

B.Tech. (Sem. - 1<sup>st</sup>)

## ELEMENTS OF MECHANICAL ENGG.

SUBJECT CODE : ME - 101Paper ID : [A0123]

[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) Selecting at least **Two** questions from Section - B & C.

## Section - A

(Marks : 2 Each)

Q1)

- a) With same compression ratio, an engine working on Dual/ Diesel/ Otto Cycle is most efficient ..... (Select the correct Cycle).
- b) Starting from the same initial state 1, plot constant volume and constant pressure heat addition processes 12 and 13 on the TS-Coordinates alongwith **Arrow-heads** indicating the direction of these processes and identify these two processes on the TS Chart.
- c) What is the fundamental and basic difference between the terms **enthalpy** and **total energy** associated with the mass of a thermodynamic medium?
- d) Justify by assigning some numerical values by way of a practical example, to justify that  $dS > \frac{dQ_1}{T}$  for an irreversible heat exchange process, Say, by taking the case of irreversible heat addition  $Q_{11}$  to a Heat Engine.
- e) Starting from the same initial state 1 plot reversible and irreversible adiabatic expansion processes on T-S Coordinates alongwith arrow-heads indicating the direction of the two processes. Show the area which is representative of the fraction of energy which became *unavailable* during the irreversible process.

- f) Is the COP of a Refrigerator can be *greater than/less than/both more than* as well as less than **Unity**? Select the Correct Answer. Justify your reply by assigning some numerical values to the **cooling effect** and the **compressor work** by way of presenting a simple live practical example.
- g) Can throttling process be plotted on PV Coordinates? Give answer in **YES** or **NO** and give reasons for the same.
- h) Super-impose a Carnot Cycle on a Diesel Cycle plotted on the T-S coordinates, such that the end-states representing the **lowest** and **highest** temperatures for the two Cycles are coinciding with each other. Justify with the aid of TS Coordinates that the Diesel Cycle operating between the same lowest and highest temperature limits will be less efficient than the corresponding Carnot Cycle.
- i) Temperature decreases / increases / remains constant during free expansion Process. .... (Select correct Answer)
- j) Define temperature stresses and stains.

### Section - B

(Marks : 8 Each)

- Q2)** (a) How enthalpy differs from the term **heat transfer**. Clearly explain the difference between the two in detail.
- (b) "One of the essential requirements for accomplishing any reversible expansion process is that there should be complete thermal equilibrium between the **system** and the **thermal reservoir** exchanging heat during the process."
- Justify the above statement by thermodynamic or any other logics.
- Q3)** (a)  $dQ = dH - Vdp$  ...Is this equation valid for a process occurring :
- (i) In an Open System, or
  - (ii) In a Closed System, or
  - (iii) In both Systems? ..... (Select the correct Answer).
- (b) The properties of a certain gas are related as follows :
- $$E = 196 + 0.718t$$
- $$Pv = 0.287 (t+273)$$
- .... where **E** is the specific internal energy (kJ/kg), '**t**' is in °C, **P** is pressure in KN/m<sup>2</sup> and **v** is specific volume(m<sup>3</sup>/kg). Determine the two specific heats **C<sub>v</sub>**, **C<sub>p</sub>** for this gas.

- Q4) (a) Select suitable coordinates for plotting free expansion process and plot it on these coordinates along with an arrow-head indicating the direction of the process.
- (b) Air at 1 bar and  $7^{\circ}\text{C}$  is heated at constant volume in a cylinder till its temperature has risen to  $827^{\circ}\text{C}$ . It is then expanded isentropically to 1 bar and subsequently heat is rejected at constant pressure until the temperature is again equal to  $7^{\circ}\text{C}$ . Determine the following per kg. of air :
- Pressure, volume and temperature at the end of each process.
  - Heat supplied to the cycle.
  - Work delivered by the cycle.
  - Efficiency of the Cycle.
- Q5) A reversible engine takes 1200 KW from a reservoir at 700K and develops and develops 200 KW of work when executing complete cycles. The engine rejects heat to two reservoirs at 600K and 500K. Determine heat rejected to both the reservoirs. Draw a schematic line sketch for the Engine and plot the Cycle for this Engine on TS coordinates.

### Section - C

(Marks : 8 Each)

- Q6) (a) Explain and justify how isothermal heat addition process contributes in optimizing the **output** and hence **efficiency** of the Carnot Cycle.
- (b) Which is more effective (i.e., better) method of increasing the efficiency of a Carnot Cycle out of the following two possibilities :
- By increasing  $T_1$  while maintaining  $T_2$  constant.
  - By decreasing  $T_2$  while maintaining  $T_1$  as constant ( $T_1 > T_2$ ).
- Arrive at your decision with the help of T-S Chart.
- Q7) In an air standard Brayton Cycle, the air enters the compressor at 1 bar and  $25^{\circ}\text{C}$ . The pressure after compression is 3 bar. The temperature at turbine inlet is  $650^{\circ}\text{C}$ . Calculate per kg of air:
- Heat supplied.
  - Heat rejected.
  - Net work done.
  - Temperature of air leaving the turbine.
  - Air-standard efficiency of the cycle.
  - Work Ratio of the Unit.

**Q8)** Write brief Notes on :

- (a) Differential wheel and axle.
- (b) Lifting Machines.
- (c) Worm and Worm wheel.

**Q9)** (a) Make a labelled sketch of the Oldham coupling and list its use (s).  
(b) Define kinematic link, kinematic pair and kinematic chain.

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