Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2017

EN3ES03 Basic Mechanical Engineering

Programme: B.Tech. Branch/Specialisation: All

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. The mil steel is **1**

(a) Ductile & soft (b) Hard & brittle

(c) High in compressive strength (d) Has poor machinability

ii. Vernier calliper is made from **1**

(a) Mild steel (b) Stainless steel

(c) Cast iron (d) Cast steel

iii. The total enthalpy of steam at 10 bar is 2000 KJ/kg. The condition of steam is **1**

(a) Wet (b) Dry & saturated

(c) Superheated (d) None of these

iv. At the critical point the temperature of water is equal to **1**

(a) 0^o C (b) 100^o C (c) 374^o C (d) -100^o C

v. The process of supplying the intake air to the engine cylinder is known as **1**

(a) Supercharging (b) Scavenging

(c) Detonation (d) Suction

vi. The compression ratio for a petrol engine varies from **1**

(a) 6 to 10 (b) 10 to 15 (c) 15 to 25 (d) 25 to 40

vii. Moment of inertia of a semicircle about its XX axis is given by **1**

(a) $0.22r^3$ (b) $0.11r^4$ (c) $0.14r^4$ (d) $0.2r^4$

viii. The moment of inertia about axis is called: **1**

(a) Mass moment of inertia (b) Second moment of inertia

(c) Principal moment of inertia (d) Centroid

P.T.O.

ix. Net driving tension in belt is given by **1**
(a) T_1-T_2 (b) T_1/T_2 (c) T_1+T_2 (d) T_2-T_1

x. Gear train in which each shaft carries one wheel only is : **1**
(a) Simple (b) Compound
(c) Epicyclic (d) None of these

Q.2 i. Define least count. What are the least count of Vernier calliper & Micrometer in the basic mechanical engineering lab. **2**

ii. What is the difference between cast iron, steel & wrought iron? **3**

iii. Draw a well label diagram of drilling machine and state the various operations performed on it. **5**

OR iv. Draw a well label diagram of shaper machine and write its operations. **5**

Q.3 i. Define : **2**
(a) Dryness fraction (b) Degree of superheat

ii. A heat pump delivers 2kW of heat to room, maintained at 25°C and receives heat from a reservoir at -10° C. If the actual coefficient of performance is 50% of heat of an ideal heat pump operating between the same temperatures limits. What is the actual power required in kW to run the heat pump. **8**

OR iii. State first law of thermodynamics and its applications. Also write its limitations. **8**

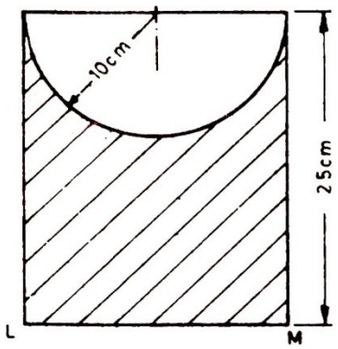
Q.4 i. Compare petrol and diesel engine. **3**

ii. A Diesel engine has an inlet temperature and pressure of 17° C & 1 bar respectively. The compression ratio is 15 and the maximum cycle temperature is 1400 K. Calculate the air standard efficiency of the Diesel cycle. Take $\gamma = 1.4$. **7**

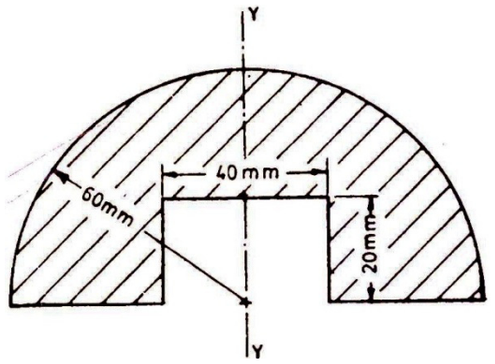
OR iii. Explain boiler mountings and accessories. **7**

Q.5 i. State and prove theorem of parallel axis. **3**

ii. Find the moment of inertia of section shown hatched about LM as shown in fig. **7**



OR iii. For the section shown in fig. Find the position of centre of gravity and calculate the moment of inertia about the horizontal centroidal axis. **7**



Q.6 i. For a belt drive, prove that $\frac{T_1}{T_2} = e^{\mu\theta}$. **3**

ii. A belt transmits 10kW through a pulley 1m diameter running at 200 rpm. The coefficient of friction between the belt and pulley is 0.25 and the allowable tension per mm width of belt is 18 N. Presuming an angle of lap on the pulley as 160degree, determine the necessary initial tension on the belt and belt width. **7**

OR iii. The maximum allowable tension in a flat belt is 1500 N The angle of contact is 170 degree and the coefficient of friction between belt material and pulley is 0.27. Neglecting the effect of centrifugal tension, calculate the net driving tension and power transmitted if the belt speed is 2 m/s. **7**

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BME -

EN3BES03

B.M.C Solution

Q.(1) (i) a (ii) b (iii) a (iv) c (v) d (vi) a

(vii) b/c (viii) c/b (ix) a (x) a

Q.(2) Ans.

(i) Least ~~cont~~ count – 1

Value – 1 [Vernier = 0.02 mm; micrometer = 0.01 mm]

(ii) Cast iron – 1

Wrought iron – 1

Steel – 1

(iii) Label Diagram – (2)

Working principle – (1)

Various operation – (2)

(Or)

(iv) Diagram – (2), Working principle – (1) operation – (2)

Q.(3) Ans

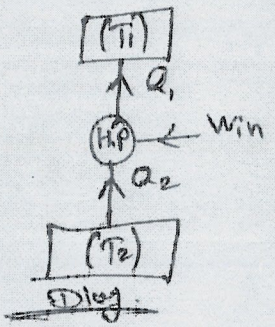
(i) Dryness fraction Definition – 1 Marks [$x = m_g/(m_g+m_w)$]

Degree of Superheat Definition – 1 [$T_{sup} - T_{sat}$]

(ii) Heat pump: given – (2) $Q_1 = 2kW$

$T_1 = 25°C + 273 = 298\ K$

$T_2 = -10°C + 273 = 263K$



Diag.

$(C.O.P)_{Ideal} = \frac{T_2}{T_1 - T_2}$ $(C.O.P)_{Act} = 50\%\ (C.O.P)_{Id}$

$(C.O.P)_{Id} = 7.51$ $(C.O.P)_{HP} = \frac{Q_1}{W_{in}} = 3.75 = \frac{2kW}{W_{in}}$

Ans → $W_{in} = 0.533\ kW$ Ans.

(Or)

- First Law Statement, with Example – (5) Marks

Limitation – (3) Marks

(1) Heat can't be converted in to work completly,

(2) It does not tell about the direction of Heat

Q.4 (i) Comparison Petrol & Diesel Engine. Minimum (3) Diffn.

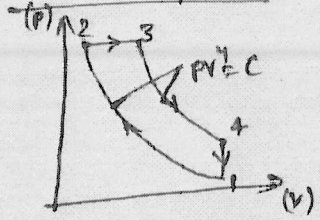
Ans.

Cycle Basis, ——— (1 marks) — ie otto, Diesel

Compression Ratio Basis — (1 marks) 6-10, 16-20

Application Basis — (1 marks) Light, Heavy v-

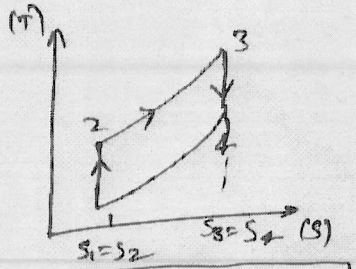
(ii) Diesel cycle.



$P_1 = 1$ bar

$T_1 = 17°C + 273 = 290\,K$

$r = 15$, $T_3 = 1400\,K$



$\frac{T_3}{T_4} = (r)^{\gamma-1}$ — ρ = cut off Ratio

(1-2)

$\frac{T_2}{T_1} = (15)^{1.4}$ $\quad T_2 = 856.71\,K$

$\frac{T_3}{T_2} = \frac{V_3}{V_2} = (\rho)$ $\quad \rho = 1.63$ — up to this. → 2 marks

$T_3 = T_2(\rho)$

$Q_S = m \times C_p (T_3 - T_2)$

$= 1 \times 1.005 \times (1400 - 856.71)$

$Q_S = 546\,kJ/kg$

$W = Q_S - Q_R$.

OR $\eta_{diesel} = \frac{W}{Q_S}$

we know that $\frac{T_3}{T_4} = \left(\frac{r}{\rho}\right)^{\gamma-1} \Rightarrow T_4 = \frac{1400}{1.21}$

$\eta_{diesel} = 1 - \frac{1}{r^{\gamma-1}}\left[\frac{1}{\gamma}\frac{\rho^{\gamma}-1}{(\rho-1)}\right]$

$\eta_{diesel} = 61.8\%$

$T_4 =$

(OR)

Boiler Mountings — (2 mark Name only)

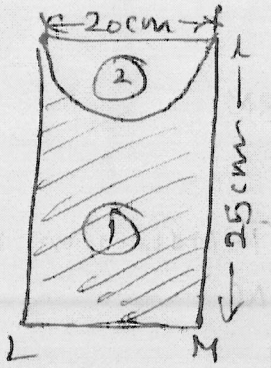
[Press. gauge, water level indicator, feed check valve, man hole, Safety Valve, steam stop valve, Blow off cock, their function (3.5 marks)]

Boiler Accessories — [feed pump, superheater, Economiser, Airpreheater]

Name only — (2 marks)

Name with function (3.5) marks.

5 (ii)



About LM (3)

$a_1 = 20 \times 25 = 500\ cm^2$

$a_2 = \frac{\pi r^2}{2} = \frac{\pi \times 10^2}{2} = \frac{314.15}{2} = 157\ cm^2$

By Parallel axis Theorem

$I_{LM} = I_G + Ah^2$ — (1)

$\bar{y} = \frac{a_1 y_1 - a_2 y_2}{a_1 - a_2} = \frac{500 \times 12.5 - 314.15 \times 20.75}{500 - 157}$

$\bar{y} = 8.7\ cm$

$I_{LM} = I_{G_1} + a_1 h_1^2 + \left[I_{G_2} + a_2 h_2^2 \right]$

$= \frac{bd^3}{12} + 500 \times (12.5 - 8.7)^2 - \left[0.11 R^4 + 157 (20.75 - 8.7)^2 \right]$

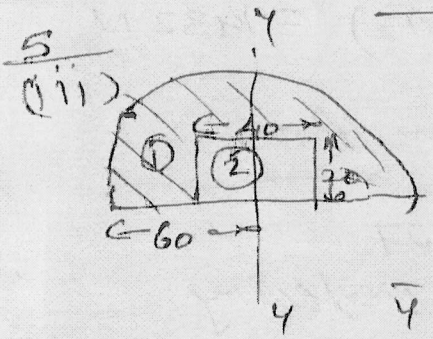
$= \frac{20 \times 25^3}{12} + 7220 - \left[0.11 \times 10^4 + 22796 \right]$

$= 33261 - 23896$

$I_{LM} = 9365\ cm^4$ Ans

OR

5 (iii)



$I_{xx} = ?$

$a_1 = \frac{A}{2} \times 60^2 = 5654.866\ mm^2$

$a_2 = 40 \times 20 = 800\ mm^2$

$\bar{y} = \frac{a_1 y_1 - a_2 y_2}{a_1 - a_2} = \frac{5654 \times 25.46 - 800 \times 10}{5654.866 - 800}$

$\bar{y} = 28mm$

$I_{xx} = I_{xx_1} - I_{xx_2}$

$= I_{G_1} + a_1 h_1^2 - \left(I_{G_2} + a_2 h_2^2 \right)$

$= 0.11 R^4 + 5654.866 \times (25.46 - 28)^2 - \left\{ \frac{bd^3}{12} + 800 (10 - 28)^2 \right.$

$= 1425600 + 36482 - (26666.6 + 259200)$

$= 1462082 - 285866$

$I_{xx} = 1176215.34\ mm^4$

Q 6(ii) $P = 10\,KW = 10{,}000\,Watt$

$\mu = 0.25 \quad N = 200\,rpm$

Tension per mm width $= 18N$

$\theta = 160^\circ = 2.79\,rad.$

Neglecting centrifugal tension, Tension in tight side

$T_1 = T_{max} = 18b\,N.$

$T_1/T_2 = e^{\mu\theta} = e^{0.25 \times 2.79} = 2.00$

$T_1 = 2T_2$

velocity of belt $v = \frac{\pi dN}{60} = 10.47\,m/sec$

Power transmitted $P = (T_1 - T_2)v$

$10{,}000 = \left(T_1 - \frac{T_1}{2}\right) 10.47$

$T_1 = 1910\,N, \quad T_2 = 955.11\,N$

Initial tension $T_0 = \frac{1}{2}(T_1 + T_2) = 1432\,N$

$\therefore 18b = 1910.2$

$b = 106.12\,mm$ Ans

(iii) $T_{max} = 1500N \qquad \mu = 0.27$

$\theta = 170^\circ = 2.96\,rad \qquad T_c$ Neglecting

$v = 2\,m/sec$

$P = 2 \quad T_1 = 2 \quad T_{max} = T_1$

$\frac{T_1}{T_2} = e^{\mu\theta} = 2.22 \qquad T_1 = 1500\,N$

$T_2 = 675.67\,N$

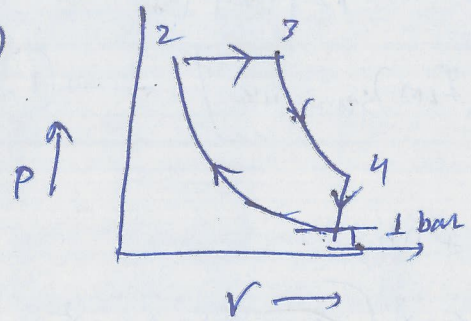
$P = (T_1 - T_2)v$

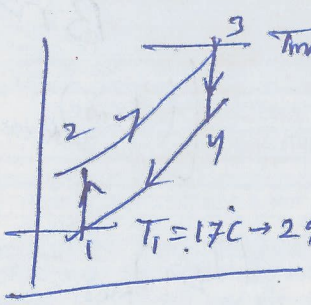
$P = 1648.64\,Watt$ Ans

Net driving tension $= (T_1 - T_2)$

$= 824.33\,N$ Ans

Q(4)/(ii)





27 → 17 → 290

$r_K = \frac{V_1}{V_2} = 15$ $\quad \gamma = 1.4$.

$\eta_{diesel} = 1 - \frac{1}{(r_K)^{\gamma-1}}\left[\frac{(\rho^{\gamma}-1)}{\gamma(\rho-1)}\right]$

$\Rightarrow P_1 V_1 = mRT_1$

$\Rightarrow (1\times10^5)\times V_1 = 0.287\times290$

$\Rightarrow V_1 = 83.23\times10^{-5}\ m^3/kg$.

$\Rightarrow \left(\frac{290}{856.7}\right) = \left(\frac{V_2}{83.23\times10^{-5}}\right)$

$\Rightarrow V_2 = 5.54\times10^{-5}\ m^3/kg$.

process 1-2: $\left(\frac{T_1}{T_2}\right) = \left(\frac{V_2}{V_1}\right)^{\gamma-1}$

$\rho = \frac{V_3}{V_2} = ?$

$\rho = \frac{9.05}{5.54} = 1.63$.

$\Rightarrow \left(\frac{290}{T_2}\right) = \left(\frac{1}{15}\right)^{0.4} = 0.3385$

$\Rightarrow T_2 = \frac{290}{0.3385} = 856.7K$.

process 2-3: $P = C$

$V \propto T \Rightarrow \frac{V_2}{V_3} = \frac{T_2}{T_3} \Rightarrow \frac{5.54\times10^{-5}}{V_3} = \frac{856.7}{1400}$

$\Rightarrow V_3 = 9.05\times10^{-5}\ m^3/kg$.

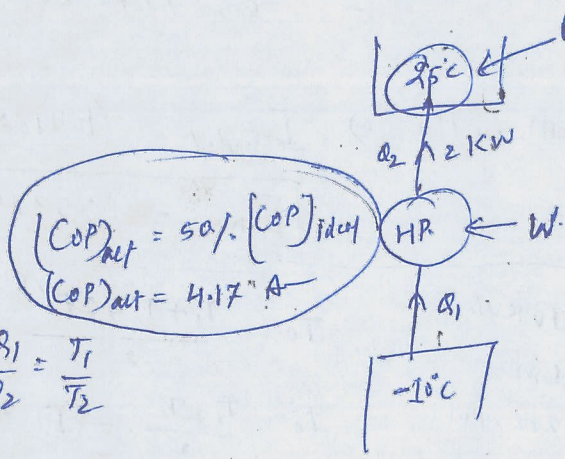
$\Rightarrow \eta_D = 1 - \frac{1}{(15)^{0.4}}\left[\frac{(1.63^{1.4}-1)}{1.4(1.63-1)}\right]$

$\eta_D = 1 - \frac{1}{2.95}\left[\frac{(1.98-1)}{1.4\times0.63}\right] = \left[1 - \frac{0.98}{0.882\times2.95}\right] = (1-0.37) = 0.623$

$= 62.34\%$ A

0.882

Q. 3. (ii)



$(COP)_{act} = 50\%\ (COP)_{ideal}$

$(COP)_{act} = 4.17$ A

$[COP]_{act} = \frac{Q_2}{W}$

$W = \frac{2}{4.17} = 0.479\ KW$

$W_{act} = 0.479\ KW$

$\Rightarrow \frac{Q_1}{Q_2} = \frac{T_1}{T_2}$

$\Rightarrow \frac{Q_1}{2} = \frac{263}{298}$

$\Rightarrow Q_1 = \frac{263}{298}\times2 = 1.76\ KW$.

$\Rightarrow Q_1 + W = Q_2$

$\Rightarrow 1.76 + W = 2$

$W = (2 - 1.76)$

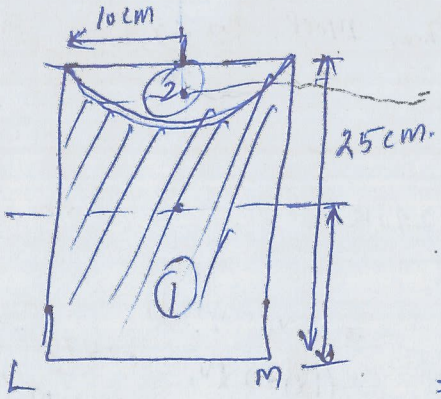
$W = 0.24\ kw$.

$[COP]_{ideal} = \frac{Q_2}{(Q_1 - Q_2)} = \frac{Q_2}{W} = \frac{2}{0.24}$

$[COP]_{ideal} = 8.33$

27 → 25 → 298

BME 12/12/17



$$(I_{LM})_{Shaded} = [(I_{LM})_{Rect} - (I_{LM})_{semicircle}] \quad \text{---(1)}$$

$$(I_{LM})_{Rect} = (I_G + Ah^2)$$

$$\Rightarrow (I_{LM})_{Rect} = \frac{20\times(25)^3}{12} + (20\times25)\times(12.5)^2$$

$$\Rightarrow (I_{LM})_{Rect} = 26041.67 + 500\times156.25$$

$$= 26041.67 + 78125$$

$$\Rightarrow \boxed{(I_{LM})_{Rect} = 104166.67\ cm^4}$$

$\frac{\pi}{64}d^4 \rightarrow \frac{\pi}{128}d^4$

$\frac{2}{}$

$= 0.0174(2r)^4$

$= 0.0174\times16r^4$

$= 0.393r^4$

$$(I_{LM})_{semicircle} = I_G + Ah^2$$

$$= 0.11r^4 + \frac{\pi r^2}{2}\left(25 - \frac{4\times10}{3\pi}\right)^2$$

$$= 0.11(10)^4 + \frac{\pi\times100}{2}\left(25 - \frac{40}{3\pi}\right)^2$$

$$= 1100 + 50\pi(25 - 4.244)^2$$

$$= 1100 + (50\pi)\times430.811$$

$$= 1100 + 67671.71$$

$$= 68771.71\ cm^4$$

From eqn (1) $\Rightarrow I_{shaded} = (104166.67 - 68771.71)$

$$\boxed{I_{shw} = 35394.95\ cm^4}$$

$P = 10\ KW.$

$d = 1m.$

$N = 200\ rpm.$

$\mu = 0.25$

T per width $= 18N.$

$\theta = 160^\circ$

$T_0 = ?$

$b = ?$

$$T_0 = \frac{T_1 + T_2 + 27^0}{2}$$

$$T_0 = \frac{T_1 + T_2}{2} \quad \text{---(1)} \Rightarrow T_0 = \frac{18+9}{2} = \frac{27}{2} = 13.5N.$$

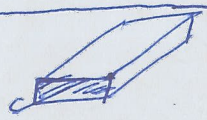
$$P = \frac{2\pi N T_{max}}{60}$$

$T_{max} = 18\ N.$

$$\frac{T_{max}}{T_2} = e^{\mu\theta}$$

$$\Rightarrow \frac{18}{T_2} = e^{0.25\times110\times\frac{\pi}{180}} = e^{0.648} = 2$$

$T_2 = 9N.$



$T_{max}(A) =$