05/06/2025 TE MECHANICAL SEM-V C-SCHEME TE QP CODE: 10086711

[Time: 03 Hours] **[Total Marks: 80**

Note :

- ***Question No.1 is compulsory.***
- *Solve **ANY THREE** questions from the **remaining** five questions.*
- *Figure to the right indicates full marks.*
- *Assume suitable data wherever required, but justify the same.*

			Marks
Q. 1		Solve **ANY FOUR** questions from following. (Each question carries **5 marks**)	**20**
	a)	State and explain Fourier's law of conduction.	
	b)	Discuss the relation between thermal boundary layer and hydrodynamic boundary layer with respect to variation in Prandtl number.	
	c)	Explain the concept of critical radius of insulation with reference to a cylinder.	
	d)	Define overall heat transfer coefficient and explain its significance.	
	e)	Explain knocking in SI engines and methods to suppress it.	
	f)	Explain the term Volumetric Efficiency in internal combustion engines.	
Q. 2	**a)**	During the trial of a single-cylinder, four-stroke oil engine, the following results were obtained. Cylinder diameter = 20 cm Stroke = 40 cm Mean effective pressure = 6 bar Torque = 407 Nm Speed = 250 rpm Oil consumption = 4 kg/h Calorific value of fuel = 43 MJ/kg Cooling water flow rate = 4.5 kg/min Air used per kg of fuel = 30 kg Rise in cooling water temperature = 45°C Temperature of exhaust gases = 420°C Room temperature = 20°C Mean specific heat of exhaust gas = 1 kJ/kg K Specific heat of water = 4.18 kJ/kg K Find the ip, bp and draw up a heat balance sheet for the test in kJ/h.	**8**
	b)	A wall of a furnace is made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick 240 mm thick. The temperatures at the inside surface of silica brick wall and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/W per unit wall area. If thermal conductivities of silica and magnesite bricks are 1.7 W/m°C and 5.8 W/m°C, calculate (i) The rate of heat loss per unit area of walls, and (ii) The temperature drop at the interface.	**12**
Q. 3	**a)**	Air at atmospheric pressure and 40°C flows with a velocity of U = 5 m/s over a 2 m long flat plate whose surface is kept at a uniform temperature of 120°C. Determine the average heat transfer coefficient over the 2 m length of the plate. Also find out the rate of heat transfer between the plate and the air per 1 m width of the plate. [The thermo-physical properties of air at 1 atm. and 80°C are $\upsilon = 2.107 \times 10^{-5}$ m^2/s, k = 0.03025 W/mK; Pr = 0.6965]. Use the following correlation: $\overline{Nu} = 0.664\,(Re_L)^{1/2}(Pr)^{1/3}$	**8**

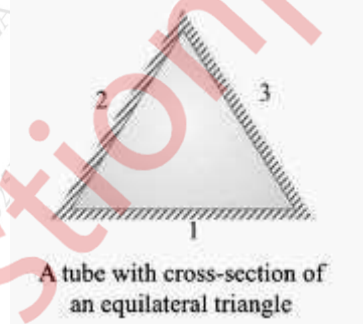
b) The air flow to a four cylinder, four-stroke oil engine is measured by means of a 5 cm diameter orifice having a coefficient of discharge of 0.6. During a test on the engine the following data were recorded : bore = 10 cm; stroke = 12 cm; speed = 1200 rpm; brake torque = 120 Nm; fuel consumption = 5 kg/h; calorific value of fuel = 42 MJ/kg; pressure drop across orifice is 4.6 cm of water; ambient temperature and pressure are 17 ^{o}C and 1 bar respectively. Calculate **12**

i. the thermal efficiency on brake power basis;
ii. the brake mean effective pressure and
iii. the volumetric efficiency based on free air condition.

Q. 4 **a)** The temperature of an air stream flowing with a velocity of 3 m/s is measured by a copper-constantan thermocouple which may be approximated as a sphere of 2.5 mm in diameter. Initially the junction and air are at a temperature o f 25°C. The air temperature suddenly changes to and is maintained at 215°C. Determine the time required for the thermocouple to indicate a temperature of 165°C. The thermal junction properties are: ρ = 8750 kg/m^3, c = 380 J/kg°C, k (thermocouple) = 28 W/m°C and h = 145 W/m^2 ^{o}C. **8**

b) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 W/m^2 ^{o}C, calculate the area of the heat exchanger. **12**

Q. 5 **a)** Calculate the shape factors for the configurations shown in the Fig. **5**



A tube with cross-section of an equilateral triangle

b) Explain Willan's line method for measurement of frictional power. **5**

c) Illustrate the variation of temperature of hot fluid and cold fluid from inlet to outlet in case of a parallel flow heat exchanger and counter flow heat exchanger. **5**

d) Differentiate between the efficiency and effectiveness of an extended surface. **5**

Q. 6 **a)** Explain Nucleate boiling and Film boiling. **5**

b) Why is short ignition delay favourable for CI engines whereas it is undesirable for an SI engine? **5**

c) State and explain Fick's Law of diffusion. **5**

d) Explain different types of emission control norms implemented in order to control the air pollution due to IC engines. **5**
