EXERCISES 1

Compression ratios

1. The total clearance volume of a six cylinder engine is 680 cm3 and the compression ratio 8.2: i. Determine the cylinder bore diameter in mm if the stroke is 98 mm. (129 mm)

2. The bore and stroke of an engine are 62 mm and 56 mm, respectively. The clearance volume is 21 cm3. Find the engine's compression ratio when the piston is commencing its compression stroke, and when 30% of the stroke is completed. (9:1, 6.63:1)

3. The compression ratio of a CI oil engine is 17.8:1 and the clearance volume per cylinder 47 cm3. Calculate the compression ratio when 58% of the compression stroke is completed. (8:1)

4. The compression ratio of an engine having a clearance volume per cylinder of 62 cm3 is 9.37:1 when 40% of the compression stroke is completed. Find the compression ratio of the engine. (14.95:1)

5. An engine having a cylinder bore of 88 mm diameter and a stroke of 110 mm has a clearance volume of 74 cm3. Calculate: (a) the compression ratio when the piston is at bottom dead centre; (b) when 40% of the compression stroke is completed. (10:1, 6.42:1)

6. The total clearance volume of a four cylinder engine is 155 cm3, and the compression ratio 7.8:1. Determine the cylinder bore diameter in mm if the engine stroke is 68 mm. (70 mm)

7. An engine having a bore and stroke of 110 mm and 100 mm respectively has a clearance volume per cylinder of 86 cm3. Calculate the engine compression ratio (a) when the piston is at bottom dead centre, and (b) when the piston has moved 20 mm on the compression stroke. (a- 12:1, b- 10.83:1)

8. A six cylinder engine of 3 litres swept volume and a clearance volume per cylinder of 44.17 cm3. The cylinder bore diameter is 80 mm. Find the compression ratio of this engine and the stroke in mm. (12.32:1, 99 mm)

EXERCISES 2

Engine bmep and power

1. A six cylinder four-stroke engine developing 168 kW brake power with a bmep of 834 kN/m^2 at 2000 rev/min, has a stroke/bore ratio of 1.25. Calculate the engine bore and stroke in millimeters. (127 mm, 158.75 mm)

2. The total swept volume of a six cylinder four-stroke engine is 0.002 65 m^3. Power of 76.4 kW is being delivered at 5200 rev/min. Determine the bmep in bar. (6.6 bar)

3. A four cylinder four-stroke engine having a total swept volume of0.0028 m3 is producing a bmep of 6.45 bar abs at 4360 rev/min. Calculate the brake power in kilowatts. (6.56 kW)

4. The swept volume of a six cylinder engine operating on the four-stroke cycle is 0.002 m3, and it develops a torque of 111.2 N m. Calculate the bmep. (346 kN/m^2)

5. A twin cylinder two-stroke diesel engine develops 14 kW at 2800 rev/min. The area of a piston crown is 0.007 85 m2 and the stroke 0.15 m. Calculate the average force created on one piston when on power stroke, and the work done. (999 N, 150 J)

6. The compression ratio of a single cylinder motorcycle engine is 9.6: 1. The clearance volume is 45 cm3 and stroke 76 mm. When the bmep is 846 kN/m^2 determine the average work done on a power stroke. (327.24 J)

EXERCISES 3

Engine thermal efficiency

1- During a test on CI oil engine, power of 22.38 kW was developed for a fuel consumption of 6.36 kg of fuel oil per hour. If the mechanical efficiency was 80% and the fuel CV was 46 MJ/kg, determine the brake and indicated thermal efficiencies. (27.54%, 34.42%)

2. The engine of a car developed an output of 30 kW whilst traveling at 96 km/h. If the thermal efficiency is 25%, CV of fuel 45 MJ/kg and relative density 0.75, calculate the fuel consumption in kilometers per litre. (7.5 km/L)

3. A CI engine consumes 8.6 litres of fuel oil per hour. The relative density is 0.84, brake thermal efficiency is 29.8%, the fuel has a calorific value of 45 MJ/kg and mechanical efficiency is 73%. What is the indicated power? (36.83 kW)

4. A CI engine consumes 7.9 kg of fuel per hour giving a brake thermal efficiency of 30.6%. If the CV of the fuel oil is 44 600 kJ/kg, calculate the indicated power if the mechanical efficiency is 78%. (38.38 kW)

5. Calculate the mechanical energy that one litre of petrol contains when its calorific value is 45 000 kJ/kg and relative density 0.718. (32.310 MJ)

6. A fuel has a CV of 44 800 kJ/kg and is used at the rate of 4.35 kg/h. If the engine has a brake thermal efficiency of 20.9%, calculate the engine brake power. (11.3 kW)

7. A fuel of CV 43 600 kJ/kg is consumed at the rate of 0.0023 kg/s while developing 28 kW of power. Calculate the brake thermal efficiency. (27.9%)

8. Determine the brake thermal efficiency and bmep of a four-stroke cycle engine having a swept volume of 2624 cm3 when it is developing a torque of 162.7 N m with a specific

fuel consumption of 0.36 kg/(kW h). The fuel having a calorific value of 45 MJ/kg. (22.2%, 779.2 kN/m^2)

9. A four-stroke engine uses 20.6 kg of fuel per hour when developing a bmep of 896 kN/m2 giving an engine torque of 57 N m. If the specific fuel consumption is 0.4 kg/(kW h) and calorific value of the fuel 44 MJ/kg, calculate the brake thermal efficiency and the engine capacity in cm^3. (20.45 %, 800 cm^3)

10. The brake thermal efficiency of an engine is 26.7% when using fuel having a calorific value of 44.5 MJ/kg. The fuel consumed was 0.0022 kg/s. Find the brake power in kW. (26.41 kW)

11. A CI oil engine developed an indicated power of 51 kW when using 0.18 kg of fuel per minute having a calorific value of 45 MJ/kg. Pumping and friction losses reduce the indicated power by ii kW. Calculate: (a) the brake power, (b) the mechanical efficiency, (c) the specific fuel consumption, and (d) the brake thermal efficiency. (a- 40 kW, b- 78.4%, c- 0.27 kg/(kW h, d- 29.62%)

12. An engine on test at 3000 rev/min overcomes a resistance of 142.35 N acting at a radius of 0.355 m while consuming fuel at the rate of 7.784 liters per hour. If one liter per hour is equivalent to 10 kW, determine the engine brake thermal efficiency. (20.39%)

EXERCISES 4

Morse test

1. The following results were recorded during a Morse test at 3000 rev/min on a four cylinder four-stroke cycle engine. The dynamometer torque arm had a 0.53 meter effective length. Determine the indicated power and mechanical efficiency of the engine.

All cylinders firing load = 114 N
no. 1 cylinder cut out load= 78N
no. 2 cylinder cut out load= 82N
no. 3 cylinder cut out load= 80.4N
no. 4 cylinder cut out load= 82.8N (22.05 kW, 85.8%)

2. A Morse test was completed on a four cylinder four-stroke engine. The dynamometer torque arm had an effective length of 0.6 m. The following data were recorded at an engine speed of 2600 rev/min:

All cylinders firing brake load = 141.6 N
no. 1 cylinder cut out brake load = 100 N
no. 2 cylinder cut out brake load =104 N
no. 3 cylinder cut out brake load =101.2 N
no. 4 cylinder cut out brake load = 103.2 N

Calculate the engine mechanical efficiency. (89.6%)

3. The following torque figures were recorded on a Morse test of a four cylinder four-stroke engine operating at a constant 5000 rev/min.

All cylinders firing 142.4 N m
no. 1 cylinder cut out 98.8 N m
no. 2cylindercutout 100.8Nm
no. 3 cylinder cutout 100Nm
no. 4cylinder cutout 100.2 Nm
Determine the engine mechanical efficiency. (82.85%)

EXERCISES 5

Mechanical efficiency

1. An engine tested for pumping and frictional losses lifted a brake load of 96.5 N at the end of a 0.53 m torque arm when motored at 2000 rev/min by the electrical dynamometer. At the same engine speed under full throttle the brake load lifted was 328 N. Determine the indicated power and mechanical efficiency. (47.11 kW, 77.26%)

2. An engine when motored at 3400 rev/min by an electrical swing field dynamometer gave a brake load reading of 108.6 N which represents 23.2 kW power. At the same speed the engine developed 27.6 kW. Determine the engine mechanical efficiency at this speed and the length of the dynamometer torque arm. (84%,0.6 m)

EXERCISES 6

General engine questions

1. An engine on test at 2800 rev/min overcomes a resistance of 165.5 N acting at a radius of 0.355 m while consuming fuel at the rate of 6.9 L/h. If 1 L/h is equivalent to 12 kW, determine the brake thermal efficiency. (20.85%)

2. A CI engine consumes 0.12 kg of fuel per minute. The fuel has a CV of 45 MJ/kg. The brake thermal efficiency is 27.8%. Calculate the brake and indicated power if the mechanical efficiency is 77%. (25 kW, 32.46 kW)

3. A four cylinder four-stroke engine having a cylinder bore diameter of 88 mm and a 120 mm stroke gave the following results on test: fuel consumption 0.3 kg/(kW h) at 1280 rev/min; indicated power 17.5 kW at same engine speed; CV of fuel used 45 MJ/kg. Calculate the imep and brake thermal efficiency when the mechanical efficiency was 82%. (562 kN/m^2, 26.66%)

4. An indicated power of 76 kW was developed by a CI engine when using 0.18 kg/min fuel of CV 44 MJ/kg. Pumping and friction losses reduced power output by 13 kW. Calculate: (a) the brake power, (b) the mechanical efficiency, (c) the specific fuel consumption, and (d) the brake thermal efficiency. (a- 63 kW, b- 82.9%, c- 0.286 kg/(kW h), d- 28.6%)

5. The brake thermal efficiency of an engine is 26.7% when using fuel having a CV of 44.5 MJ/kg. The fuel consumed was 0.0022 kg/s. Find the engine brake power. (26.1%)

6. A twelve cylinder four-stroke engine having a swept volume of 14 760 cm3 on test at 3800 rev/min developed a bmep of 896 kN/m2 and the mean piston speed was 914 m/min. What torque is being delivered at the crank shaft? and what force in tones is acting on a piston crown when the peak cylinder pressure is 4137 kN/m2? 1052 N m, 4.22 tones)

7. Determine the brake thermal efficiency and bmep for a four-stroke engine having a swept volume of 1600 cm3 when it is producing a torque of 62.7 N m with a fuel consumption of 0.32 kg/(kW h). The CV of the fuel is 45 MJ/kg. (25%, 492 kN/m^2)

8. A four-stroke engine is connected to a dynamometer having a torque arm of 0.355 m effective radius. The fuel CV is 45 MJ/kg and has a relative density of 0.74. From the following data calculate the percentage of the fuel power converted into brake power, and the percentage lost to the cooling system, exhaust, radiation and friction. Produce a simple heat balance sheet. Rev/min, 4000; brake load, 181.56 N; water temperature, inlet 7°C, outlet 50°C; water flow, 7.71 kg/min; fuel consumption, 14.5 l/h. (P_b 20.12%, cooling 17.258%, exhaust, radiation, etc. 62.62%)

9. An engine of 1640 cm3 swept capacity has four cylinders and operates on the four-stroke cycle. A torque of 112 N m at 3000 rev/min is developed. The bore/stroke ratio is 1:1. Using the bmep, determine the average force on a piston in kN. (4.36 kN)

10. A four-stroke engine uses 18.6 kg of fuel per hour while developing a bmep of 796 kN/m^2 and torque of 59 N m. If the specific fuel consumption is 0.4 kg/(kW h) and the CV of the fuel 44 MJ/kg, calculate the brake thermal efficiency and the engine's cubic capacity. (20.45%, 931 cm^3)

11. Define bmep and mechanical efficiency. A six cylinder four-stroke engine has a total swept volume of 1624 cm3 and develops 33.57 kW at 3000 rev/min. The mechanical efficiency is 80%. Determine the bmep and imep figures. (826.8 kN/m^2, 1033.5 kN/m^2)

12. An oil engine developing 29.84 kW power consumes fuel oil at the rate of 0.150 kg/min; the CV of the fuel oil is 45 MJ/kg. Cooling water circulates at the rate of 8.4 kg/min having an inlet temperature of 200C and an outlet temperature of 85"C. The specific heat capacity of water is 4.2 kJ/(kg °C). Draw up a simple heat balance sheet. (P_b 26.52%, cooling 33.97%, exhaust, radiation, etc. 39.51%)

13. A petrol engine developing 33.57 kW consumes 12 kg of fuel per hour under full throttle. The CV of the fuel is 45 MJ/kg. Cooling water is supplied at the rate of 11.2 kg/min with inlet and outlet temperatures of 15.5 ° C and 83.3° C, respectively. If the mechanical efficiency is 90%, determine the indicated thermal efficiency, and draw up a simple heat balance sheet on power basis. (24.86%, P_b 22.38%, cooling 35.4%, friction 2.48%, exhaust, radiation 39.7%)

* Motor vehicle science, part one, P.W. Kett, Chapman and Hall Ltd, 1982.