CBCS SCHEME

USN | | | | | | | | | | 15AE33

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

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of thermodynamic data hand book is permitted.

Module-1

1 a. Define the following:
i) Open system
ii) Closed system and
iii) Isolated system and
Classify the following into open, closed and isolated system.
i) Radiator of a car
ii) Thermos flask
iii) Water pump
iv) Pressure cooker. **(08 Marks)**

b. A temperature scale of certain thermometer is given by the relation t = alnp + b, where a and b are constants and P is the thermometer property of the fluid in the thermometer. If at the ice point and steam point the thermometric properties are found to be 1.5 and 7.5 respectively. What will be the temperature corresponding to the thermometric property of 3.5 on Celsius scale. **(08 Marks)**

OR

2 a. Derive an expression for work done per unit mass for a reversible isothermal process taking place in a closed system containing an ideal gas. **(04 Marks)**

b. Gas from a cylinder of compressed helium is used to inflate an inelastic flexible balloon. Originally folded completely flate, to a volume of $0.5 m^3$. If the barometer reads 760 mm Hg, what is the amount of work done upon the atmosphere by the balloon? Sketch the system before and after the process. **(06 Marks)**

c. The combustion gases of an IC engine expand within an enclosed piston and cylinder arrangement and follow the path $Pr^{1.6} = C$. The pressure at the beginning of the power stroke is 5MPa and volume $50 cm^3$. At the end of the stroke the volume is $1500 cm^3$. Calculate:
i) Work developed during the power stroke
ii) Power developed for 20 strokes per second. **(06 Marks)**

Module-2

3 a. Derive an expression for heat transfer per unit mass for a reversible polytropic process taking place in a closed system containing an ideal gas. **(06 Marks)**

b. State I law of thermodynamics as applied to a closed system. **(02 Marks)**

c. A fluid system contained in a piston and cylinder machine passes through a complete cycle of four processes. The sum of all heat transferred during a cycle is -340 kJ. The system completes 200 cycles per min. Complete the following table showing the method for each item and compute the net rate of work output in kW. **(08 Marks)**

Process	O (kJ/min)	W (kJ/min)	E (kJ/min)
1-2	0	4340	-
2-3	42000	0	-
3-4	-4200	-	-73200
4-1	-	-	-

OR

4 a. Write the steady flow energy equation for the following with sketches:
   i) Adiabatic horizontal steam nozzle
   ii) Adiabatic steam turbine **(04 Marks)**

b. What is a perpetual motion machine of first kind? Why is it impossible? **(03 Marks)**

c. 10 kg of fluid per minute goes through a reversible steady flow process. The properties of fluid at the inlet are: $P_1 = 1.5$ bar, $\rho_1 = 26$ kg/m^3, $C_1 = 110$ m/s and $u_1 = 910$ kJ/kg and the fluid rejects 55 kJ/s and rises through 55 metres.
At the exit, the properties of the fluid are $P_2 = 5.5$ bar, $\rho_2 = 5.5$ kg/m^3, $C_2 = 190$ m/s and $u_2 = 710$ kJ/kg. Determine : i) The change in enthalpy ii) Work done during the process. **(09 Marks)**

Module-3

5 a. Show that all reversible heat engines operating between same source and sink will have same thermal efficiency. **(07 Marks)**

b. Series combination of three carnot engines A, B and C operate between temperatures of 1500K and 300K. If the amount of heat addition to each engine is in the ratio of 6:3:2, calculate the intermediate temperature. **(09 Marks)**

OR

6 a. Derive Clausius Inequality and prove that entropy is a property of the system. **(08 Marks)**

b. A 50 kg metal block at a temperature of 500°C is quenched in 140kg of oil at 30°C. C_p of metal = 0.5 and $C_{p_o} = 2.5\,kJ/kg^\circ k$. Assume no heat losses. Calculate change in entropy for a system consisting of oil and casing. **(08 Marks)**

Module-4

7 a. Write a neat P-T diagram for a pure substance and define
   i) Triple point ii) Critical point. **(06 Marks)**

b. Sketch and explain the construction and working of a separating and throttling calorimeter used for determining the dryness fraction of stream in a boiler. **(06 Marks)**

c. What amount of heat would be required to produce 4.4 kg of steam at a pressure of 6 bar and temperature of 250°C from water at 30°C. Take specific heat for superheated steam as 2.2 kJ/kg°K. **(04 Marks)**

OR

8 a. Starting from the relation Tds = du + pdv, show that for an ideal gas undergoing a reversible adiabatic process, the law for the process is given by T_v^{r-1} = constant. **(06 Marks)**

b. Explain reduced coordinates and generalized compressibility chart. **(06 Marks)**

c. Prove that specific heat at constant volume (C_v) of a Vander Waal's gas is a function of temperature alone. **(04 Marks)**

Module-5

9 a. What do you understand by the 'Air standard efficiency'? Derive an expression for air standard efficiency of a Otto cycle with usual notations. **(08 Marks)**

b. An engine operating on the ideal diesel cycle has a compression ratio of 16:1. Heat is added during constant pressure process upto 8% of the stroke. If the engine inhales 0.04 m^3/s at 101 kPa and 25°C. Determine:
   i) The maximum pressure and temperature of the cycle.
   ii) Thermal efficiency of the engine.
   iii) The power developed. **(08 Marks)**

OR

10 a. Explain the effect of
   i) Maximum pressure
   ii) Exhaust pressure
   iii) Superheat on the simple Rankine cycle. **(06 Marks)**

b. List the methods of improving the performance of Rankine cycle. **(02 Marks)**

c. In a steam turbine, steam at 20 bar 360°C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal process, find per kg of steam the net work done and the cycle efficiency. **(08 Marks)**

* * * * *