CBCS SCHEME

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17AU33

Third Semester B.E. Degree Examination, June/July 2019
Engineering Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of thermodynamic data handbook, steam tables, psychrometry chart are allowed.

Module-1

1 a. Explain i) Thermodynamic equilibrium ii) Quasistatic process. **(06 Marks)**

b. Distinguish between :
i) Microscopic and macroscopic point of approach
ii) Open system and closed system
iii) Intensive and extensive properties **(04 Marks)**

c. A certain thermometer is calibrated using ice and steam as fixed points and designing them as 0°C and 100°C respectively. The thermodynamic function chosen to establish the scale is $t = (a \ell n\, x + b)$, instead of the linear scale $t = (ax + b)$. Determine constants 'a' and 'b' in terms of x_{ice} and x_{steam} and show that the new scale is given by $t = 100 \dfrac{\ell n(x / x_{ice})}{\ell n\left(\dfrac{x_{steam}}{x_{ice}}\right)}$ **(10 Marks)**

OR

2 a. State and explain thermodynamic definition of work. **(06 Marks)**

b. Differentiate between the work obtained using i) $\int p.dv$ ii) pv, where 'p' is the pressure and 'v' is the specific volume. **(04 Marks)**

c. Determine the total work done by a gas system following an expansion process as shown in Fig Q2(c)

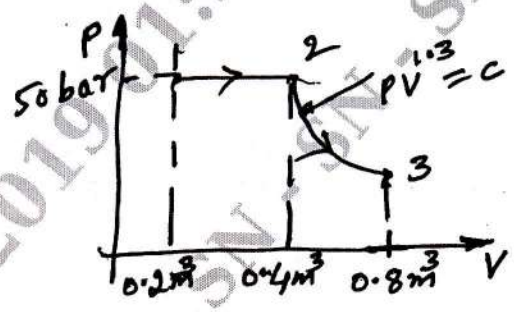

Fig Q2(c) **(10 Marks)**

Module-2

3 a. State the first law of Thermodynamics for a
i) Closed system undergoing cyclic process
ii) Closed system undergoing non-cyclic process
iii) Open system undergoing a steady flow process **(06 Marks)**

b. Show that internal energy as a property of system. **(06 Marks)**

c. In a steady flow steam turbine, the steam flows at the rate of 220 kg/min. The turbine rejects 100kJ/sec, of heat to the surroundings. The velocity, pressure, internal energy and specific volume at entry and exit are 320 m/sec, 6 bar, 2000kJ/kg, $0.36m^3$/kg and 140m/sec, 1.2bar, 1400kJ/kg and $1.3m^3$/kg respectively. The change in potential energy may be neglected. Determine the power generated. **(08 Marks)**

OR

4 a. How are the efficiency of heat engine and the cop of a heat pump and refrigerator are defined. **(06 Marks)**

b. State the Kelvin – Planck and Clausius statement of the second law of thermodynamics. **(06 Marks)**

c. A heat engine receives reversibly 3000 kJ/min of heat per cycle from a source at 327°C and rejects heat to a sink at 27°C. There are no other heat transfers. Three hypothetical amount of heat rejection are given below :

i) 200kJ/min
ii) 150kJ/min
iii) 100kJ/min.

For each of these cases, show which cycle is reversible, irreversible and impossible. **(08 Marks)**

Module-3

5 a. Derive an expression for mean effective pressure in an air standard Otto cycle. **(10 Marks)**

b. Compression ratio of an air standard dual cycle is 8. Air is at 100KPa, 300K at the beginning of the compression process. The temperature of air at the end of constant pressure heat addition process is 1300K. The net heat transfer to the cycle is 480 kJ/kg. Determine :

i) Heat added during constant volume per Kg of air
ii) Air standard cycle efficiency
iii) m.e.p. **(10 Marks)**

OR

6 a. Define the following term with respect to I.C engine :

i) Brake power
ii) Indicated power
iii) Mechanical efficiency
iv) Specific fuel consumption
v) Thermal efficiency. **(05 Marks)**

b. For the same compression ratio which cycle is more efficient, Otto, Diesel or Dual? Explain with P-V and T-S diagram. **(05 Marks)**

c. During a test on a single cylinder 4 stroke oil engine the following observations were made Bore = 30cm, Stroke = 45cm, duration of trail = 1 hr, total fuel consumption = 7.6 kg, calorific value of fuel = 45,000 kJ/kg, total revolutions made = 12000, mean effective pressure = 6 bar, net brake load = 1.47kN, Brake drum diameter = 1.8m, rope diameter = 3cm, mass of cooling water circulated = 550 kg, water enters at 15°C, water leaves at 60°C. Total air consumption = 360kg, room temperature 20°C. Exhaust gas temperature = 300°. Calculate :

i) Indicated and brake power
ii) Mechanical efficiency.

Draw heat balance sheet on minute basis. **(10 Marks)**

Module-4

7 a. What are the desirable properties of good refrigerant? **(04 Marks)**

b. With a neat sketch describe summer air conditioning system for hot and dry weather. **(08 Marks)**

c. On a particular day, the atmospheric air was found to have a dry bulb temperature of 30°C and wet bulb temperature of 18°C. The barometric pressure was observed to be 760mm of Hg. Obtain the following properties using psychrometric chart i) Relative humidity ii) Specific humidity iii) Dew point temperature iv) The enthalpy of per kg of dry air. **(08 Marks)**

OR

8 a. Define :
   i) Dry bulb temperature (DBT)
   ii) Wet bulb temperature (WBT)
   iii) Dew Point Temperature (DPT)
   iv) Relative humidity v) specific humidity. **(05 Marks)**

b. Explain the following psychometric process
   i) Sensible heating
   ii) Sensible cooling
   iii) Humidification
   iv) Dehumidification
   v) Heating and humidification **(08 Marks)**

c. A vapour compression plant uses R – 12 and is to develop 5 tonnes of refrigeration. The condenser and evaporator temperatures are to be 40°C and -10°C respectively. Determine:
   i) The refrigerant flow rate in Kg/s
   ii) Heat rejected in the condenser
   iii) COP. **(07 Marks)**

Module-5

9 a. Define:
   i) Single acting compressor
   ii) Double acting compressor
   iii) Single stage compressor
   iv) Multistage compressor
   v) Free Air Delivery (FAD). **(05 Marks)**

b. Write the advantages of multistage compressor. **(05 Marks)**

c. A single stage, double acting air compressor, required to deliver $14m^3$ of air per minute measured at 1.013 bar and 15°C. The delivery pressure is 7 bar and speed is 300 rpm. Take the clearance volume as 5% of swept volume with the compression and expansion index n = 1.3, calculate :
   i) The bore and stroke of the cylinder assuming L = 1.2 D
   ii) Delivery temperature
   iii) Indicated power. **(10 Marks)**

OR

10 a. With neat sketch, explain the differences between open and closed cycle gas turbines. **(06 Marks)**

b. With a neat sketch explain :
   i) Turbo – jet engine
   ii) Rocket propulsion. **(08 Marks)**

c. Draw a net line diagram and T-S diagram for the regeneration Gas turbine (G-T) cycle. **(06 Marks)**

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