05-06-2026 TE MECHANICAL SEM-V C SCHEME TE QP CODE: 20008942

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

N. B : (1) **Question No.1** is **Compulsory**.
(2) Solve **ANY THREE** questions from question no.2 to 6.
(3) Use illustrative diagrams wherever possible.
(4) Figure to the right indicates full marks.
(5) Assume suitable data if necessary and mention it clearly.

Q.1 Answer **Any Four** questions from the following:

a)	Explain Thermal Contact Resistance in composite wall.	**5**
b)	Distinguish between Film and Dropwise condensation.	**5**
c)	Derive an expression for steady state, one dimensional heat flow through a composite cylinder (2 layers) taking into account the film heat transfer coefficients on the inside and outside surface of the cylinder with usual notations.	**5**
d)	State and explain Fick's law of diffusion mass transfer.	**5**
e)	Explain any one pollution control device fitted with engine systems in brief with neat sketch.	**5**

Q.2 **(a)** A steel rod (k=32W/m^{0}C),12 mm in diameter and 60 mm long with an insulated end ,is to be used as spine. It is exposed to surroundings with a temperature of 60^{0}C and a heat transfer coefficient of 55 W/m^2 ^{0}C.The temperature at the base of fin is 95^{0}C. Determine:- **10**

i) The fin efficiency.
ii) The temperature at the edge of the spine.
iii) The heat dissipation.

(b) Define 'Heat Exchanger Effectiveness'. Draw temperature profile for Parallel flow heat exchanger, Counter flow heat exchanger. **6**

(c) Differentiate between Four stroke cycle and Two stroke cycle engines. **4**

Q.3 **(a)** Calculate the rate of heat flow per m^2 through a furnace wall consisting of 200mm thick inner layer of chrome brick,a centre layer of kaolin brick 100 mm thick and an outer layer of masonry brick 100mm thick.The convection coefficient at the inner surface is 74 W/m^2 ^{0}C and the outer surface temperature is 70^{0}C.The temperature of the gases inside the furnace is 1670^{0}C.What temperatures prevail at the inner and outer surfaces of the centre layer? **12**
Take: $k_{chrome\ brick}$=1.25 W/m ^{o}C, $k_{kaolin\ brick}$=0.074 W/m ^{o}C,$k_{masonry\ brick}$=0.555 W/m ^{o}C
Assume steady heat flow.

(b) A Six cylinder, 4-stroke oil engines develops 200 kW at 1200 RPM. Its specific fuel consumption is 0.3 kg/kWh. Determine the diameter of a single orifice injector if the injection pressure is 200 bar and combustion chamber pressure is 40 bar. The fuel injection is carried out for 30^0 rotation of a crank.Take The fuel density is 900 kg/m^3 , Cd_f =0.65.Each nozzle on a cylinder provided with a single orifice. **08**

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Q.4 **(a)** A Parallel flow heat exchanger has a overall heat transfer coefficient of 600 W/m^2K based on the outer side having the surface area of 108 m^2 .The hot fluid enters at 800^0C at the rate of 18 kg/s and the cold fluid enters at 100^0C at the rate of 24 kg/s. Assume Cph=3.2 kJ/kg.K, Cpc=4.2kJ/kg.K. Using effectiveness -NTU method, find the exit temperatures of hot and cold fluids. **10**

(b) Explain Willan's line method for measurement of frictional power. **05**

(c) What is Thermal Boundary Layer? Illustrate the same with the help of a neat diagram. **05**

Q.5 **(a)** The following observations were recorded in a test of one hour duration on a single cylinder oil engine working on four stroke cycle and engine is fitted with rope brake : **12**

Bore =150 mm
Stroke=300mm
Fuel used =2.4 kg/hr
Calorific value of fuel=42000 kJ/kg
Average speed =300 rpm
Indicated mean effective pressure=7 bar
The dead load on the engine=360 N
Spring balance reading =30N
Quantity of cooling water =300 kg/hr
Temperature rise of cooling water $=35^0C$
Diameter of the brake wheel= 1.2 m
Air used =52.8 kg/hr
Temperature of air in test room $=20^0C$
Temperature of exhaust gases = 410^0C
Specific heat of exhaust gases =1kJ/kg.K
Specific heat of water = 4.18 kJ/kg.K
Atmospheric pressure =1.013bar
Calculate: i) Indicated power ii) Brake thermal efficiency iii) Draw heat balance sheet on kJ/min and percentage basis

(b) What is Lumped parameter analysis? When is it applicable? Explain Biot number and Fourier number applied to transient heat transfer. **08**

Q.6 **(a)** Air at 27^0C is flowing across a tube with a velocity of 25 m/s. The tube could be either a square of 5 cm side or circular cylinder of 5 cm diameter. Compare the rate of heat transfer per metre length in each case, if the tube surface is at 127^0C.Assume steady state heat transfer condition. **12**

Use the correlation: $Nu = C\ (Re)^n\ (Pr)^{1/3}$
Where, C=0.027, n=0.805 -- for cylinder
C=0.102, n=0.675 -- for square tube

Properties of air $77^0C = 350K$:
$\rho = 0.955\ kg/m^3$, $k_f = 0.03 W/mK$, $Cp = 1.009\ kJ/kgK$, $Pr = 0.7$, $\nu = 20.92 \times 10^{-6}\ m^2/s$.

(b) Explain with neat sketch actual valve timing diagram of Four Stroke Diesel Engine. **08**

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