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B.Tech. (Sem. - 2nd)

ELEMENTS OF MECHANICAL ENGINEERING

SUBJECT CODE : ME - 101

Paper ID : [A0114]

[Note : Please fill subject code and paper ID on OMR]

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 at least **Two** questions from Section B & C.

Section - A

Q1) ***(Marks 2 Each)***

a) Minimum number of processes required to complete a workable ideal Heat Engine cycle are : 1, 2, 3, 4, 5, 6 .....(*Select the correct answer*)

b) Why a constant volume process line is more steeper than the constant pressure process line on the T - S coordinates. Explain the reason just in two/three lines with the aid of TS charts, or otherwise.

c) **COP** which de facto implies the efficiency of a Heat Pump; is always greater than unity. But on the contrary, the efficiency of any System (including Heat Pump) can not be more than **100%**, otherwise the basic laws of thermodynamic (eg. 1st law and 2nd law etc.) would fail.

Justify in two to three lines, that true efficiency even in case of a Heat Pump **can not** be more than 100%.

d) Substantiate by giving some live example with numerical values or otherwise, that $dS > \frac{dQ_I}{T}$ (where $dQ_I \Rightarrow$ irreversible heat exchange) for an irreversible heat exchange process, say, for the case of irreversible heat rejection dQ_{21} from a Heat Engine to the Sink (atmosphere).

e) Starting from the same initial state 1 plot a reversible and an irreversible adiabatic compression processes on T - S Coordinates with arrow - heads indicating the direction of the two processes. Show the area which is representative of the fraction of energy which became unavailable during this irreversible process.

f) Prove that two adiabatic processes can not cut each other, i.e., they can not have a common state.

g) Can free expansion process be plotted on PV Coordinates? Give answer in YES or NO and give reasons for the same.

h) Fuel used in an engine operating on Otto Cycle (i.e., Constant volume heat addition cycle) is Petrol because ..... (Fill the blanks to complete the statement).

i) Temperature decreases/increases/remains constant during throtting Process ..... (Select the correct Answer)

j) Sketch stress - strain curves for **ductile** and **brittle** materials and show the salient points on it.

Section - B

(Marks 8 Each)

Q2) (a) What is the difference between **total energy** and **enthalpy**? Express both terms in detail.

(b) "One of the requirements for a process to become most efficient or reversible process is that it should be carried out in the system under complete thermodynamic equilibrium conditions".

Justify and substantiate the above statement by thermodynamic or any other logics.

Q3) (a) dQ = dE + PdV .... Is this equation valid for a process occurring

(i) In an Open System, or

(ii) In a Closed System, or

(iii) In both?

What is PdV?

(b) A mass of 10 kg at room temperature is dropped from a height of 100 m into a pond containing 1000kg of water at room temperature. Calculate the change in internal, potential and kinetic energies, heat and work transfer for the following three cases:

(i) Stone is just about to strike the water.

(ii) Stone just after striking the water, stopped immediately at the bottom of pond.

(iii) Stone achieves the ambient temperature after reasonable amount of time.

Q4) (a) Select suitable coordinates for plotting throttling process, and plot it on these coordinates alongwith an **arrow - head** indicating the direction of the process.

(b) $0.2m^3$ of ideal gas at a pressure of 20 bar and 600K is expanded is expanded isothermally to $1m^3$. It is then cooled to 300K at constant volume and then compressed back polytropically to its initial state. Find not work done and the net heat transfer during the cycle.

Q5) (a) A Carnot Engine operating between a heat reservoir at T_1 and cold reservoir at T_2 is to drive a Carnot Refrigerator removing heat Q_c from a reservoir at a temperature T_c and rejecting the heat at T_2. What is the minimum amount of heat Q_1 that is to be taken out from the hot body at T_1 to remove Q_c from coolest reservoir? Given: $(T_1 > T_2 > T_c)$.

(b) If $T_1 = 800K$, $T_2 = 310K$, $T_c = 210K$, determine the minimum value of Q_1 if Q_c is 100 KW and heat is rejected by the heat pump at temperature T_2.

Section - C

(Marks 8 Each)

Q6) (a) Explain and justify how isentropic expansion process contributes in maximising the Output and hence efficiency of the Carnot Cycle.

(b) Why a diesel engine is less efficient as compared to the Carnot cycle, when both are operating between the same temperature limits? Explain it with the aid of T - S diagrams for the two cycles.

Q7) In an air standard diesel cycle, the compression ratio is 15 and the pressure and temperature of air at the beginning of the compression are 1 bar and 288 K. The peak temperature in the cycle is 2700K. Determine

(a) heat supplied.
(b) Work done.
(c) Cycle Efficiency.
(d) Peak Pressure of the Cycle
(e) cut off ratio.
(f) M.E.P.

Q8) Discuss various inversions of double slider crank chain mechanism.

Q9) Explain longitudinal and lateral strain, Poission's Ratio, Yield Point and Bulk Modulus.