Mid-Semester Examination

First Semester 2023-2024

Name: Id:

Birla Institute of Technology and Science, Pilani
ME F317: Engines, Motors, and Mobility

Close Book 60 Marks 09:00-10:30 AM, 11/10/2023

Instructions: *1. Please write concisely and legibly. Final answers should be clearly marked.*
2. Draw neat labelled diagrams wherever necessary.
3. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
4. Assumptions made if any, should be stated clearly at the beginning of your answer.

Q1. Please answer the following questions briefl:

a) What is the function of a *crankshaft* in a reciprocating engine? What are the loading and operating considerations for the design of a crankshaft? Which technique is commonly used in its manufacturing, and why? **[4]**

b) What do you understand by the *biodiesel*? How is biodiesel produced? What is the current status of biodiesel in India? **[4]**

c) The engine of Maruti Suzuki Swift was studied by the students. It was found that the bore and stroke of the engine are 73 X 71.5 mm respectively. The engine maximum speed is 6000 rpm.
   i) Find out the mean piston speed at the peak rpm.
   ii) A formula-1 engine has bore and stroke of 96.52 mm and 40.64 mm respectively. The top engine speed goes up to 20000 rpm. Calculate the mean piston speed and compare with the previous case.
   iii) Repeat the calculation for Mahindra Thar (diesel engine) with bore and stroke 88.9 X 101.6 mm @ 1800 rpm.
   iv) Can you draw a conclusion from these exercises? **[4]**

d) At the injection pressure of 150 bar, the injection duration is estimated to be 40° crank angle (CA) for a direct injection system. It is suggested that performance of the engine can be improved by reducing the fuel injection duration. Estimate the required fuel injection pressure (in bar) so that same amount of fuel injection can be achieved in 20° CA. The average combustion chamber pressure during injection is 25 bar. Assume the same orifice and combustion chamber density. **[4]**

e) Calculate the stoichiometric air-fuel ratio for *Cetane* ($C_{16}H_{34}$) as the fuel. What would be the desirable range of air-fuel ratio for Cetane in the engine and why? **[4]**

Q2. A turbocharged six-cylinder Diesel engine has a swept volume of 39 litres. The inlet manifold conditions are 2.0 bar and 53°C. The volumetric efficiency of the engine is 95%, and it is operating at a load of 16.1 bar (bmep), at 1200 rpm with an air-fuel ratio of 21.4. The power delivered to the compressor is 100 kW, with entry conditions of 25°C and 0.95 bar. After the compressor, air is passed through an inter-cooler before delivering to the engine. The fuel has a calorific value of 42 MJ/kg. Calculate:

a) Power output of the engine (kW) **[4]**
b) Brake thermal efficiency of the engine (%) **[4]**
c) Compressor isentropic efficiency (%) **[4]**
d) Effectiveness of the inter-cooler **[4]**
e) Estimate the effect of removing the inter-cooler on the power output of the engine (% change) **[4]**

Q3. The following data relate to a petrol engine:

Petrol consumed per hour = 7.2 kg
The specific gravity of the fuel = 0.75
The temperature of air = 27°C
The air fuel ratio = 15:1
The diameter of the choke tube = 24 mm
The height of top of the jet above the petrol level = 4.2 mm in the float chamber
The coefficient of discharge for air = 0.8
The coefficient of discharge for fuel = 0.7
Atmospheric pressure = 1.013 bar
Determine the following:

a) Derive the expression for air-fuel ratio through a simple carburettor assuming flow to be incompressible. **[8]**
b) Calculate the pressure drop at the throat (in kPa) , **[4]**
c) Calculate the diameter of the fuel jet (in mm), **[4]**
d) Explain the air fuel requirement in a typical automotive vehicle, **[4]**

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