

B.Tech/AEIE/BT/CE/CHE/CSE/ECE/EE/IT/ME/2nd Sem/MECH-1201/2015

2015

**ENGINEERING THERMODYNAMICS AND FLUID MECHANICS
(MECH 1201)**

Time Alloted : 3 Hours

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 most appropriate alternative for the following : **[10×1=10]**
 - i) A Carnot cycle consists of :
 - (a) two isothermals and two adiabatics
 - (b) two isochorics and two adiabatics
 - (c) two isobars and two isothermals
 - (d) two resersible isothermals and two reversible adiabatics.
 - ii) During throttling process
 - (a) Internal energy does not change
 - (b) Pressure does not change
 - (c) Entropy does not change
 - (d) Enthalpy does not change

- iii) A closed system moves from state 1 to state 2 by an irreversible process. Then it goes back to state 1 by a reversible process. Net entropy change of the system will be
- (a) positive (b) negative
(c) zero (d) cannot be any of these
- iv) Gauge pressure + vacuum pressure is
- (a) positive (b) negative
(c) zero (d) all of these
- v) Non-zero value of local acceleration indicates
- (a) non-uniform flow (b) uniform flow
(c) turbulent flow (d) unsteady flow
- vi) For a compressible system, undergoing a process, the equation $Tds = du + Pdv$ is valid only if the process is
- (a) necessarily reversible
(b) reversible or irreversible
(c) necessarily non adiabatic
(d) necessarily isothermal.
- vii) Which of the following is a property of a system?
- (a) Work Transfer (b) Heat Transfer
(c) Temperature (d) None of these
- viii) In SI system, the unit of viscosity is:
- (a) N-s/m² (b) Pa-s
(c) kg/m-s (d) all of these
- ix) Within a SFEE device system, if P is a property, t is time and s is a spatial co-ordinate then
- (a) $\partial P/\partial t = 0$, $\partial P/\partial s \neq 0$ (b) $\partial P/\partial s = 0$, $\partial P/\partial t \neq 0$
(c) $\partial P/\partial t \neq 0$, $\partial P/\partial s \neq 0$ (d) None of these

- x) Which is not a boundary phenomenon?
(a) Work transfer (b) Mass transfer
(c) Heat transfer (d) Change of temperature.

GROUP - B

2. (a) State the first law of Thermodynamics referred to a cycle for a closed system. Hence show that energy is a property of the system.
(b) To a closed system 150kJ of work is supplied. If the initial volume is 0.6m^3 and the pressure of the system changes in quasi-static process as $p = 8 - 4V$, where p is in bar and V is in m^3 , determine the final volume and pressure of the system. **(2+4)+6 = 12**
3. (a). Define thermodynamic equilibrium. State the zeroth law of thermodynamics.
(b) 10 kg. mass of a perfect gas at 800kPa, 600K is contained in a cylinder. Quasi-static expansion (of the type $PV^n = \text{constant}$) is carried out, until the volume becomes six times the original volume, with a pressure of 80kPa. Find (i) the value of n (ii) work transfer and (iii) heat transfer during the process, Given, $\gamma = 1.4$, $R = 287\text{J/kg-K}$. **(3+2)+(1+3+3) = 12**

GROUP - C

4. (a) Derive the steady flow energy equation for an open system with standard notations on a time rate basis and on unit mass basis with one each entry and exist channel.
(b) Steam flows through a turbine at a rate of 2.5 kg/s. The inlet and exit enthalpy of steam are 2700 KJ/kg and 1800 KJ/kg respectively. Velocity of steam at inlet and outlet are 35 m/s and 250 m/s. There is heat loss to the surroundings @40 kW. Calculate the power output from the turbine. **6+6 = 12**

5. (a) Prove the equivalence of Kelvin-Planck and Clausius statements of the 2nd law of Thermodynamics.
- (b) A reversible heat engine operates between a source at 1000K and two sinks at 300K and 400K. If equal amount of heat is rejected to each sink, what is the efficiency of the heat engine? **6+6 = 12**

Group - D

6. (a) A closed vessel contains a liquid of specific gravity 1. A piezometer communicates with the vessel at a depth of 1.5m from the free liquid surface. Given that, the absolute pressure on the free liquid surface is $2.5 \times 10^5 \text{ N/m}^2$, and atmospheric pressure is $1.0135 \times 10^5 \text{ N/m}^2$, calculate the height to which the liquid in the piezometer will rise. Given, acceleration due to gravity, $g = 9.8 \text{ m/s}^2$.
- (b) Draw the P-v diagram of an air standard diesel cycle indicating the various processes comprising the cycle and derive the expression for thermal efficiency. **5+(2+5) = 12**
7. (a) A square plate of size 600mm \times 600mm and mass 25 kg. slides down a plane inclined at 25° with horizontal, with a constant velocity of 0.30 m/s. There is an oil film of 1mm thickness between the plate and the inclined surface. The specific gravity of the oil is 0.9. Find the kinematic viscosity of the oil.
- (b) An engine working on Otto cycle has an air standard efficiency of 56% and rejects 544kJ/kg of air. The pressure and temperature of air at the beginning of compression are 0.1 MPa and 60°C respectively. Compute (i) the compression ratio of the engine. (ii) the work done per kg of air, (iii) the pressure and temperature at the end of compression (iv) the maximum pressure in the cycle. **6+(1+2+2+1) = 12**

GROUP - E

8. (a) A velocity field is given by $\mathbf{V} = 10x^2y\mathbf{i} + 15xy\mathbf{j} + (25t - 3xy)\mathbf{k}$ m/s; x, y, z are in m, and t is in sec. Characterize the flow field as steady or unsteady. Find the total acceleration of a fluid particle at the point (1m, 2m, -1m) and at time $t = 0.5$ sec.
- (b) Derive Euler's equation of motion along a streamline. Mention the assumptions made. **6+(5+1) = 12**
9. (a) Derive the differential equation of a streamline in a flow field with standard notation. The velocity vector in a flow field is given as $\mathbf{V} = 2kx\mathbf{i} + 2ky\mathbf{j} - 4kz\mathbf{k}$, where k is a given constant. Obtain the equation of the streamline passing through the point (1,0,1).
- (b) A U-tube manometer is used to measure the pressure of water in a pipe line, which is in excess of atmospheric pressure. The right limb of the manometer contains mercury and is open to atmosphere. The contact between water and mercury is in the left limb. Determine the pressure of water in the main pipe line, if the difference in level of mercury in the limbs of U-tube is 12cm and the free surface of mercury is in level with the centre of the pipe. **(3+4)+5 = 12**
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