Assignment 2 and Practice Problems (ME301A)

Submit 1,6,7,12,13 only. Remaining for exercise

1. A four-stroke SI engine delivers a brake power of 442 kW with a mechanical efficiency of 85 %. The measured fuel consumption is 160 kg of fuel in one hour and air consumption is 410 kg during one sixth of an hour. The heating value of the fuel is 42000 kJ/kg. Calculate (i) indicated power, (ii) frictional power, (iii) air-fuel ratio, (iv) indicated thermal efficiency and (v) brake thermal efficiency.

2. A pickup truck has a five-litre, V6, SI engine operating at 2400 rpm. The engine has a compression ratio of 10.2:1 and its volumetric efficiency is 0.91. The bore and the stroke are related as L=0.92B. Calculate (a) stroke length, (b) average piston speed, (c) clearance volume of one cylinder and (d) airflow rate into the engine. [9.65 cm, 7.72m/s, 90.6 cm^3, 0.107 kg/s]

3. The Rolls Royce CV12 turbocharged four-stroke direct injection diesel engine has a displacement of 26.1 litres. The engine has a maximum output of 900 kW at 2300 rpm and is derated to 397.5 kW at 1800 rpm for industrial use. What is the bmep for each of these types? [18 bar, 10.15 bar]

4. A 380 cc single-cylinder two-stroke motorcycle engine is operating at 5500 rpm. The engine has a bore of 82 mm and stroke of 72 mm. Performance testing gives a bmep of 6.81 bar, bsfc of 0.49 kg/kW hr, and a delivery ratio of 0.748. Calculate the fuel to air ratio and the airflow rate. [30.48 gm/s, 0.106]

5. A petrol engine of compression ratio 6 uses a fuel of calorific value 44000 kJ/kg. The fuel air ratio is 15:1. The temperature and pressure of the charge at the end of the suction stroke are 333 K and 1 bar respectively. Estimate the maximum pressure in the cylinder if the index of compression is 1.32 and the specific heat at constant volume is expressed by the relation $c_v = 0.71 + 20 \times 10^{-5} T$ kJ/kg K, where T is the temperature in K. Compare this value with that of constant specific heat c_v =0.71 kJ/kg K. [56.6 bar, 80.5 bar]

6. An engine working on dual combustion cycle, the temperature and pressure at the beginning of compression are 363 k and 1 bar. The compression ratio is 13:1. The heat supplied per kg of air is 1675 kJ, half of which is supplied at constant volume and half at constant pressure. Calculate (i) the maximum pressure in the cycle, and (ii) the percentage of stroke at which cut-off occurs. Take k for compression = 1.4, R = 0.287 kJ/kg K and cv for products of combustion to be 0.71 + 20 x 10-5 T.

7. The spark plug is fired at 18^0 BTDC in an engine running at 1800 RPM. It takes 8^0 of engine rotation to start combustion and get into flame propagation mode. Flame termination occurs at 12^0 ATDC. Bore diameter is 8.4 cm and the spark plug is offset 8 mm from the centerline of the cylinder. The flame front can be approximated as a sphere moving out from the spark plug. Calculate the effective flame front speed during the flame propagation.

8. An automobile has a 3.2-litre, five-cylinder, four-stroke cycle engine operating at 2400 RPM. Fuel injection occurs from 20^0 BTDC to 5^0 ATDC. The engine has a compression ratio of 18:1 and operates on an air-standard Dual cycle. At 2400 RPM, combustion starts at 7^0 BTDC and lasts for 42^0 of engine rotation. The ratio of connecting rod length to crank offset is *R*=3.8. Calculate (a) ignition delay and cycle cut-off ratio. [13^0, 2.91]

9. A trial carried out in a four-stroke single cylinder gas engine gave the following results: cylinder dia = 300 mm, stroke = 500mm, clearance volume = 6750cc, explosions per minute=100, P_{max} = 765 KN/m2, net work load on the brake=190 kg, brake dia=1.5 m, rope diameter =25 mm, Speed of the engine=240 rpm, gas used = 30 m^3/kg-hr, calorific value of gas=22515 KJ/m^3. Determine compression ratio, mechanical efficiency, indicated thermal efficiency, air standard efficiency, relative efficiency, assume γ=1.4

10. A six cylinder 4-stroke CI engine developing power output at 270 kW at 1000 rpm has fuel consumption of 0.25 kg/kWh. Injection takes place over 20° crank angle with the pressure of injector orifice of 100 MPa. Find (i) the rate of fuel injection in mg/s through each hole of the four-hole injector fitted in engine cylinder, (ii) thermal efficiency of the engine. The calorific value of the fuel is given as 40000 J/kg.

11. The power output of a six cylinder four-stroke engine is absorbed by a water brake for which brake power is WN/20000, W is brake load in Newton and N is speed in rpm. The air consumption is measured by an air box with sharp edged orifice system. The following readings are obtained:

Orifice diameter, discharge coefficient	30 mm, 0.6
Pressure drop across orifice	14.5 cm of Hg
Bore, stroke	100 mm, 120 mm
Brake load	560 N
C/H ratio by mass of fuel	83:17
Ambient condition	1 bar, 27°C
Fuel density	831 kg/m^3
Time taken for 100 cc of fuel consumption	20 s

Calculate (i) the brake power, (ii) torque, (iii) bsfc, (iv) % excess air, (v) volumetric efficicny

12. A six-cylinder, four-stroke cycle gasoline engine with a bore of 120 mm and a stroke of 200 mm under test was supplied with gasoline of composition C = 82% and H_2 = 18% by mass. The dry exhaust composition by volume was CO_3 = 11.2%, O_2 = 3.6% and N_2 = 85.2 %. Determine the mass of air supplied per kg of gasoline at 17°C and 1 bar which were the condition for the mixture entering the cylinder during the test. Also determine the volumetric efficiency of the engine based on intake condition when the mass of the gasoline used was 30 kg/hour and the engine speed was 1400 rpm. Gasoline is completely evaporated before entering the cylinder and the effect of its volume on the volumetric efficiency should be included. Take the density of gasoline vapour as 3.4 times that of air at the same temperature and pressure. One kg of air at 0°C and 1 bar occupies 0.783 m^3. Air contains 23% oxygen by mass.

13. Using Morse test on four-cylinder engine following measurements of brake power were taken at constant speed:

No. of cylinders firing	Brake power
All cylinders	3037 kW
All except 1st	2102 kW
All except 2nd	2102 kW
All except 3rd	2100 kW
All except 4th	2098 kW

Determine (a) mechanical efficiency, (b) frictional power.