

**B.E., DEGREE EXAMINATIONS: MAY/JUNE 2013**

Sixth Semester

**MECHATRONICS ENGINEERING**

MCT 116: Thermodynamics and Heat Transfer

**Use of steam tables and HMT data book is permitted**

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Which of the following one is a path function
  - a) work done
  - b) heat transfer
  - c) volume
  - d) both a and b
2. When the cycle is impossible its entropy change is .....
  - a) 0
  - b)  $> 0$
  - c)  $< 0$
  - d)  $\geq 0$
3. For the same compression ratio and same heat input which cycle gives higher efficiency
  - a) Diesel
  - b) Dual
  - c) Otto
  - d) Both diesel and Otto
4. The efficiency of Brayton cycle depends on
  - a) Cut off ratio
  - b) Pressure ratio
  - c) Compression ratio
  - d) Explosion ratio
5. The mode of heat transfer in the steam pipe of the boiler is.....
  - a) conduction
  - b) convection
  - c) Radiation
  - d) All the above
6. The emissive power of the black body is .....
  - a) Zero
  - b) Minimum
  - c) Maximum
  - d) None
7. In a steady state heat conduction in the x- direction, the sectional area increases along the flow direction. Then the temperature gradient in the x direction will be
  - a) Remains constant
  - b) Will become flatter
  - c) Will become steeper
  - d) Either b or c depending upon the heat flow rate
8. The value of shape factor will be highest when
  - a) The surfaces are farther apart
  - b) Surfaces are closer
  - c) Surfaces are smaller and closer
  - d) Surfaces are larger and closer



**(OR)**

- b) In a steady flow apparatus, 135 kJ of work is done by each kg of fluid. The specific volume of fluid, pressure, and velocity at the inlet are 0.37 cu.m/kg, 600KPa and 16 m/s. The inlet is 32m above the floor, and the discharge pipe is at the floor level. The discharge conditions are 0.62 m<sup>3</sup>/kg, 100 kPa, and 270m/s. The total heat loss between the inlet and discharge is 9 kJ/kg of fluid. In flowing through this apparatus, does the specific internal energy increase or decrease, and by how much?

22. a) Derive the relation for air standard efficiency of the limited pressure cycle with its PV and TS diagrams.

**(OR)**

- b) The compression ratio for a single cylinder operating on a dual cycle is 8. The maximum pressure in the cycle is limited to 55 bar. The pressure and temperature of the air at the beginning of the cycle are 1 bar and 27 deg C. Heat is added during constant pressure process up to 3 % of the stroke. Assuming cylinder diameter as 25 cm and stroke as 30 mm. find the following 1. The work done per cycle, 2. The air standard efficiency of the cycle. 3. Power developed if the no of working cycles are 200 per minute.

23. a) Derive the general heat conduction equation for cylindrical coordinates.

**(OR)**

- b) (i) A hollow sphere with 10cm ID and 30 cm OD of a material having thermal conductivity 50 W/m K is used as a container for a liquid chemical mixture. Its inner and outer surface temperatures are 300 and 100 deg C. Determine the heat flow rate through the sphere. Also estimate the temperature at the point of quarter of the way between the inner and outer surfaces. (8)
- (ii) What is called logarithmic mean area of cylinder and derive its expression? (6)

24. a) Nitrogen at a pressure of 0.1 atm flows over a flat plate with a free stream velocity of 8 m/s. The temperature of the gas is -20 deg C. The plate temperature is 20 deg C. Determine the length for the flow to turn turbulent. Assume  $5 \times 10^5$  as critical Reynolds number. Also determine the thickness of thermal and velocity boundary layers and average convection coefficient for a plate length of 0.3m.

**(OR)**

- b) A furnace in the form of cube of 2m in side has gas in it at 1500 K. The composition of gas by volume is 16 % of CO<sub>2</sub>, 10 % of water and the rest are on non radiating gases. Determine the emissivity of the gas body. The total pressure is 1 atm. If the total pressure was 3 atm, determine the emissivity of gas volume.

25. a) The water in a 5m×15 m outdoor swimming pool is maintained at a temperature of 27 deg C. The ambient temperature and relative humidity are 27 deg C and 40 percent respectively. Assuming a wind speed of 2m/s in the direction of long side of the pool. Estimate the mass transfer coefficient for the evaporation of water from the pool surface.

**(OR)**

- b) (i) Define molar average velocity and mass diffusion velocity. (4)  
(ii) What is convective mass transfer coefficient and what are its units? (4)  
(iii) Describe the various mechanisms of mass transfer. (6)

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