7. (a) An ideal Diesel cycle with air as the working fluid has a compression ratio of 18 and cut-off ratio of 2. At the beginning of compression process, the working fluid is at 100 kPa, 27^0C, and 1917 cm^3. Determine (i) the temperature and pressure of air at the end of each process, (ii) the net work output in kJ (iii) the thermal efficiency of the cycle.
For air, c_p=1.005 kJ/kg-K; c_v = 0.718 kJ/kg-K; γ =1.4; R= 0.287 kJ/kg-K.

(b) A closed tank contains 0.5m of mercury (specific gravity 13.6) at bottom, above which there are 2 m of water, 3 m of oil of specific gravity 0.6 and there is air space above the oil at the top part, inside the tank. If the gauge pressure at the bottom of the tank is 196.2 kPa, what is the pressure of the air at the top part of the tank?

(6 + 1 + 1) + 4 = 12

Group – E

8. (a) Oil of specific gravity 0.9 and viscosity 2.5 Poise flows through a 100mm diameter pipe, 500m long at a rate of 2 litre/sec. Find the Reynolds number of the flow.

(b) Two small closed vessels are connected to a U-tube manometer containing mercury (relative density 13.56) and the connecting tubes are filled with oil (relative density 0.82). The vessel at the higher pressure is 2m lower in elevation than the other.
(i) What is the pressure difference between the vessels when the steady difference between mercury meniscus is 225mm?
(ii) What is the difference of piezometric head between manometer connection points?
(iii) If an inverted U-tube manometer containing a liquid of relative density of 0.74 were used instead, what would be the manometer reading for the same pressure difference?

4 + (3 + 2 + 3) = 12

9. (a) Water flows up a vertical venturimeter whose inlet and throat diameters are 250 mm and 125 mm respectively, the throat section being 0.30 m above the inlet section. The pressure at the inlet and the throat sections are 60 kPa and 20 kPa respectively. Find the rate of flow through the meter. Take C_d = 0.98.

(b) Differentiate between steady and uniform flow with example. What is turbulent flow? Write the expression of Reynolds number and specify the range of values for laminar and turbulent flow through a pipe.

6 + (3 + 3) = 12

ENGINEERING THERMODYNAMICS AND FLUID MECHANICS
(MECH 1201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) As differentials, heat transfer and work transfer can be described mathematically as
(a) inexact (b) exact
(c) point function (d) discontinuity.

(ii) A thermodynamic system is referred to be an isolated system when there is transfer of _____ across the system boundaries
(a) only mass (b) only energy
(c) both mass and energy (d) neither mass nor energy.

(iii) Heat transferred to a closed stationary system at constant volume equals to
(a) increase in enthalpy (b) increase in internal energy
(c) increase in entropy (d) none of these.

(iv) A reversible adiabatic process on T–S diagram is represented by
(a) horizontal line (b) curved line
(c) vertical line (d) inclined line.

(v) Which parameter can be considered to remain constant if the value of the exponent n in the polytropic equation pv^n = constant takes a unit value for an ideal gas in a quasi-static expansion?
(a) enthalpy (b) entropy
(c) internal energy (d) pressure or volume.

(vi) In a Carnot cycle, the addition and rejection of heat take place at constant
(a) pressure (b) volume (c) temperature (d) enthalpy.

(vii) The piezometric head in a static liquid
(a) remains constant only on a horizontal plane
(b) increases linearly with depth below a free surface
(c) remains constant at all points in the liquid
(d) decreases linearly with depth below a free surface.

(viii) Which fluid does not experience shear stress during flow?
(a) Pseudoplastic (b) Dilatant
(c) Inviscid (d) Newtonian.

(ix) Newton's law of viscosity relates to
(a) angular deformation, velocity and viscosity
(b) shear stress and rate of angular deformation
(c) shear stress, temperature, viscosity and velocity
(d) pressure, viscosity and rate of angular deformation.

(x) The continuity equation is based on principle of conservation of
(a) mass (b) energy
(c) momentum (d) force.

Group – B

2. (a) One kg of a certain fluid is contained in a horizontal cylinder fitted with a frictionless leak proof piston at a pressure of 10 bar. The fluid is allowed to expand reversibly in the cylinder until the volume becomes two times its original volume. During the expansion process, the relation between pressure and volume is given by pv^2 = constant. The fluid is then cooled reversibly at constant pressure until the piston regains its original position. Finally the fluid is heated reversibly with the piston firmly locked in position and the fluid pressure rises to initial value of 10 bar. If the fluid has an initial volume of 0.05 m^3, make calculations for the net work done by the fluid.

(b) Define specific heat at constant volume and constant pressure. Explain what is meant by a quasi-static process.

7 + (3 + 2) = 12

3. (a) A stationary mass of gas is compressed reversibly from an initial state (0.4m^3, 0.1MPa) to a final state (0.2m^3, 0.1MPa); the pressure remaining constant during the process. If there is a transfer of 15 kJ of heat from the gas during the process, evaluate the change in internal energy of the gas.

(b) Explain what is meant by a thermodynamic system and classify different thermodynamic systems. Define a PMM1. What is the converse of a PMM1?

6 + (4 + 2) = 12

Group – C

4. (a) Steam flows steadily into a condenser and at entry it has an enthalpy of 2050 kJ/kg and velocity of 500 m/s. The condensate (condensed steam) leaves with an enthalpy of 200 kJ/kg and velocity of 10 m/s. The exit from the condenser is in line with the inlet. Determine the heat transfer to the cooling water per unit mass of steam.

(b) State Kelvin Planck statement of the second law of Thermodynamics and hence explain what is meant by a PMM2. Make an energy analysis of a steam turbine as a steady flow energy device.

6 + (3 + 3) = 12

5. (a) (i) What is the difference between a refrigerator and a heat pump?
(ii) What is entropy principle?

(b) A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K at a rate twice that at which the engine rejects heat to it. If the efficiency of the engine is 40% of the maximum possible and the COP of the heat pump is 50% of the maximum possible,
(i) What is the temperature of the reservoir to which the heat pump rejects heat?
(ii) What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 kW?

(2 + 2) + (5 + 3) = 12

Group – D

6. (a) Distinguish between
(i) Compressible and Incompressible fluid
(ii) Gauge pressure and Vacuum pressure.

(b) A hydraulic ram, having 200mm diameter and 1.2m long moves within a concentric cylinder 200.2mm diameter. The annular clearance is filled with oil of specific gravity 0.85 and kinematic viscosity 400mm^2/s. What is the power required to move the ram at a speed of 120mm/s?

(2 + 2) + 8 = 12