B.E. (Aeronautical Engineering) Third Semester (C.B.S.)

Aero Thermodynamics Paper – II

P. Pages : 3 **TKN/KS/16/7347**

Time : Three Hours Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No.2.
3. Solve Question 3 OR Questions No.4.
4. Solve Question 5 OR Questions No.6.
5. Solve Question 7 OR Questions No.8.
6. Solve Question 9 OR Questions No.10.
7. Solve Question 11 OR Questions No.12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.
12. Use of steam tables, Thermodynamic table for Moist air, Mollier's chart is permitted.

1. a) Define thermodynamic system, and classify them with suitable example. **6**

b) Explain zeroth law of thermodynamics. State its significance. **3**

c) Which approach of thermodynamics is more preferable to study Engineering Thermodynamics. Explain why. **5**

OR

2. a) What are Intensive properties and extensive properties in thermodynamics. **4**

b) Prove that $C_P - C_V = R$. **3**

c) Justify heat transfer and work transfer as a path function. **7**

3. a) State first law of thermodynamics. **2**

b) Prove that for a non- flow process the application of first law. Leads to the energy equation $Q = W + \Delta u$. **5**

c) In a system, executing a non-flow process, the work and heat per degree change of temperature are given by $\frac{dW}{dT} = 200\,J/^{o}C$ and $\frac{dQ}{dT} = |160\,J|^{o}C$ what will be the change of Internal energy of the system when its temperature changes from $T_1 = 55^{o}C$ to $T_2 = 95^{o}C$? **6**

OR

4. a) Prove that the rate of heat transfer during polytrophic process is $Q = \left(\frac{\gamma - n}{r - 1}\right) \times W$. **3**

b) Write down steady flow energy equation for **3**

i) Nozzle ii) Turbine

c) A centrifugal pump delivers 50kg of water per second. The inlet and outlet pressures are 1 bar and 4.2 bar respectively. The suction is 2.2m below the centre of the pump and delivery is 8.5 above the centre of pump. The suction and delivery pipe diameter are 20cm and 10cm respectively determine the capacity of electric motor to run the pump. **7**

5. a) Explain Kelvin-Plank and Clausius statement of second law of thermodynamics. **4**

b) Show that $[COP]_{H.P.} = [C.O.P]_R + 1$. **3**

c) Two reversible heat engines A and B are arranged in series. A rejecting heat directly to B. Engine A receives 200KJ at a temperature of 421ºC from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4ºC. If the work output of A is twice that of B. Find **6**

i) The intermediate temperature between A and B.
ii) The efficiency of heat engine.
iii) The heat rejected to the cold sink.

OR

6. a) Show that the efficiency of reversible carnot engine is independent of the nature and amount of working substance. **5**

b) Explain the principle of increase of entropy. **3**

c) 300 KW of heat is supplied at a constant temperature of 290ºC to a heat engine. The engine rejects heat at 8.5ºC. The following results were recorded. **5**

i) 215 KW is rejected.
ii) 150 KW is rejected.
iii) 75 KW is rejected

Classify which of the results reports reversible, irreversible or impossible cycle.

7. a) Define the following terms. **5**

i) Latent heat of Fusion.
ii) Latent heat of Vaporization.
iii) Sensible heat of water.
iv) Dry saturated steam.
v) Superheated steam.

b) Find the Internal Energy of 1Kg of steam at a pressure of 10 bar, when the condition of steam is. **8**

i) Wet with dryness fraction of 0.85
ii) Dry and saturated.
iii) Superheated with degree of superheat being 50ºC.Take specific heat of Superheat steam at constant pressure is 2.01 KJ/Kg K.

OR

8. a) Explain the method to determine dryness fraction of steam using throttling calorimeter. **5**

b) Steam initially at a pressure of 15 bar and 0.95 dryness expand isentropically to 7.5 bar and is then throttled until it is just dry. Determine per kg of steam. **8**

i) Change in entropy
ii) Change in enthalpy
iii) Change in internal Energy.

9. a) Derive an expression for air standard efficiency of an otto cycle. **6**

b) In an air standard diesel cycle the compression ratio is 16, and at the beginning of Isentropic compression the temperature is 15ºC and the pressure is 0.1 MPa. Heat is added until the temperature at the end of constant pressure process is 1480ºC. Determine. **8**

i) The cutoff ratio
ii) The heat supplied per kg of air
iii) The cycle efficiency
iv) M.E.P.

OR

10. a) Show that the efficiency of otto cycle depends only on compression ratio for fixed working substance. **6**

b) An Engine working on the otto cycle has an air standard efficiency of 56% and rejects 554 KJ/kg of air. The pressure and temperature of air at the beginning of compression are 1bar and 60ºc respectively Determine **8**

i) The compression ratio of the engine.
ii) The work done per kg of air
iii) The pressure and temperature at the end of compression.

11. a) Apply the steady flow energy equation to the following devices. **6**

i) Nozzle
ii) Diffuser
iii) Throttling valve

b) In a steam power station, steam flows through a 0.2m diameter pipeline from the boiler to the turbine. At the boiler end, the steam conditions are found to be P = 4 MPa, t = 400ºC, h = 3213.6 kJ/kg and $\nu = 0.073 m^3/kg$. At the turbine end the conditions are found to be P = 3.5MPa, t = 392ºC, h = 3202.6 kJ/kg and ν = 0.084 m^3/kg There is a heat loss of 8.5 kJ/kg from the pipeline. Calculate the steam flow rate. **7**

OR

12. a) In a gas turbine, the gas enter at the rate of 5 kg/sec with a Velocity of 50 m/sec and enthalpy of 900 kJ/kg and leaves the turbine with a velocity of 150 m/sec. And enthalpy of 400 kJ/kg. The loss of heat from the gases to the surrounding is 25 kJ/kg Assume for gas R = 0.285 kJ/kg and $C_P = 1.004 \, kJ \,|\, kg \, k$ and the inlet conditions to be at 100 kPa and 27ºC. Determine the power output and diameter of the inlet pipe. **8**

b) Using general steady flow energy equation, show that enthalpy of fluid before throttling is equal to enthalpy after throttling. **5**

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