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Total No. of Questions : 09] **[Total No. of Pages : 02**

B.Tech. (Sem. – 1st)
ELEMENTS OF MECHANICAL ENGINEERING
SUBJECT CODE : BTME – 101 (2011 Batch)
Paper ID : [A1107]

Time : 03 Hours **Maximum Marks : 60**

Instruction to Candidates:
1) Section - A is **Compulsory**.
2) Attempt any **Five** questions from Section – B & C.
3) Select atleast **Two** questions from Section – B & C.

Section - A

Q1) ***(2 Marks each)***

a) An ideal gas goes through an expansion process where the volume doubles. Which process will lead to the larger work output: an isothermal process or a polytrophic process with n=1.25?
b) In an effort to conserve energy in a heat engine cycle, somebody suggests incorporating a refrigerator that will absorb some of the waste energy Q_L and transfer it to the energy source of the heat engine. Is this a smart idea? Explain.
c) Air at 500 K, 500 kPa is expanded to 100 kPa in two steady flow cases. Case one is a throttle and case two is a turbine. Which has the highest exit T? Why?
d) Assume a heat engine with a given Q_H. Can you say anything about Q_L if the engine is reversible? If it is irreversible?
e) Why is the carnot cycle not suitable as an ideal cycle for all power producing cycle devices?
f) A substance is compressed adiabatically so P and T go up. Does that change S?
g) For the same maximum pressure and heat input, compare Otto cycle and Diesel cycle on P-v and T-s diagrams.
h) What are the technological properties of metals and alloys? Name any four.
i) What are the smart materials? Name any two along with their applications.
j) State the purpose of cam shaft and flywheel in an I.C. engine.

Section – B ***(8 Marks each)***

Q2) Fluid is confined in a cylinder by a spring loaded, frictionless piston so that the pressure in the fluid is linear function of volume (p = a+bV). The internal energy of the fluid is given by the following equation U=34+3.15PV
Where U is in kj, p is in kPa, and V is in m^3. If the fluid changes from an initial state of 170 kPa , 0.03m^3 to a final state of 400 kPa, 0.06 m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer.

Q3) Air at 9 bar and 200°C is throttled to 5 bar before being expanded through a nozzle to a pressure of 1.1 bar. Assuming that the flow through the nozzle is reversible steady flow process, and that no heat is rejected. Calculate the velocity of air at nozzle outlet when the inlet velocity is 80m/s.

Q4) a) 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 the temperature T is the geometric mean of temperatures T_1 and T_2 if the engines have the same mechanical efficiencies.

b) A source X can supply energy at the rate of 11000 kj/min at 320°C. Another source Y can supply at the rate of 11000 kj/min at 60°C. Which source X or Y would you choose, to supply energy to an ideal reversible engine, that is to produce a large amount of power, if the temperature of the surroundings is 4°C.

Q5) a) State and prove clausius inequality

b) 1 kg of water at 0°C is brought into contact with a heat reservoir at 100°C. When the water has reached at 100°C, find

1) Entropy change of water,
2) Entropy change of heat reservoir,
3) Entropy change of universe.

Section – C ***(8 Marks each)***

Q6) a) Derive an expression for mean effective pressure of diesel cycle.

b) A diesel engine has a compression ratio of 14. The fuel is cut-off at 0.08 of stroke. The relative efficiency is 52%. Find the mass of fuel of calorific value 41800 kj/kg which would be required per kWh.

Q7) a) Prove the parallel axis theorem in the determination of moment of inertia of areas with the help of a neat sketch.

b) Find the centroid of a semicircular lamina of radius r.

Q8) a) What are ER and MR fluids? Discuss their properties and areas of applications.

b) Give the composition, properties and uses of following alloy steels:

1) Heat resisting steels 2)Spring steels
3) Stainless steels 4)High speed steels.

Q9) a) Discuss the difference between theoretical and actual p – V diagrams for two stroke S.I. and C.I. engines.

b) An ideal air standard Brayton cycle operates with air. At the compressor inlet, the air is at 305 K and 1 bar. It is further compressed to 5.5 bar. The maximum cycle temperature is limited to 1050 K. The heat supplied is 10.5 MW. Find,

i) Thermal efficiency of the cycle, ii) Work ratio, iii) Power output.