# Final term

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Sec: B

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Batch: 2016

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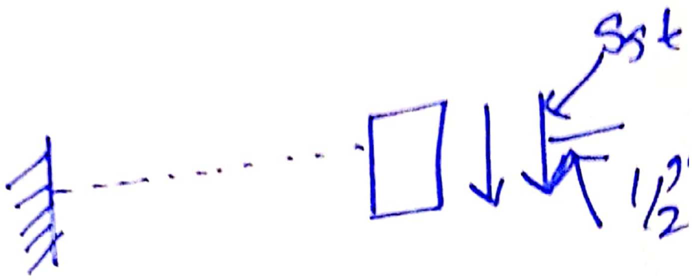
Q.No 1:: ①    IDNO = 7705

Promblem




Given data

$E = 29000$ Ksi

$I = 150\ in^4$

$\delta_{st} =$ ~~[illegible]~~ 7705 lb

The general EOM for SDOF System

$$Ku + Cu + Mu = P(t)$$

→ In our case System is undamped $(C = 0)$ undergoing free vibration $P(t) = 0$

→ Hence general EOM become

$$Ku + Mu = 0 \rightarrow ①$$

Scanned with CamScanner

Now

$$K = \frac{3EI}{L^3} = \frac{3 \times 29000 \frac{K}{in^2} \times 150 in^4}{(10 \times 12)^3}$$

$K = 7.55 \ K/in$

$K = 90625 \ lb/ft$

→ $m = \frac{7705 \ lb\,sec^2}{32.2 \ ft}$

→ $m = 239.28$ slug

$$w_n = \sqrt{\frac{K}{m}} = \sqrt{\frac{90625}{239.28}}$$

$w_n =$ ~~20.03~~ rad/sec

~~$w_n =$ 19.96 rad/sec~~

$w_n = 19.46$ rad/sec

$$T_n = \frac{2\pi}{w_n} = \frac{2\pi}{20.03} = 0.313 \text{ sec}$$

→ Substituting the corresponding value in eq ①

$$Ku + mu = 0$$

$$90625u + 239.28u = 0$$

where 'K' is in lb/ft and 'm' is in lb sec/ft²

General solution to the EOM for undamped free vibration is

~~$u(t) = u(0)\cos(w_n t) + \frac{u(0)}{w_n}\sin(w_n t)$~~

$$u(t) = u(0)\cos(w_n t) + \frac{u(0)}{w_n}\sin(w_n t)$$

$\because u(0) = 1/2 - \frac{1}{2} \times \frac{1}{12} = \frac{1}{24}$ ft

and

$\dot{u}(0) = 0$

$u(t) = \frac{1}{24}(\cos(19.46\,t)) + 0 = \left(\frac{1}{24}\right)(\cos(19.46\,t))$

Equivalent static force at any time "t" is

$f_{(S)}(t) = K\,u(t) = \frac{90625 \times \cos(20.03)}{24}$

$f_{(S)}(t) = 3776.04 \cos(20.03)$

$= 3776.04(0.9378)$

$= 3541.094$

⑤

Amplitude of dynamic displacement

$$u_0 = \sqrt{(u(0))^2 + (\dot{u}(0)/\omega_n)^2}$$

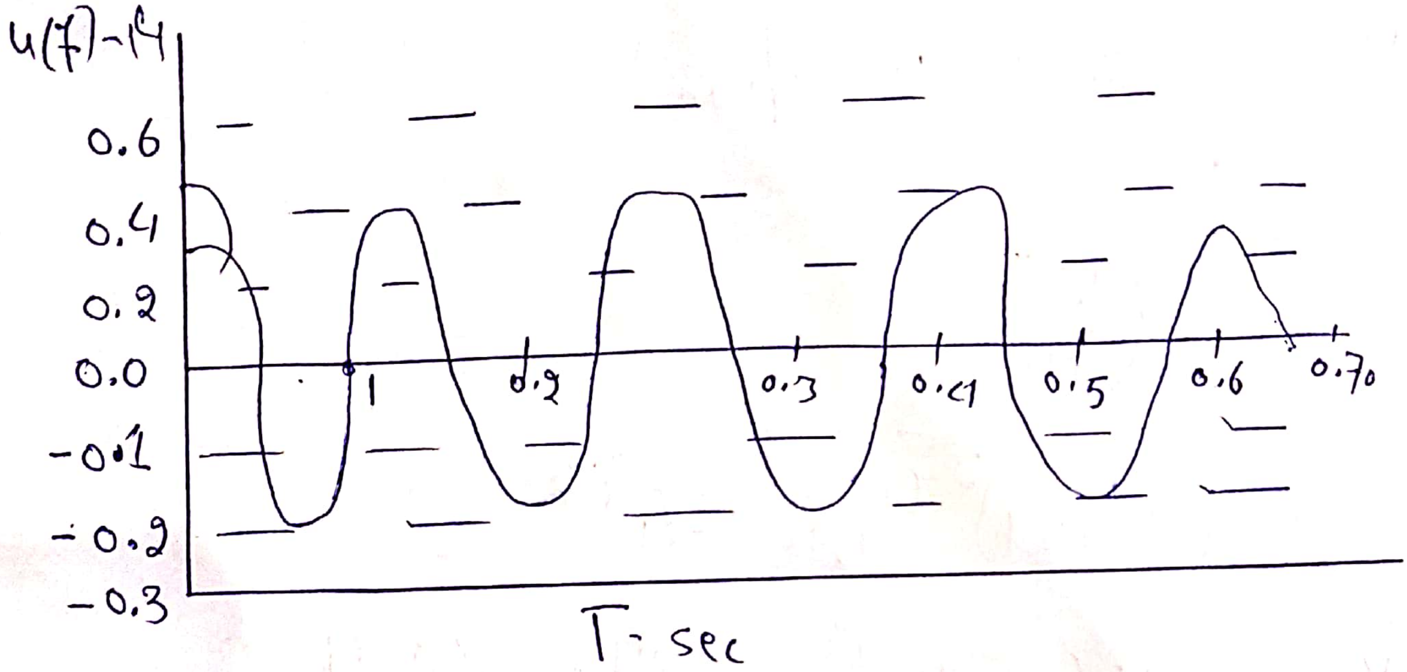
$$u_0 = \sqrt{\left(\frac{1}{24}\right)^2 + 0}$$

$$= \sqrt{(1/24)^2}\ ft = \frac{1}{24}\ ft$$

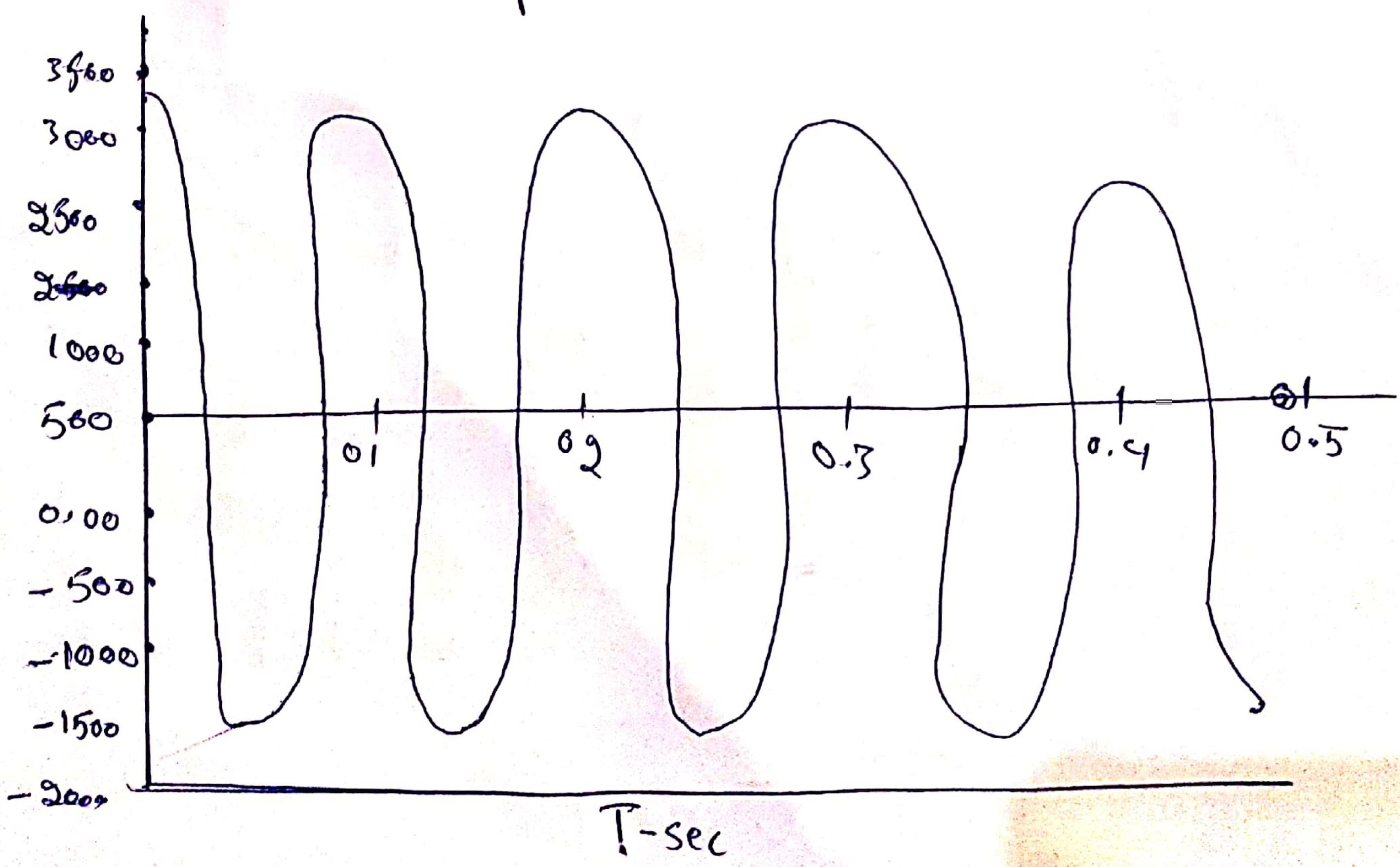
$$Ku_0 = 90625 \times \frac{1}{24} = 3776.041\ lb$$

(6)

# Undamped Free Vibration




# Undamped Free Vibration



Q. No (2):

Promblem:

Given data:

$E = 29000$ Ksi

$I = 150\ in^4$

$\delta_{st} = 7705$ lb

Take $\zeta_0 =$ ~~[illegible]~~ % 5 %

Sol:

EOM for damped free vibration

$$Ku + C\dot{u} + m\ddot{u} = 0 \longrightarrow (1)$$

It is known from promblem No. 4 that

$K = 96625 \, lb/ft$

$m = 239.28 \, lb \, sec^2/ft$

$C = \zeta_0 \times 2 m \omega_n$

$C = 0.05 \times 2(239.28)(19.46)$

$C = 0.05 \times 9312.7776$

$C = 465.638 \, lb.sec/ft$

By Subsituting values of K, C and m in eq (1)

~~96625u~~.

$Ku + Cu + mu = 0$

(9)

$$96625 + 465.638 + 239.28 = 0$$

Solution the EOM for damped free vibration is

$$u(t) = e^{-\zeta_0 \omega_n t}\left[u(0)(0)(\omega_D t + \frac{1}{\omega_D}\left[u(0)\zeta_0\omega_n\right].\sin(\omega_D t)\right)$$

$$\omega_D = \sqrt{\frac{K}{m}} = \sqrt{\frac{96625}{239.28}}$$

$$\omega_D = 19.46 \text{ rad/sec}$$

$$u(t) = e^{-0.05\times19.46t}\left[\frac{1}{24}\times\cos(19.46) + \frac{1}{19.46}\times\left[0+\frac{1}{24}\times0.05\times19.46\right)\times\sin(19.46t)\right]$$

$$u(t) = e^{-0.9725}\left[0.0416\times\cos(19.46t) + 0.0513\times0.0416\times0.973\times\sin(19.46t)\right)$$

$$u(t) = e^{-0.9725}\left[0.0416\times\cos(19.46t) + 0.00207\sin(19.46t)\right)$$

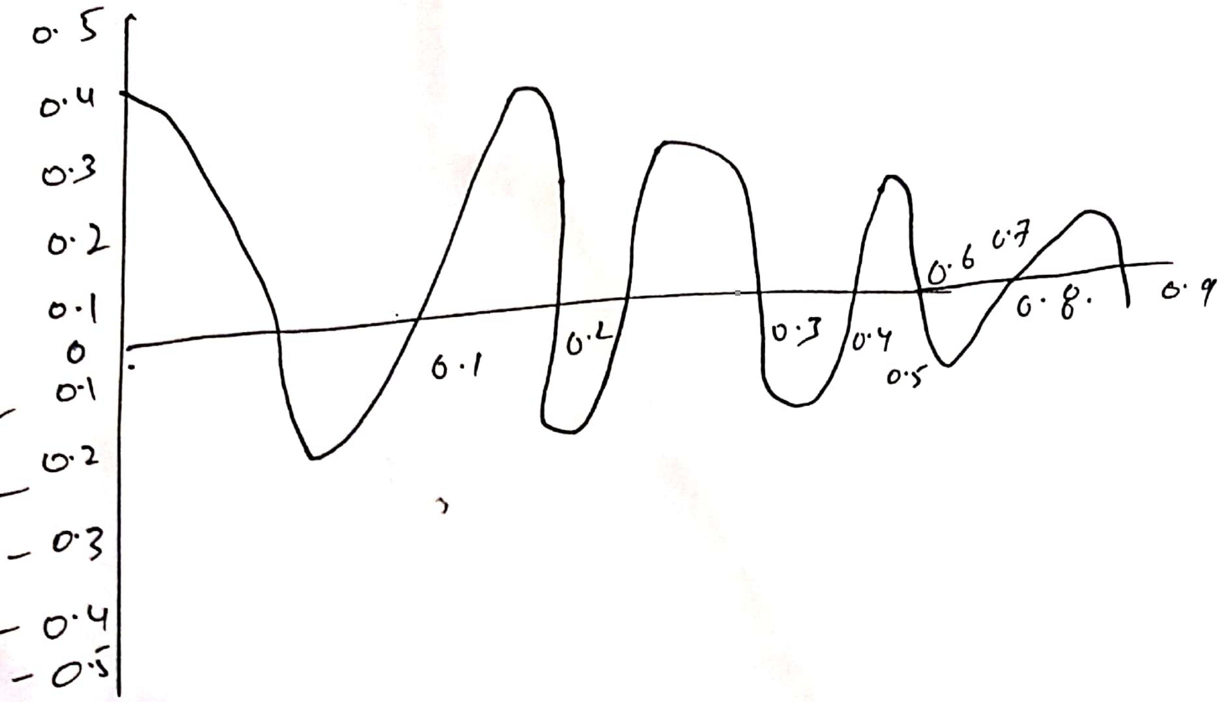
10

$$f_s(t) = K \cdot u(t) = 90625 \times u(t)$$

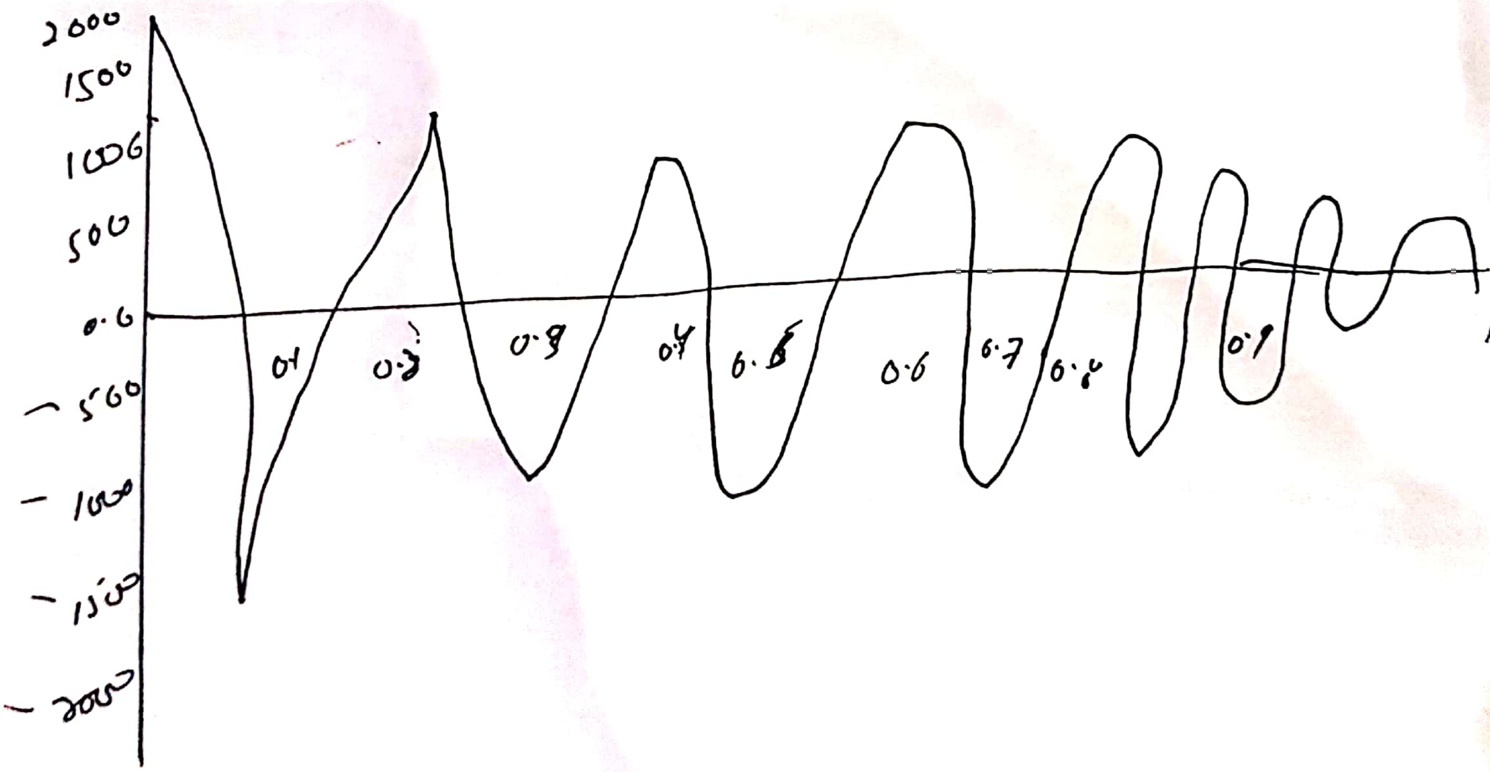
$$f_s(t) = e^{-0.9725}[3776 \cos(19.46) + 94.34 - \sin(19.46)$$

(10) (11)

Damped Free vibration




Damped Free vibration



(15) (15) (12)

Q.3

Sol:. Given data

Force = 60 Kips

$u_1 = \frac{7705}{1000} = 7.705$

After, j = 7 (cycles)

Completed = 3.57 sec

$u_{j+1} = 2.286\,cm = 0.9\,in$

Ignore the verticle vibratvon

Required

(a) Damping ratios

(b) Natural period of undamped vibration

(c) Stiffness of structures

(8) (12) (13)

(d) weight of tank

(e) Damping co-efficient

(f) Number of cycles for to reduce the displacement amplitude to 0.5"

(14)

Solution

'a $\xi$ = Damping ratio = ?

As

$$j = \frac{1}{2\pi \xi} \ln \left[ \frac{u_1}{u_{j+1}} \right]$$

By putting values:

$$7 = \frac{1}{2(3.14)\xi} \ln \left[ \frac{7.705}{0.9} \right]$$

$$\xi (7 \times 2 \times 3.14) = 2.147$$

$$\xi (43.96) = 2.147$$

$$\xi = 2.147/43.96$$

$$= 0.0488$$

$$\xi = 4.88\%$$

(16) (15)

"b" $T_n = ?$

As "Seven cycles are completed in "3.57" Sec

Thus Time required to Complete one cycle $= 7/3.57 = 1.96 sec$

$T_D = 1.96 sec$

Now

$$\omega_D = \omega_n \sqrt{(1-\zeta^2)}$$

$$\Rightarrow 2\pi/\omega_D = 2\pi/\omega_n (\sqrt{1-\zeta^2})$$

As

$$T_D = T_n/\sqrt{1-\zeta^2}$$

$$\Rightarrow T_n = T_D (\sqrt{1-\zeta^2})$$

(15) (16)

$$= 1.96\left(\sqrt{1-(0.0488)^2}\right)$$

$T_n = 1.957\ \text{sec}$ "Natural of undamped vibration"

(15) (17)

"c" Stiffness of Structure "K = ?"

As;

$$K = \frac{F.\cos Q}{2}$$

F = 60 Kips
Q = 60°

$$K = \frac{60.\cos(60°)}{2}$$

$$= 15\ K/in$$

$$K = 1800\ lb/ft$$

"d" Weight of Tank W = ?

As

$$\omega n = \sqrt{K/m} = \sqrt{K/(W/g)} = \sqrt{K.g/W}$$

$$\Rightarrow \omega n^2 = K.g/W \Rightarrow (W = K.g/\omega n^2)$$

By putting values of $\omega n = 2\pi/Tn$

(13) (13)

$$W = K \cdot g / (4\pi^2 / T_n^2) = Kg\left(\frac{T_n^2}{4\pi^2}\right)$$

$$W = \frac{18000\,lb}{ft} \cdot \frac{32.2\,ft}{Sec^2} \left(\frac{(1.957)^2}{4(3.14)^2}\right)$$

$$W = 56284.75\,lb = 56.284\,K\,lb$$

(11) (19)

"e Damping Co-efficient "G?"

It is Know that $G = \frac{C}{2 m \omega_n}$

$= C = G \cdot (2 m \omega_n) = G(2m(2\pi / T_N))$

By putting values

$$C = \frac{0.0462 \left(2\left(\frac{56284}{32.2}\right)\right)\left(2(3.14)\right)}{1.957}$$

$C = 518.286$ lb.sec/ft

(15) (20)

"f" No of Cycles to reduce displacement altitude from 6.872 into 0.5in"

1

$J = ?$

$$j = \frac{1}{2\pi G} \ln\left(\frac{u_1}{u_{j+1}}\right)$$

~~$= \frac{1}{2\pi}$~~

~~$= \frac{1}{2(3.14)(0.488)}$~~

$$= \frac{1}{2(3.14)(0.0488)} \ln\left[\frac{7.705}{0.9}\right]$$

$= 7.066$ OR

$j = 7$ Cycles