UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER II
SESI 2010/2011

NAMA KURSUS	:	ENJIN PEMBAKARAN DALAM
KOD KURSUS	:	BDE 4063
PROGRAM	:	BDD
TARIKH PEPERIKSAAN	:	APRIL / MEI 2011
JANGKA MASA	:	3 JAM
ARAHAN	:	JAWAB **EMPAT (4)** SOALAN DARIPADA **TUJUH (7)** SOALAN YANG DISEDIAKAN

KERTAS SOALAN INI MENGANDUNGI ENAM (6) MUKA SURAT BERCETAK

Q1 (a) Explain the importance of calculating engine brake mean effective pressure (bmep).

(4 marks)

(b) A 4-cylinder, two-stroke cycle diesel engine with 11.8 cm bore and 13.6 cm stroke produces 93kW of brake power at 2100 rpm. The compression ratio, r_c is 18:1. Calculate:

(i) the engine displacement, V_d (cm^3, litre)

(ii) brake mean effective pressure, bmep (kPa,bar)

(iii) engine torque, T (Nm); and

(iv) clearance volume of one cylinder, V_c (cm3)

(21 marks)

Q2 (a) Describe the terms specific weight and specific volume for an engine and their respective units.

(2 marks)

(b) What is a thermal efficiency and explain the procedure of measuring this quantity, for an internal combustion engine.

(4 marks)

(c) The operation of a four stroke compressed ignition engine can be approximated using air standard cycle or sometimes called constant pressure cycle.

(i) Justify the assumptions of isentropic compression and expansion strokes being used for this idealised cycle;

(ii) Sketch this ideal air standard diesel cycle on a *P-v* diagram; and

(iii) Derive the expression for the cycle thermal efficiency, based on its temperature values of T_1, T_2, T_3 and T_4.

(19 marks)

Q3 (a) Provide the explanations to the terms Cetane Number and Cetane Index.

(4 marks)

(b) A 1500 cm^3, four-stroke cycle, four-cylinder compression ignition (C.I.) engine, operating at 3200 RPM, produces 48 kW of brake power. The engine volumetric efficiency is 0.92 and with operating air-fuel ratio of 21:1. Calculate:

(i) the required mass air flow rate into the engine (kg/sec)

(ii) brake specific fuel consumption, bsfc (g/kW·hr)

(iii) the mass flow rate of the exhaust gas (kg/hr); and

(iv) brake power output per displacement (kW/litre).

(21 marks)

Q4 (a) Describe functions of intake valves in the operation of internal combustion engines.

(4 marks)

(b) A 2.5 litre, 4-cylinder square engine with two intake valves per cylinder is designed to have a maximum speed of 6700 rpm. Air enters the engine at 50°C. Calculate:

(i) the required intake valve area;

(ii) diameter of this intake valve; and

(iii) the expected maximum valve lift.

(21 marks)

Q5 (a) Explain the importance of achieving stoichiometric combustion, rich combustion and lean combustion.

(5 marks)

(a) Light diesel ($C_{12}H_{22}$) used for compression ignition engine reacts exothermically with 30% excess air from the surroundings.

(i) Write the chemically balanced equation of the fuel reaction with air;

(ii) Calculate the mass of water that will be produced, assuming complete combustion process has taken place;

(iii) Calculate the air to fuel ratio and the corresponding fuel to air ratio; and

(iv) Determine the equivalence ratio value.

The molecular weight values of Carbon (C), Hydrogen (H_2), Nitrogen (N_2) and Oxygen (O_2) are 12.01, 2.02, 28.01 and 32.00, respectively.

(20 marks)

Q6 A V6, square engine with capacity of 3000cc operates on a 4-stroke cycle at 3600 rpm. The compression ratio is 9.49 and the length of the connecting rods is 17.1 cm. At the given engine speed, the combustion terminates at 20 °C after-top-dead-centre (aTDC). Calculate:

(i) the cylinder bore and stroke length, B and S;

(ii) average piston speed;

(iii) the clearance volume of each cylinder, V_c;

(iv) piston speed at the end of combustion; and

(v) volume in the combustion chamber at the end of combustion.

(25 marks)

Q7 A four-stroke diesel engine is operated at 1765 rpm and inducts air having a density of 1.184 kg/m^3. The displacement of the engine is 0.01m^3, the volumetric efficiency is 0.92, and the fuel-air ratio is 0.05.

(i) Determine the mass flow rates of air and fuel used by the engine; and

(ii) If the engine has six cylinders, what mass of fuel is injected per cylinder per cycle?

(25 marks)

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The distance between the crank axis and wrist pin axis or piston position is given by, s:

$$s = a\cos\theta + \sqrt{r^2 - a^2\sin^2\theta}$$

Where a = crankshaft offset, r = connecting rod length and θ = crank angle, measured from the centerline and it is zero when the piston is at TDC

For an engine with N_c cylinders, displacement volume, V_d:

$$V_d = V_{BDC} - V_{TDC} \qquad V_d = N_c\left(\frac{\pi}{4}\right)B^2S$$

Where B = cylinder bore, S = stroke, S = 2a

Compression ratio, r_c is defined as: $r_c = V_{BDC}/V_{TDC}$

The cylinder volume at any crank angle is given by: $V = V_c + \left(\frac{\pi B^2}{4}\right)(r + a - s)$

Where V_c = clearance volume

Brake work of one revolution, W_b: $W_b = 2\pi T$; $\qquad W_b = \frac{V_d(bmep)}{n}$

Where T = engine torque, bmep = brake mean effective pressure, n = number of revolutions per cycle

Mean effective pressure: $mep = \frac{\dot{W}n}{V_d N}$

Engine torque, T, for 2-stroke and 4-stroke cycles:

$$T_{2-stroke} = \frac{V_d(bmep)}{2\pi} \qquad T_{4-stroke} = \frac{V_d(bmep)}{4\pi}$$

Engine power,

$$\dot{W} = \frac{WN}{n} \qquad \dot{W} = 2\pi NT$$

N = engine speed

Specific fuel consumption $sfc = \dot{m}_f/\dot{W}$

Instantaneous volume, V at any crank angle, θ:

$$\frac{V}{V_c} = 1 + \frac{1}{2}(r_c - 1)\left[R + 1 - \cos\theta - \sqrt{R^2 - \sin^2\theta}\right]$$

V_c = clearance volume, R = r/a,

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Minimum valve intake area:

$$A_i = 1.3B^2\left[\frac{(U_p)_{max}}{c_i}\right] = \left(\frac{\pi}{4}\right)d_v^2$$

where:

B = bore

$(U_p)_{max}$ = average piston speed at maximum engine speed

c_i = speed of sound at inlet conditions

d_v = diameter of valve

Speed of sound = $\sqrt{kRT}$

where: $k = 1.35$ and R = universal gas constant = $287\frac{J}{kg \cdot K}$

Maximum average piston speed = $\frac{2 \times \text{stroke} \times \text{engine speed}}{60}$

Valve lift, $l_{max} < \frac{d_v}{4}$