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18/ENG05/010 MECHATRONICS

FLUID MECHANICS ASSIGNMENT

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18/ENG05/010

(i) Actual Flowrate(Qa) = $10dm^3/min$

$10dm = 1m$

dm^3 to m^3

$= 10^3 dm^3 = 1m^3$

$\therefore 10dm^3/min = 0.01m^3/min$

$= m^3/min$ to m^3/sec

$60s = 1min$

$(Q) = \frac{0.01}{60} = 1.67 \times 10^{-4} m^3/sec$

speed, $N = 1500 rev/min$

$= \frac{1500}{60} = 25 rev/sec \approx 25rps$

$\Delta p = 12 bar = 12 \times 10^5 Nm^{-2}$

Nominal Displacement $= 10cm^3/rev$

$= \frac{10}{1 \times 10^6} = 10 \times 10^{-6} m^3/rev$

ideal flow rate = nominal displacement x speed

$= 25 \times 10 \times 10^{-6} = 2.5 \times 10^{-4} m^3/sec$

Volumetric efficiency = $\frac{\text{Actual flow rate}}{\text{ideal flow rate}} \times 100\%$

$= \frac{1.67 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100$

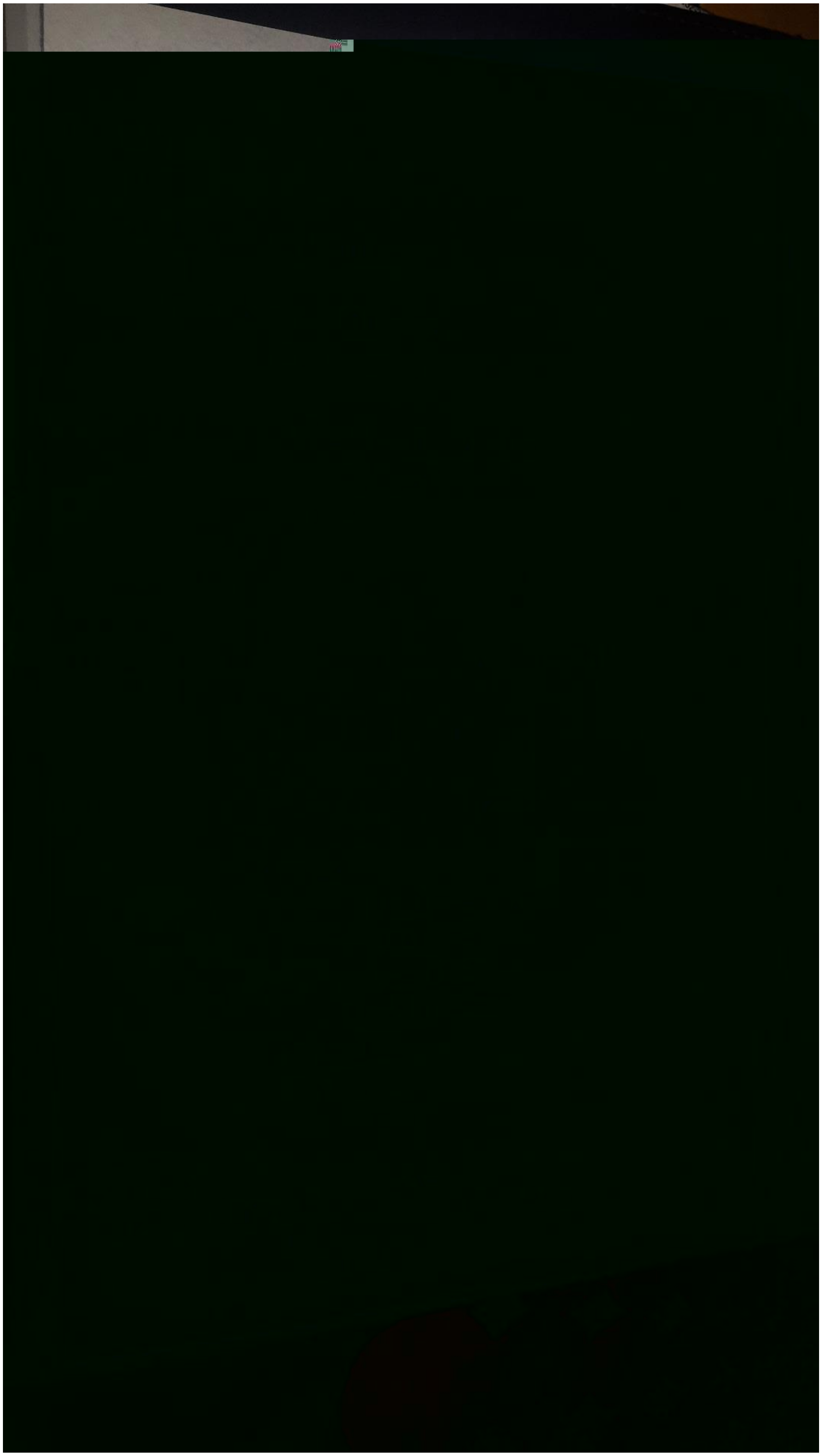
$= 66.8\%$

ii) Fluid Power = $Q \cdot \Delta P$

$= 1.67 \times 10^{-4} \times 12 \times 10^5 = 200.4$ watts

iv) Shaft Power = $T \cdot \omega$

$T = 12.5 Nm$



$\Delta p = 100 bar \simeq 100 \times 10^5 Nm^{-2}$
shaft power = 15kw = 15×1000 = 15000 watts

(c) Overall efficiency = $\frac{\text{fluid power}}{\text{shaft power}} \times 100$

fluid power = $Q \times \Delta p = 5.83 \times 10^{-4} \times 100 \times 10^5$
= 5830 watts

$\therefore O.E = \frac{5830}{15,000} \times 100 = 38.87\%$

Ideal flowrate = nominal disp × speed
speed, N = 850rpm

$= \frac{850}{60} = 14.17 rps$

$\therefore$ ideal flow rate = $50 \times 10^{-6} \times 14.17$
$= 7.085 \times 10^{-4} m^3/sec$

volumetric efficiency

$= \frac{\text{Actual flowrate}}{\text{ideal flowrate}} \times 100\%$

$= \frac{5.83 \times 10^{-4}}{7.085 \times 10^{-4}} \times 100 = 82.3\%$

Number 4

4 $Z = 24000 cm$

100cm = 1m

Z = 240 m

Volumetric flow rate = Q = 134rep/sec

1000 litres = $1m^3$

$Q = \frac{1^3}{1000}$

$Q = 13 \times 10^{-5} m^3/sec$

Velocity of ret = 66m/sec
At dit level, P = 0 and Z = 6

Power of jet

since its at datum level

$P = 0, \; Z = 0$

substitute into eqn

$$P = PQ + \frac{\rho Q v^2}{2} + \rho g Q Z$$

$$= \frac{\rho Q v^2}{2}$$

$$= \frac{1000 \times 13 \times 10^{-3} \times (66)^2}{2} = 28314 \text{ watts}$$

(ii) Power from reservoir

here $P = 0$ and $v = 0$

substitute into equation

$$P = PQ + \frac{\rho Q v^2}{2} + \rho g Q Z$$

$$= \rho g Q Z$$

$$= 1000 \times 9.81 \times 13 \times 10^{-3} \times 240$$

$$= 30607.2 \text{ watts}$$

(iii) Head loss in pipeline (h)

$$h = \frac{\text{power lost in transmission}}{\rho g Q}$$

But power lost in transmission = Power of reservoir − Power of jet

$$= 30607.2 - 28314 = 2293.2 \text{ watts}$$

$$\therefore h = \frac{2293.2}{\sqrt{1000 \times 9.81 \times 13 \times 10^{-3}}} = 17.98 \text{m}$$

iv Efficiency $= \frac{\text{power of jet}}{\text{power of reservoir}} \times 100\%$

$$= \frac{28314}{30607.2} \times 100 = 92.5\%$$

ii) Power from reservoir

Here $P = 0$ and $v = 0$

$$P = PQ + \frac{\rho Q v^2}{2} + \rho g Q z$$

$= 890 \times 9.81 \times 0.22 \times 300$

$= 576239.4$ watts

iii) Head loss in pipeline (h)

$$h = \frac{\text{power lost in transmission}}{\rho \cdot g\, Q}$$

But power lost in transmission

= power of reservoir − power of jet

$= 576239.4 - 4797.1$

$= 571442.3$ watts

~~h = 297.5m~~ $h = \frac{571442.3}{890 \times 9.81 \times 0.22}$

$= h = 297.5m$

iv) Efficiency $= \frac{\text{Power of jet}}{\text{Power of reservoir}} \times 100$

$\frac{4797.1}{576239.4} \times 100$

$= 0.832\%$

Question 5

$Z = 30{,}000$

$100cm = 1m$

$\therefore Z = 300m$

volumetric flowrate $(Q) = 220$ litres/sec

1000 litres $= 1m^3$

$Q = \frac{220}{1000} = 0.22m^3/sec$

Velocity of jet $(V) = 7$ m/sec

$sg = 0.89$

$\rho = s.g \times 1000 = 0.89 \times 1000 = 890 Nm^{-2}$

At datum level

(i) Power jet

$P = 0$ and $Z = 0$

$$P = \rho Q + \frac{\rho Q \cdot V^2}{2} + \rho g \cdot Qz$$

$$= \frac{\rho Q \cdot V^2}{2} = \frac{890 \times 0.22 \times (7)^2}{2}$$

$= 4797.1$ watts