SPECIAL SUPPLE B.TECH/AEIE/BT/CE/CHE/CSE/ECE/EE/IT/ME/2ND SEM/MECH 1201/2018

ENGINEERING THERMODYNAMICS & 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) Which is not a property of a system?
(a) Temperature (b) Pressure
(c) Specific volume (d) Work.

(ii) Work done in free expansion is
(a) zero (b) maximum (c) positive (d) negative.

(iii) In the polytropic process equation $pv^n = constant$, if $n = 0$, the process is termed as
(a) isochoric (b) isobaric
(c) isothermal (d) adiabatic.

(iv) Internal energy of a perfect gas depends on
(a) temperature, pressure and volume (b) pressure and volume
(c) temperature and pressure (d) temperature only.

(v) For a reversible adiabatic process, the change in entropy is
(a) zero (b) positive (c) negative (d) infinite.

(vi) The efficiency of a Carnot cycle working between t_1° C and t_2° C ($t_1 > t_2$) is
(a) $\frac{t_1-t_2}{t_1}$ (b) $\frac{t_1}{t_1-t_2}$ (c) $\frac{t_1-t_2}{t_1+273}$ (d) $\frac{t_1+273}{t_1-t_2}$

(vii) The air standard Otto cycle consists of the following reversible processes
(a) two isobaric and two isochoric
(b) two isothermal and two isobaric
(c) two adiabatic and two isochoric
(d) two adiabatic and two isobaric.

(viii) Between air standard Otto cycle and Diesel cycle with same compression ratio

(a) $\eta_{otto} > \eta_{diesel}$ (b) $\eta_{otto} < \eta_{diesel}$

(c) $\eta_{otto} = \eta_{diesel}$ (d) both (a) and (b) are possible.

(ix) Newton's law of viscosity is valid for

(a) ideal fluid (b) dilatant fluid

(c) Bingham plastic (d) Newtonian fluid.

(x) For a fluid having dynamic viscosity μ, kinematic viscosity υ and density ρ

(a) $(\upsilon/\mu) = \rho$ (b) $(\mu/\upsilon) = \rho$

(c) $\rho = (\mu \times \upsilon)$ (d) $(\mu \times \upsilon \times \rho) = 1$

Group – B

2. (a) State and explain the 1st Law of Thermodynamics for a closed system executing a complete cycle. What is the difference between a cycle and a process? Explain what is meant by a PMM 1.

(b) A gas of mass 8 kg expands within a flexible container so that the p-v relationship is of the form $pv^{1.2}$ = constant. The initial pressure is 1000 kPa and initial volume is 1 m^3, the final pressure is 5 kPa. If the specific energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction.

(2 + 1 + 1) + 8 = 12

3. (a) 2 kg of a gas is contained in a piston-cylinder assembly at initial conditions of 2 m^3 and 100 kPa. The gas is allowed to expand to a final volume of 5 m^3. Determine the amount of work done for the processes given by the equation PV^2 is constant.

(b) In an internal combustion engine, during the compression stroke the heat rejected to the cooling water is 50 kJ/kg and the work input is 100 kJ/kg. Calculate the change in internal energy of the working fluid stating whether it is a gain or loss.

6 + 6 = 12

Group – C

4. (a) Steam flows through a turbine at a rate of 3 kg/s. the inlet and exit enthalpy of steam are 2800 kJ/kg and 1700 kJ/kg respectively. Velocity of steam at inlet and outlet are 30 m/s and 240 m/s. there is heat loss to the surroundings at 50 kW. Calculate the power output from the turbine.

(b) An inventor claims that his engine has following specifications:

Temperature limits	--------	750° C and 25° C
Power developed	--------	75 kW
Fuel burned per hour	--------	3.9 kg

State whether his claim is valid or not.

6 + 6 = 12

5. (a) Find the COP and heat transfer rate in the condenser of a refrigerator in kJ/kg which has a refrigeration capacity of 12000 kJ/h when power input is 0.75 kW.

(b) Write the Clausius statement of 2nd law of Thermodynamics. Explain what is PMM 2. Show the block diagram of a heat pump.

6 + (2 + 2 + 2) = 12

Group – D

6. (a) A 100N rectangular solid block slides down a 30° inclined plane. The plane is lubricated by a 2 mm thick oil of viscosity 0.8 Pa-s. If the contact area is 0.4 m^2, estimate the terminal velocity of the block.

(b) Describe the four processes of an air standard Diesel cycle. What is meant by the coefficient of compressibility of a fluid? How is it mathematically expressed? What are meant by absolute pressure, gauge pressure and vacuum pressure?

6 + 6 = 12

7. (a) State Newton's law of viscosity and hence define coefficient of dynamic viscosity. Derive its SI unit.

(b) The minimum pressure and temperature in an air standard Otto cycle are 100 kPa and 27° C with a compression ratio of 7. The amount of heat added to air per cycle is 1550 kJ/kg.

(i) Determine the pressure and temperature at all the other salient points.

(ii) Also calculate the specific work and thermal efficiency of the cycle.

Given for air: $\gamma = 1.4$ and $c_v = 0.72$ kJ/kg-K.

4 + 8 = 12

Group – E

8. (a) A pipe of diameter 250 mm conveys water at the rate of 2.4 m^3 per minute and has a pressure of 20 kPa at a certain section. Find the total energy head with respect to a datum of 4000 mm below the pipe.

(b) Derive Euler's equation of motion with the mention of the conditions.

6 + 6 = 12

9. (a) A horizontal pipe of diameter 200 mm converges to a diameter of 100 mm. The pipe conveys water, the pressure intensities being 400 kPa and 250 kPa at the larger and the smaller sections respectively. Ignoring energy losses, find the discharge.

(b) The velocity vector in an incompressible fluid flow is given by:
$\vec{V} = (6xt + yz^2)$ **i** + $(3t + xy^2)$ **j**+ $(xy - 2xyz - 6tz)$ **k** m/s
where x, y, z are in m, and t is in s.
(i) Verify whether flow is possible.
(ii) Determine the local acceleration vector at point A (1, 1, 1) at t = 1s.

6 + (3 + 3) = 12