CBCS SCHEME

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15AE33

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Aero Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use of thermodynamics data handbook / charts / tables is permitted.

Module-1

1 a. What are open system, closed system and isolated system? Give examples of each. **(06 Marks)**

b. A readings t_A and t_B of two celcius thermometer A and B agree at ice point and steam point but elsewhere they are related by the equation $t_A = L + Mt_B + nt_B^2$ where L, M and n are constant when both the thermometer are immersed in oil A indicates 55°C and B indicates 50°C, determine the values of constant L, M and n and also the temperature reading on thermometer A when B reads 25°C? **(10 Marks)**

OR

2 a. A system undergoes a process in which the pressure and volume are related by an equation of the form $PV^n = C$. Derive an expression for displacement work during this process. **(06 Marks)**

b. A spherical balloon of 0.5m diameter contains air at a pressure of 500 KPa the diameter increases to 0.55m in a reversible process during which pressure proportional to diameter. Determine the work done by the air during this process. **(10 Marks)**

Module-2

3 a. Show that energy is a property of system. **(06 Marks)**

b. A cylinder contains 1kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a distance according to a law $PV^2 = C$ until the volume is double. The fluid is there cooled reversibly at constant pressure until the piston regains its original position, heat is then added with the piston firmly locked in position until the pressure rises to original value of 20 bar. Sketch the cycle on the PV diagram and calculate the net work done by the fluid for an initial volume of $0.5m^3$. **(10 Marks)**

OR

4 a. Obtain an expression for steady flow work from the steady flow energy equation. **(08 Marks)**

b. A closed system undergoes a cyclic process 1 – 2 – 3 – 1 it is given that :
$Q_{1-2} = 30kJ$, $Q_{2-3} = 10kJ$, $W_{1-2} = 5kJ$, $W_{3-1} = 25kJ$ and $du_{3-1} = 15kJ$, determine Q_{3-1}, W_{2-3}, $(dv)_{1-2}$ and $(dv)_{2-3}$. **(08 Marks)**

Module-3

5 a. State Kelvin Plank and Clausius statements of second law of thermodynamics and show that they are equivalent. **(08 Marks)**

b. A reversible engine operates between temperature T_H and T_I with $T_H > T_I$. The energy rejected from this engine is utilized for driving another reversible engine which operates between the temperature limits T_I and T_L with $T_I > T_L$. For this arrangement show that :

i) The temperature T_I is the arithmetic mean of the temperature T_H and T_L, if both the engines produce equal amount of work

ii) The temperature T_I is geometric mean of the temperature T_H and T_L when both the engines have the same thermal efficiency. **(08 Marks)**

OR

6 a. State and prove clausius inequality. **(08 Marks)**

b. A reversible engine receives 430kJ of heat per cycle from a source maintained at 327°C engine rejects heat to a sink maintained at a temperature of 27°C for each of the following cases of heat rejection. Find whether the cycle is reversible, irreversible or impossible using the clausius inequality.

i) Heat rejected is 220 kJ/cycle
ii) Heat rejected is 105 kJ/cycle
iii) Heat rejected is 315 kJ/cycle. **(08 Marks)**

Module-4

7 a. Define the following :

i) Pure substance
ii) Saturation pressure
iii) Triple point
iv) Critical point. **(08 Marks)**

b. Find the enthalpy, specific volume and internal energy if the pressure of steam is 50 bar and temperature is 443°C. **(08 Marks)**

OR

8 a. Show that the change in entropy when a perfect gas undergoes a polytrophic change PV^n = constant is given by the expression.

$$S_2 - S_1 = \frac{\gamma - n}{n - 1} \cdot C_V \ell n\left(T_1/T_2\right).$$ **(08 Marks)**

b. Determine the change in entropy of 1kg of perfect gas which is compressed according to the law $PV^{1-3} = c$ from initial pressure of 1 bar and volume of $0.85m^3$ to a final volume of $0.5m^3$. Find also the work done and heat supplied during this process.
Assume $C_V = 0.7kJ/kg\ K$ and $\gamma = 1.4$. **(08 Marks)**

Module-5

9 a. With the help of PV and T-S diagram, explain the working of diesel cycle. Derive an expression for the efficiency of diesel cycle in terms of its compression and cut off ratios. **(10 Marks)**

b. An ideal heat engine works on Carnot cycle between the temperature limits of 1100°C and 150°C. If 4000kJ/min heat is added to the engine at the higher temperature determine :

i) Power developed by the engine
ii) The quantity of heat rejected
iii) The change in entropy during heat rejection. **(06 Marks)**

OR

10 a. With the help of P-V and T-S diagram, derive an expression for the air standard efficiency of a petrol cycle [Otto cycle]. **(10 Marks)**

b. An Otto cycle has upper and lower temperature limits of T_3 and T_1. If maximum work/kg of air is to be done. Show that intermediate temperature is given by $T_2 = T_4 = \sqrt{T_1 T_3}$ **(06 Marks)**

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