

Notes: Answer all questions

Q.1/A: An eight-cylinder, turbocharged, four-stroke, diesel engine with $B = 128$ mm and $L = 140$ mm operates at 2000 rpm with atmospheric condition (before compressor) of 1 bar and 27°C . An inlet manifold (after compressor) pressure of 1.8 bar, the volumetric efficiency of $\eta_v = 90\%$ and $FAR = 0.035$. Calculate: (1) the power required to drive the compressor of turbocharger if the compressor isentropic efficiency is 70%, (2) the pressure at the inlet of turbine if the exhaust gas temperature is 650°C and the turbine isentropic efficiency is 65%. Using the values $C_p = 1.005$ kJ/kg.K and $\gamma = 1.4$ for air, $C_p = 1.05$ kJ/kg.K and $\gamma = 1.333$ for exhaust gases. [16 marks]

Q.1/B: Answer the following items:

- (1) What is the main difference between internal combustion engine (ICE) and external combustion engine (ECE)? [4 marks]
- (2) What is the main difference between 2-stroke and 4-stroke engines? [4 marks]

Q.2: 4-stroke, six cylinder, diesel engine with a compression ratio of 17, clearance volume of 107.8 cm^3 and stroke of 150 mm. The test on the engine was carried out and the following observations were recorded: $b_{mep} = 9.2$ bar, $N = 2100$ rpm, $LHV = 42.5$ MJ/kg, $bsfc = 0.23$ kg/kW.h, $\eta_v = 83\%$, $\eta_m = 78.26\%$, exhaust gas temperature 650°C and $C_{p_g} = 1.08$ kJ/kg.k. The ambient temperature and pressure were 30°C and 1.017 bar respectively. Determine: (1) brake power, (2) indicated power, (3) AFR , (4) $\eta_{th,i}$, and (5) evaluate the exhaust heat loss. [20 marks]

Q.3: The fuel (butane: C_4H_{10}) and air flow rates are measured 0.4 g/s and 5.6 g/s respectively, then mixed and combusted in SI engine. (1) Calculate the AFR_{act} , AFR_{st} , equivalence ratio (ϕ) and relative ratio (λ), (2) Describe the combustion in a chemical reaction equation by assuming the fuel is fully burned within the cylinder and consider no hydrogen gas in the exhaust gases. [16 marks]

Q.4: Answer the following items:

- (1) Define the flame speed and list the factors affecting on it. [5 marks]
- (2) How does the mixture strength (lean, stoichiometric and rich) affect the dissociation? [5 marks]
- (3) Why the actual cycle efficiency is much lower than the air standard cycle efficiency? Specify and identify the reasons. [5 marks]
- (4) What is the meaning of the ignition delay "ID" period and how can be classified? [5 marks]

Q.5/A: A 3.2-liter an in-line, four-cylinder, four-stroke, SI engine is to be designed with bowl-in-piston combustion chambers. With a central spark plug and combustion at TDC, this gives a flame travel distance of $B/4$. The engine is to operate with a mean piston speed of 8 m/sec and a burn interval ($\Delta\theta_b$) of 25° of engine crank rotation. Stroke and bore will be related by $L = 0.95 B$. Calculate the average flame speed. [8 marks]

Q.5/B: Answer the following items:

- (1) What is the relation between ignition delay "ID" and Cetane number "CN"? [4 marks]
- (2) What is the relation between Octane and Cetane numbers? [4 marks]
- (3) What is the meaning of "MBT"? [4 marks]

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