1100472 Internal Combustion Engines

H.W # 2

Problem # 1 :-

$$B.P = \frac{2\pi n T}{60} = \frac{2(\pi)(240)\ 5.16}{60} = 129.7\ kW$$

$$bmep = \frac{4\pi T}{V_{dis}} = \frac{4\pi(5.16)}{2\pi(0.14)^2(0.585)} = 482.7\ kPa = 4.89\ bar$$

$$\text{mean piston speed} = \frac{2L \times (RPM)}{60} = \frac{2(0.585)(240)}{60} = 4.68\ m/s$$

$$\eta_v = \frac{\text{Volume of intake air}}{\text{sweept Volume}}$$

$$0.85 = \frac{V_{air}}{\frac{(0.38)^2\pi}{4} \times (0.585) \times 2 \times \frac{240}{2}}$$

$$V_{air} = 811.6\ m^3$$

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Problem # 2 :-

$$I.m.e.p = \frac{\text{Net area of diagram}}{\text{lenght of d}} \times \text{spring constant}$$

$$= \frac{5.78}{70} \times 0.815$$

$$I_{mep} = 6.729 \text{ bar}$$

$$I_p = \frac{n (I_{mep}) LANK \times 10}{6} = \frac{1 \times (6.729)(0.28) \times \frac{\pi (0.1496)^2}{4} * 0.5 \times 10 \times 4.75}{6}$$

$I_P = 12.5$ KN

$$BP = \frac{2\pi NT}{60} = \frac{2\pi(475)(\sqrt{433 \times 0.45})}{60} = 9.69 \text{ kW}$$

$$\eta_{mech} = \frac{B.P}{I.P} = \frac{9.69}{12.5} \times 100\%$$

$$\eta_{mech} = 77.5\%$$

Problem # 3 :

$$bmep = \frac{4\pi T}{V_d} = \frac{4\pi T}{4\pi\left(\frac{0.212}{2}\right)^2(3.292)} = 5.93 \text{ kN}$$

$$\eta_v = \frac{\text{Volume of intake air}}{\text{Swept Volume}}$$

$$\dot{m}_a = \dot{m}_f \times A/F$$

$$= (33.2)(25) = 830 \text{ kg/h}$$

$\eta_v = \dfrac{\text{volume of intake air}}{\text{swept volume}}$

$\dot{m}_a = \dot{m}_f \times A/F$

$= (33.2)(25) = 830 \ kg/h$

$\dot{V}_a = \dfrac{\dot{m}_a R_a T_a}{P_a} = \dfrac{(830)\times(0.278)(15+273)}{1.01 \times 10^2}$

$= 679.25 \ m^3/h$

$\text{Swept volume} = \dfrac{(0.212)^2 \pi}{4} (0.292) \times 4 \times \dfrac{720}{2} \times 60$

$= 890.55 \ m^3/h$

$\eta_v = \dfrac{679.25}{890.55} \times 100\% = 76.4\%$

Problem # 4

$(I.mep)_{net} = mep_{power} - mep_{pumping}$

$= 6.2 - 0.35 = 5.85$ bar

firing strokes / min = 47

dead strokes / min = $\left(\frac{400}{2} - 47\right) = 153$

Frictional power (F.p) = $(I.p)_{net}$ - Pumping Power of dead cycle

$$(I.p)_{net} = \frac{n\,(i.m.e.p)_{net} * LANK * 10}{6}$$

$$= \frac{(1)\,(5.85)\,(0.33)\,\frac{\pi}{4}\,(0.178)^2 * 47 * 10}{6}$$

$= 3.76$ kW

$$\text{Pumping power of dead cycle} = \frac{(1)(0.62)(0.33)\,\frac{\pi}{4}\,(0.178)^2 * 153 * 10}{6}$$

Pumping power of dead cycle = $\frac{(1)(0.62)(0.33)\frac{\pi}{4}(0.178)*153*10}{6}$

$= 1.3$ kW

F.P = 3.76 - 1.3

= 2.46 kW

at full load engine fires every two revolutions:

$\Rightarrow \frac{400}{2} = 200$ firing stroke /min

I.P = $\frac{n\,(i.m.e.p)_{net} * LANK * 10}{6}$

$= \frac{(1)(5.35)(0.33) * \frac{\pi}{4} * (0.178)^2 * 400 * 0.5 * 10}{6}$

= 16.01 kW

B.P = I.P - F.P

= 16.01 - 2.46

$B.P = 13.55 \text{ kW}$

$\eta_{mech} = \frac{B.P}{I.P} = \frac{13.55}{16.01} = 84.6\ \%$

Problem # 5 :-

Brake load (N)	1.26	165.5	169	170	169	162	159
	2.08	2.04	2.17	2.5	2.84	3.393	3.56

① $b.p = \frac{WN}{26830} = \frac{120 \times 3000}{26830} = 14.088 \text{ kW}$

$bmep = \frac{b.p * 2}{A L N n} = \frac{14.088 * 2}{\frac{\pi}{4}(0.063)^2 * (0.076) * 3000 * 4}$

$= 9.9 \text{ bar}$

$s.fc = \frac{m_f}{b.p} = \frac{2.08 * 10^{-3} * 0.724 * 3600}{14.088} = 0.385 \text{ kg/kWh}$

B.P = 13.55 kW

$$\eta_{mech} = \frac{B.P}{I.P} = \frac{13.55}{16.01} = 84.6 \%$$

Problem # 5 :-

Brake load (N)	1.26	165.5	169	170	169	162	159
	2.08	2.04	2.17	2.5	2.84	3.393	3.56

① $b.p = \frac{WN}{26830} = \frac{120 \times 3000}{26830} = 14.082$ kW

$$bmep = \frac{b.p * 2}{ALN_n} = \frac{14.082 * 2}{\frac{\pi}{4}(0.063)^2 * (0.076) * 3000 * 4}$$

= 9.9 ba

$$s.f.c = \frac{mf}{b.p} = \frac{2.08 * 10^{-3} * 0.724 * 3600}{14.082} = 0.385 \text{ kg/kWh}$$

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② b.p = (165.5) (0.11182) = 18.51 kW

bmep = (18.51) (0.7039) = 13.03 bar

$$s.f.c = \frac{2.04}{18.51} \times 2.6064 = 0.287 \text{ kg/kWh}$$

③ b.p = (169) (0.11182) = 18.89 kW

bmep = (18.89) (0.7039) = 13.29 bar

$$sfc = \frac{2.17}{18.89} \times 2.6064 = 0.299 \text{ kg/kWh}$$

④ b.p = (170) (0.11182) = 19 kW

bmep = (19) (0.7039) = 13.37 bar

$$sf.c = \frac{2.5}{19} \times 2.6064 = 0.343 \text{ kg/kW.h}$$

(v 10

$\dot{V}_a \backslash cylinder = \frac{1.16}{4} = 0.291 \; m^3 \backslash min$

$\dot{m}_a = 5.884 \times 10^{-3} \; kg/s$

from the previous Question (5)

the mass flow rate of the fuel during test is:

$\dot{m}_{f_1} = 1.506 \times 10^{-3} \; kg/s$

$\dot{m}_{f_2} = 1.477 \times 10^{-3} \; kg/s$

$\dot{m}_{f_3} = 1.57 \times 10^{-3} \; kg/s$

$\dot{m}_{f_4} = 1.81 \times 10^{-3} \; kg/s$

$\dot{m}_{f_5} = 2.050 \times 10^{-3} \; kg/s$

$\dot{m}_{f_6} = 2.458 \times 10^{-3} \; kg/s$

$\dot{m}_{f_7} = 2.577 \times 10^{-3} \; kg/s$

$I_1 = B.T - B_1 = 248.3 - 177 = 71.3$ N.m

$I_2 = B.T - B_2 = 248.3 - 170 = 78.3$ N.m

$I_3 = B.T - B_3 = 248.3 - 168 = 80.3$ N.m

$I_4 = B.T - B_4 = 248.3 - 174 = 74.3$ N.m

$\Rightarrow I.T = 71.3 + 78.3 + 80.3 - 74.3$

$= 304.2$ N.m

$\eta_{mech} = \frac{248.3}{301.2} \times 100\% = 81.6\%$

$\eta_{B.T} = \frac{BP}{mf \times H_m}$

$Sfc = \frac{mf}{BP}$

$0.364 = \frac{mf}{52}$

teh

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$A/F = \frac{5.766}{1.506} \quad \frac{5.766}{1.477} \quad \frac{5.766}{1.81} \quad \frac{5.799}{1.81} \quad \frac{5.799}{2.656} \quad \frac{5.84}{2.452} \quad \frac{5.884}{2.577}$

$= 3.83 \quad 3.9 \quad 3.67 \quad 3.7 \quad 2.22 \quad 2.38 \quad 2.28$

Problem # 7:

$B.P = 52 \text{ kW} = \frac{2\pi NT}{60 \times 10^3}$

$52 = \frac{2\pi (2000) T}{60 \times 10^3}$

$\Rightarrow T = 248.3 \text{ N.m}$

$\eta_{mech} = \frac{B.T}{I.T}$

$I.T = I_1 + I_2 + I_3 + I_4$

$I_1 = B.T - B_1 = 248.3 - 177 = 71.3 \text{ N.m}$

$I_2 = B.T - B_2 = 248.3 - 170 = 78.3 \text{ N.m}$

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(4) & (5)

$\dot{V}_a = 0.623 \sqrt{\frac{33.8}{10}} = 1.1454 \ m^3/min$

$\dot{V}_a / cylinder = \frac{1.1454}{4} \ m^3/min$

$= 0.2864 \ m^3/min$

$\dot{m}_{air} = \frac{(0.286)(1.215)}{60} = 5.799 \times 10^{-3} \ kg/s$

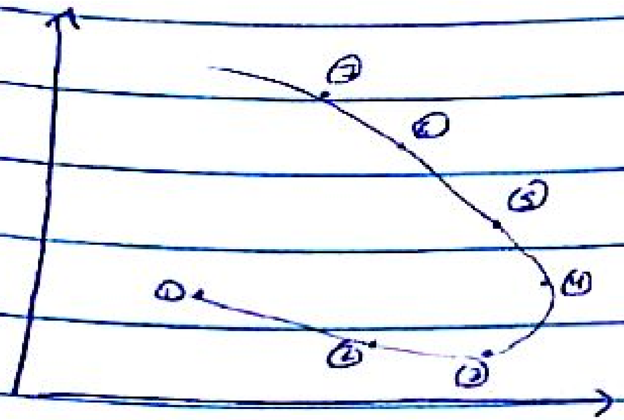
(6) $\dot{V}_a = (0.623)\sqrt{3.425} = 1.153 \ m^3/min$

$\dot{V}_a / cylinder = \frac{1.153}{4} = 0.2883 \ m^3/min$

$\dot{m}_a = \frac{(0.2883)(1.215)}{60} = 5.84 \times 10^{-3} \ kg/s$

(7) $\dot{V}_a = (0.623)\left(\sqrt{\frac{34.8}{10}}\right) = 1.16 \ m^3/min$

$s.f.c = \frac{3.56}{17.78} \times 2.6064 = 0.522 \ kg/kWh$



maximum power at ⑤

maximum economy at ②

Problem # 6:

$\dot{V}_a = 840 A_o c_d \sqrt{\frac{h_w}{\rho_a}} = (0.623)(\sqrt{[illegible]})$

① & ② & ③ same value of h

$\dot{V}_a = 1.14 \ m^3/min$

$\frac{\dot{V}_a}{cylinder} = \frac{1.14}{4} = 0.285 \ m^3/min = \frac{0.285}{60} /s$

$= 5.766 \times 10^{-3} \ kg/s$

(5) b.p = (169)(0.11182) = 18.89 kw

bmep = (18.89)(0.7039) = 13.29 bar

s.f.c = $\frac{2.84}{18.89}$ × 2.6064 = 0.392 kg/kw.h

(6) b.p = (162)(0.11182) = 18.11 kW

bmep = (18.11)(0.7039) = 12.75 bar

s.f.c = $\frac{3.395}{18.11}$ × 2.6064 = 0.489 kg/kwh

(7) b.p = (159)(0.11182) = 17.78 kW

bmep = (17.78)(0.7039) = 12.57 bar.

s.f.c = $\frac{3.56}{17.78}$ × 2.6064 = 0.522 kg/kwh

$\dot{m}f = 18.928 \ kg/h$

$= 5.258 \times 10^{-3} \ kg/s$

$\eta BT = \frac{52}{5.258 \times 10^{-3} \times 44200} \times 100\% = 22.4\%$

Problem # 8 :-

$\eta_{B.T} = \frac{B.P}{\dot{m}f \times H.V} = 0.32$

$\frac{186.5}{\dot{m}f \times 44200} = 0.32$

$\dot{m}f = 0.0131858 \ kg/s \times 3600$

$= 47.468 \ kg/h$