B^2$$

Where l, m and n are constants. When both the thermometers are immersed in a well stirred bath, A registers 51ºC and B registers 50ºC. Determine the reading on B when A registers 25ºC.

c) Derive an work done expression for polytropic process. **4**

d) An elastic sphere initially has a diameter of 25 cm and contains a gas at a pressure of 1.2 bar. Due to heat transfer the diameter of the sphere increases to 30 cm. During the heating process the gas pressure inside the sphere is proportional to the sphere diameter. Calculate the work done by the gas during the process. **6**

UNIT - II

2 a) State the first law for a closed system undergoing a cycle. Show that internal energy is a property of a system. **6**

b) A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfers is − 170 kJ. The system completes 100 cycles per min. Complete the following table-1 showing the method for each item, and compute the net rate of work output in kW. **8**

Table-1

Process	*Q (KJ/min)*	*W (KJ/min)*	*ΔE (KJ/min)*
a-b	*0*	*2,170*	-
b-c	*21,000*	*0*	-
c-d	*-2,100*	-	*-36,600*
d-a	-	-	-

c) A turbine operates under steady flow conditions, receiving steam at the following state: pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3 m. The steam leaves the turbine at the following state: pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW **6**

UNIT - III

3 a) Give the Clausius and Kelvin-Planck's statements of second law and establish the equivalence of both the statements. **8**

b) What is a PMM-2? Why is it impossible? **4**

c) Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, Determine: i) the intermediate temperature between A and B, ii) the efficiency of each engine, and iii) the heat rejected to the cold sink. **8**

OR

4 a) With the help of P-v and T-s diagrams derive an expression for efficiency of dual cycle in terms of compression ratio, pressure ration and ratio of specific heats. **10**

b) In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate: i) the cut off ratio, ii) the heat supplied per kg of air, iii) the cycle efficiency, and iv) the m.e.p. of the cycle. For air take c_p=1.005 kJ/kg K, c_v=0.718 kJ/kg K. **10**

UNIT - IV

5 a) Derive an expression for depth of center pressure from free surface of liquid of an inclined plane surface sub-merged in the liquid. **10**

b) A square aperture in the vertical side of a tank has one diagonal vertical and is completely covered by a plane plate hinged along one of the sides of the aperture. The diagonals of the aperture are 2 m long and the tank contains a liquid of specific gravity 1.15. The center of aperture od 1.5 m below the free surface. Calculate the thrust exerted on the plate by the liquid and position of its center of pressure. **10**

OR

6 a) What is Euler's equation of motion? How will you obtain Bernoullis equation from it? **06**

b) Define an orifice-meter? Prove that the discharge through an orifice-meter is given by the relation ship **08**

$$Q = C_d \frac{a_0 a_1}{\sqrt{a_1^2 - a_0^2}} \sqrt{2gh}$$

c) In a 100 mm diameter horizontal pipe a venturimeter of 0.5 contraction ratio has been fixed. The head of water on the meter when there is no flow is 3 m (gauge). Find the rate of flow for which the throat pressure will be 2 meters of water absolute. The co-efficient of meter of 0.97. Take atmospheric pressure head=10.3 m of water. **06**

UNIT - V

7 a) What do you understand by total energy line and hydraulic gradient line **04**

b) Derive an expression for energy loss due to friction by Darcy's equation. **08**

c) A horizontal pipe line 40 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 m of its length from the tank, the pipe is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the center of the pipe. Considering all the losses of head which occur, determine the rate of flow. Take f=0.01 for both sections of the pipe. **08**

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