SE / IV / App. Thermodynamics / PROD / 17.12.15

Q.P. Code : 5479

(3 Hours) Total Marks : 80

N.B: (1) Q.1 is compulsory.
(2) Attempt any three questions from the remaining **five** questions.
(3) Assume suitable data wherever necessary.
(4) Use of steam tables is allowed.

1. Attempt **any four** following : 20

(a) Prove that internal energy is a property of the system ?

(b) Explain the terms : state, path, process, cyclic process and quasi-static process?

(c) Calculate the non-flow workdone for a gas which expands from initial pressure 5 bar and volume $4m^3$ to final volume $20m^3$, for an isothermal process. Calculate final pressure also.

(d) Calculate the state of steam (i.e whether it is wet, dry or superheated), when steam has a pressure of 15 bar and specific volume of $0.12\ m^3/kg$.

(e) State the assumptions made in air-standard cycles.

2. (a) During a non-flow process, the temperature of the system changes from $20^\circ c$ to $40^\circ c$. The work done by the system and heat transfer per degree rise in temperature at each temperature reached is given by : 8

$$\frac{dw}{dt} = (4 - 0.08t) KJ/^\circ c \text{ and}$$

$$\frac{dQ}{dt} = 1.003\ KJ/^\circ c$$

Determine the change in internal energy of the system during the process.

(b) $2m^3$ of hydrogen at a pressure of 1 bar and $20^\circ c$ is compressed isentropically to 4 bar. The same gas is expanded and restored to original volume by constant volume heat rejection process. Determine (i) Pressure, volume and temperature at each end of operation (ii) The heat added during the isothermal process (iii) The heat rejected during constant volume process and (iv) The change in internal energy during each process. 12

Assume R = 4.206 KJ/KgK; Cp = 14.25 KJ/KgK

TURN OVER....

3. (a) Prove that $\int Pdv = -\int vdp$, in case of reversible isothermal process. 5

(b) Steam enters a nozzle at a pressure of 7 bar and $20^\circ c$ (i.e initial enthalpy 2850 kj/kg) and and leaves at a pressure of 1.5 bar. The initial velocity of steam at the entrance is 40 m/s and the exit velocity from the nozzle is 700 m/s. The mass flow rate through the nozzle is 1400 kg/h. The heat loss from the nozzle is 11705 kj/h. Determine the final enthalpy of steam and nozzle area if specific volume is 1.24 m^3/kg. 8

(c) Prove that Kelvin-planck and claussius's statements are equivalent. 7

4. (a) Two reversible heat engines A and B are arranged in series. Engine A receives 30kj at a temperature of $500^\circ c$ from a heat source while engine B is in communication with a cold sink at a temperature of $5^\circ c$. If the work output of A is twice that of B, calculate 10
   (i) The intermediate temperature between A and B.
   (ii) The thermal efficiency of each engine.

(b) State and prove claussius's inequality. 10

5. (a) A diesel engine working on air-standard diesel cycle takes in air at 1 bar and $15^\circ c$ The specific volume of air at inlet is $0.8 m^3/kg$. The compression ratio is 14 and 480 KJ/kg of heat is added at constant pressure. Determine: 10
   (i) Pressure, specific volume and temperature at each point of cycle
   (ii) Thermal efficiency
   (iii) Mean effective pressure
   (iv) Power developed by engine, if it consumes 0.2 kg/s of air.

(b) With a neat sketch of simple steam power plant working on Rankine cycle, explain the working of cycle and derive an expression for thermal efficiency of cycle ? Also draw T.S and P.V diagrams ? 10

6. (a) Define and briefly explain the following : 10
   (i) Dryness fraction of steam (ii) Degree of super heat
   (iii) Sensible heat (iv) Enthalpy of evaporation
   (v) Superheated steam

(b) Define entropy and obtain expressions for change in entropy for : 10
   (i) Isothermal process (ii) Polytropic process
