Roll No.....

BTECH –2014

Elements of Mechanical Engineering

Paper Code (BTME 101)

Paper Id. [A1107]

Time : 3 Hrs | Maximum Marks: 60

Note : This paper consists of three sections. Section A is compulsory. Do any three questions from section B and C selecting minimum two from each section..

Section A (2 marks each)

1. (a) If the change in energy of a closed system is known for a process between two end states, can you determine, if the energy change was due to work, to heat transfer, or some combination of work and heat transfer.

(b) Show how the polytropic exponent n can be evaluated if you know the end state properties, (P_1, V_1) and (P_2, V_2).

(c) What In the absence of any friction and other irreversibilities, can a heat engine have an efficiency of 100 percent? Explain

(d) In a complete cycle what is the net change in energy and in volume?

(e) The entropy of a hot baked potato decreases as it cools. Is This a violation of the increase of entropy principle? Explain.

(f) Ice cubes in a glass of liquid water will eventually melt and all the water approach room temperature. Is this a reversible process? Why?

(g) The moment of inertia of a triangular section of base b and height h about an axis passing through its vertex and parallel to its base is ..... times as that passing through its centre of gravity and parallel to its base.

(h) State the purpose of piston rings and crank shaft in an I.C. engine.

(i) Name any four mechanical properties of metals and corresponding tests to find them.

(j) What are composites? Name any four along with their applications.

Section B (8 marks each)

2. i) A piston cylinder device contains unit mass of a fluid at $20\ atm$ and $0.04\ m^3$. The fluid is expanded reversibly according to the law $pV^{1.5} = C$ until the volume becomes 2 times that of its initial value. The fluid is then cooled reversibly at constant pressure until the piston comes back to its original position. Now, heat is supplied reversibly with the piston locked in position until the pressure rises to the original value of $20\ atm$. Calculate the net work done by the fluid. (6)

ii) Justify the statement that work and heat are not the properties. (2)

3. Oxygen passes through an adiabatic steady flow compressor at the rate of $1000\ kg/h$, entering as saturated vapour at $2.5\ atm$ and emerging at $17.5\ atm$ and $175\ K$. Find the shaft power required per kg of oxygen and the required power of the motor to run the compressor. Treat oxygen as an ideal gas and take $\gamma = 1.4$.

4. i)Prove that the COP of a reversible refrigerator operating between two given temperatures is the maximum. (4)

   ii) A reversible engine operates between temperatures T_1 and T $(T_1 > T)$. The energy rejected from the engine is received by a second reversible engine at the same temperature T. The second engine rejects energy at temperature T_2 $(T_2 < T)$. Show that (a) temperature T is the arithmetic mean of temperatures T_1 and T_2 if the engine produces the same amount of work output. (4)

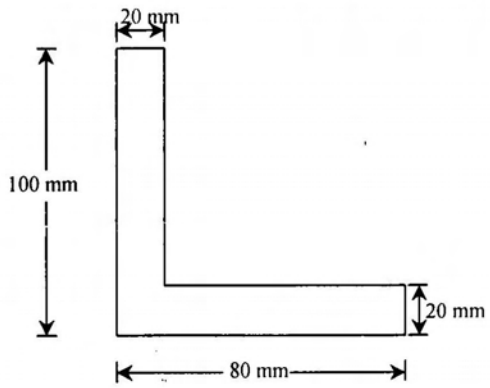
5. i)Define the term entropy. Show that entropy is a property of the system. (3)

   ii) $1\ kg$ of ice at $-5°C$ is exposed to the atmosphere, which is at $20°C$. The ice melts and comes to thermal equilibrium with the surroundings. Determine the entropy increase of the universe. Take $c_{p,ice} = 2.093\ kJ/kg - K$ and the latent heat of fusion of ice = $334\ kJ/kg$. (5)

6. i) What do you mean by air standard cycles? What are the assumptions for air standard cycles? (3)
   ii) An engine working on air standard Otto cycle in which the salient points are 1, 2, 3 and 4 has upper and lower temperature limits T_3 and T_1. If the maximum work per kg of air is to be done, show that the intermediate temperature $T_2 = \sqrt{T_3 T_1}$. (5)

Section C (8 marks each)

7. i) Find the centroid of a lamina as shown in figure: (4)



ii) Find the moment of inertia for a triangular lamina about a) centroidal axis parallel to the base, b) the base. (4)

8. i) Differentiate between the following:
a) Creep and fatigue
b) Ductility and malleability
c) Elastic limit and proportional limit
d) Yield stress and proof stress (4)
ii) Briefly describe the selection procedure of materials. (4)

9. i) Discuss the difference between theoretical and actual $p - V$ diagrams for four stroke S.I. and C.I. engines (4)

ii) In an engine based on Carnot cycle $0.6\ kg$ of air is used giving a thermal efficiency of 60 percent. During isothermal expansion the heat transfer is $50\ kJ$. At the start of isothermal expansion, the pressure is $7\ bar$ and the volume is $0.125\ m^3$. Calculate, a) the maximum and the minimum temperature for the cycle, b) Volume at the end of isothermal expansion, c) Heat transfer during each of the four processes. Take $c_v = 0.718\ kJ/kg - K$ and $c_p = 1.005\ kJ/kg - K$. (4)

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