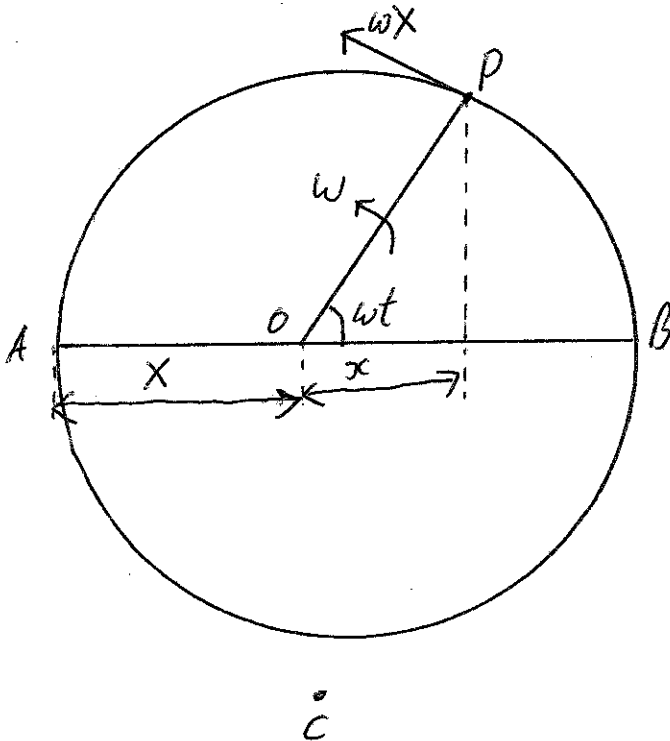


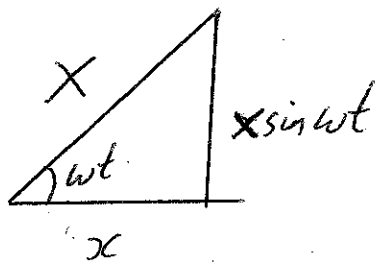
**EXAMINATION SOLUTIONS: SESSION 2001/12**

School:	LOGISTICS & MANUFACTURING ENGINEERING		
Programme:		Year:	
Module/Unit:	STRESS ANALYSIS & DYNAMICS		
Author:	KELVIN LAKE	Page:	1 of 17

Question No	Question	Marks
①	 DISTANCE x: $x = X \cos \omega t$ $\therefore$ <u>VELOCITY $v = \omega X \sin \omega t$</u> ①	1½

Continuation Sheet

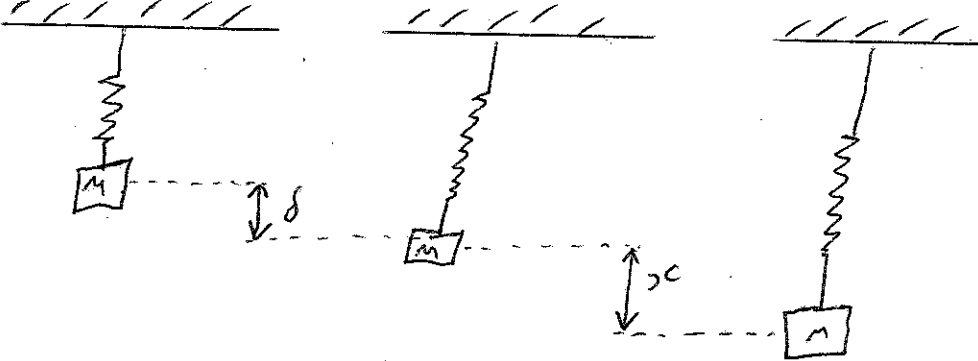
Module/Unit:	STRESS ANALYSIS & DYNAMICS	Page:	2 of 17
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Question No	Question	Marks
	 $(x \sin \omega t)^2 + x^2 = X^2$ $\underline{x \sin \omega t = \sqrt{X^2 - x^2}} \quad (2)$ COMBINING ① & ② $v = \omega X \sin \omega t$ $\underline{\underline{v = \omega \sqrt{X^2 - x^2}}}$ v IS MAX WHEN $x=0$, i.e. WHEN p PASSES O.	$1\frac{1}{2}$ 2

Continuation Sheet

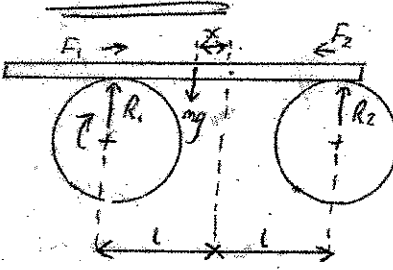
Module/Unit: STRBS ANALYSIS & DYNAMICS

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Question No	Question	Marks
16	 - IN EQUILIBRIUM $mg = K\delta$ - WHEN OSCILLATING RESTORING FORCE $F = Kx$ - NEWTON'S 2ND LAW $\therefore F = ma$ $\therefore Kx = ma$ $\therefore \underline{\underline{\frac{a}{x} = \frac{K}{m}}}$	

Continuation Sheet

Module/Unit:	STATICS ANALYSIS & DYNAMICS	Page:	4 of 17
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Question No	Question	Marks
	<u>Given</u> $f = \frac{1}{T} = \frac{1}{2\pi} \omega$ <u>Also</u> $a = \omega^2 x \therefore \omega = \sqrt{\frac{a}{x}}$ $\therefore f = \frac{1}{2\pi} \sqrt{\frac{a}{x}}$ $\therefore$ FROM * $f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$  TAKING MOMENTS ABOUT R_2 $mg(l+x) = R_1 \times 2l$ $\therefore R_1 = \frac{mg}{2l} (l+x)$ TAKING MOMENTS ABOUT R_1 $mg(l-x) = R_2 \times 2l$ $\therefore R_2 = \frac{mg}{2l} (l-x)$	① ① ② ②

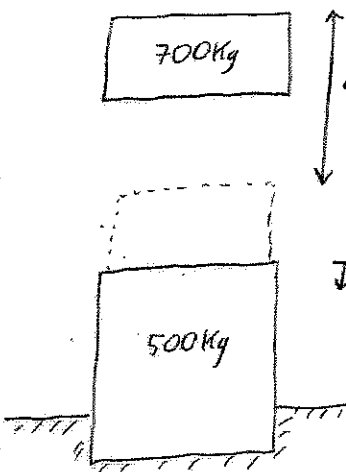
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Question No	Question	Marks
	$F_1 = \mu R_1$ $= \frac{\mu mg}{2l} (l+x)$ $F_2 = \mu R_2$ $= \frac{\mu mg}{2l} (l-x)$ $\therefore \text{RESULTANT FORCE } F = F_1 - F_2$ $= \frac{\mu mg}{2l} (l+x) - \frac{\mu mg}{2l} (l-x)$ $= \frac{\mu mg}{2l} (l+x - (l-x))$ $F = \frac{\mu mgx}{l}$ $F = ma \quad \therefore a = \frac{F}{m} = \frac{\mu gx}{l}$ $T = \frac{1}{f} = \frac{2\pi}{\omega} = 2\pi x \frac{1}{\omega}$ $\text{SINCE } a = \omega^2 x, \quad \omega = \sqrt{\frac{a}{x}}$ $\therefore T = 2\pi \sqrt{\frac{\text{DISPLACEMENT}}{\text{ACCELERATION}}}$ $= 2\pi \sqrt{\frac{x}{\mu gx}}$ $\therefore T = 2\pi \sqrt{\frac{l}{\mu g}}$	(2) (2) (2)

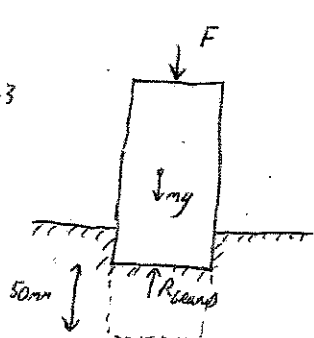
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Question No	Question	Marks
2a	 $v = \text{VELOCITY OF DIVER IMMEDIATELY BEFORE IMPACT}$ $v^2 = u^2 + 2as$ $= 0^2 + 2 \times 9.81 \times 0.2$ $= 3.924$ $\therefore v = \underline{\underline{1.98 \text{ m/s}}}$ $u = \text{COMMON VELOCITY IMMEDIATELY AFTER IMPACT}$ CONSERVATION OF MOMENTUM $m_o v_o + m_p v_p = m_o u_o + m_p u_p$ $700 \times 1.98 + 500 \times 0 = 700 u_o + 500 u_p$ $1386 = 1200 u_o \quad (\text{SINCE } u_o = u_p)$ $\therefore u_o = \underline{\underline{1.155 \text{ m/s}}}$	(1) (2)

Continuation Sheet

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Question No	Question	Marks
i	BEFORE IMPACT $K.E. = \frac{1}{2} M_D V^2$ $= \frac{1}{2} \times 700 \times 1.98^2$ $= \underline{\underline{1372.1 J}}$ AFTER IMPACT $K.E. = K.E._{DAVER} + K.E._{MCE}$ $= \frac{1}{2} M_D u^2 + \frac{1}{2} M_P u^2$ $= \frac{1}{2} \times 700 \times 1.155^2 + \frac{1}{2} \times 500 \times 1.155^2$ $= \underline{\underline{800.4 J}}$ $\therefore \Delta K.E. = 1372.1 - 800.4 = \underline{\underline{571.7 J}}$	(1) (1) (1)
ii	LOSS DUE TO HEAT, NOISE, DISTORTION. IF REACTION IS CONSTANT THEN ACCELERATION MUST BE CONSTANT SINCE $F = ma$ $v^2 = u^2 + 2as$ $0 = 1.155^2 + 2a \times 50 \times 10^{-3}$ $\therefore a = \underline{\underline{-13.34 m/s^2}}$ 	(2)

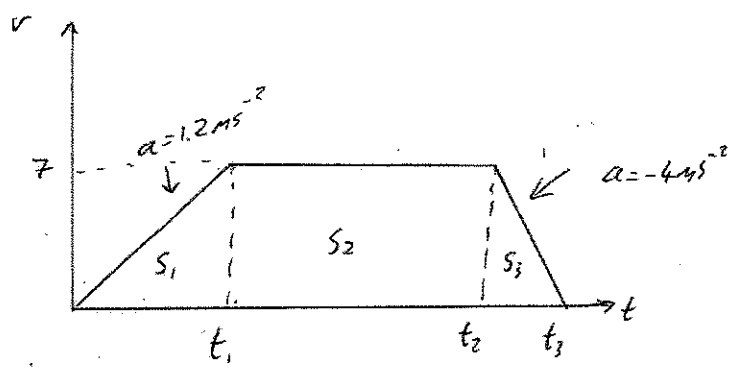
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Question No	Question	Marks
	now $R = F + mg$ $= (M_0 + M_p)a + (M_0 + M_p)g$ $= (700 + 500)13.34 + (700 + 500) \times 9.81$ $= 1200 \times 13.34 + 1200 \times 9.81$ $= \underline{\underline{27,780 \text{ N}}}$ RESISTANCE IS LIKELY TO CHANGE AS THE GROUND IS COMPACTED. b $m = 205 \text{ kg}$ $r = 0.45 \text{ m}$ RADIUS OF CYLINDER = 0.4 m 7 ms^{-1} $m = 1.5 \text{ kg/m}$ 300kg ACCELERATES AT 1.2 ms^{-2} DECELERATES AT 4 ms^{-2}	(2)

Continuation Sheet

Module/Unit:	STRESS ANALYSIS & DYNAMICS	Page:	9 of 17
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Question No	Question	Marks
	 $S_{TOTAL} = 80m$ <u>Average Acceleration</u> $u=0, v=7, a=1.2, t=?, s=?$ $v = u + at$ $v^2 = u^2 + 2as$ $\therefore t_1 = \frac{v-u}{a}$ $\therefore s = \frac{v^2 - u^2}{2a}$ $= \frac{7-0}{1.2}$ $= \frac{7^2 - 0^2}{2 \times 1.2}$ $= \underline{\underline{5.83s}}$ $= \underline{\underline{29.4m}}$ <u>Average Acceleration</u> $u=7, v=0, a=-4, t=?, s=?$ $t = \frac{v-u}{a}$ $s = \frac{v^2 - u^2}{2a}$ $= \frac{0-7}{-4}$ $= \frac{0^2 - 7^2}{2 \times -4}$ $= \underline{\underline{1.75s}}$ $= \underline{\underline{6.125m}}$	① ① ①

Continuation Sheet

Module/Unit:	ST083S ANALYSIS & DYNAMICS	Page:	10 of 17
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Question No	Question	Marks
	$S_{TOTAL} = S_1 + S_2 + S_3$ $80 = 29.4 + S_2 + 6.125$ $\therefore S_2 = \underline{44.5m}$ CONSTANT VELOCITY $v = \frac{d}{t} \therefore t = \frac{d}{v} = \frac{44.5}{7} = \underline{6.35s}$ $\therefore TOTAL TIME = 5.83 + 1.75 + 6.35$ $= \underline{13.9s}$	(2)
11	ROPE TENSION AT DRUM = $M_{TOT} \times a_{TOT}$ $= (M_{CAGE} + M_{ROPE}) \times (a + g)$ $= (300 + 80 \times 1.5) \times (1.2 + 9.81)$ $= \underline{4624.2N}$ TORQUE TO ACCELERATE CAGE + DRUM = 4624.2×0.45 $= \underline{2080.9Nm}$ HOWEVER TORQUE IS ALSO NEEDED TO ROTATE DRUM ITSELF $T_{DRUM} = I_{DRUM} \alpha_{DRUM}$ NOW $\alpha_{DRUM} = \frac{a}{r} = \frac{1.2}{0.45} = \underline{2.67 rad s^{-2}}$	(2)

Continuation Sheet

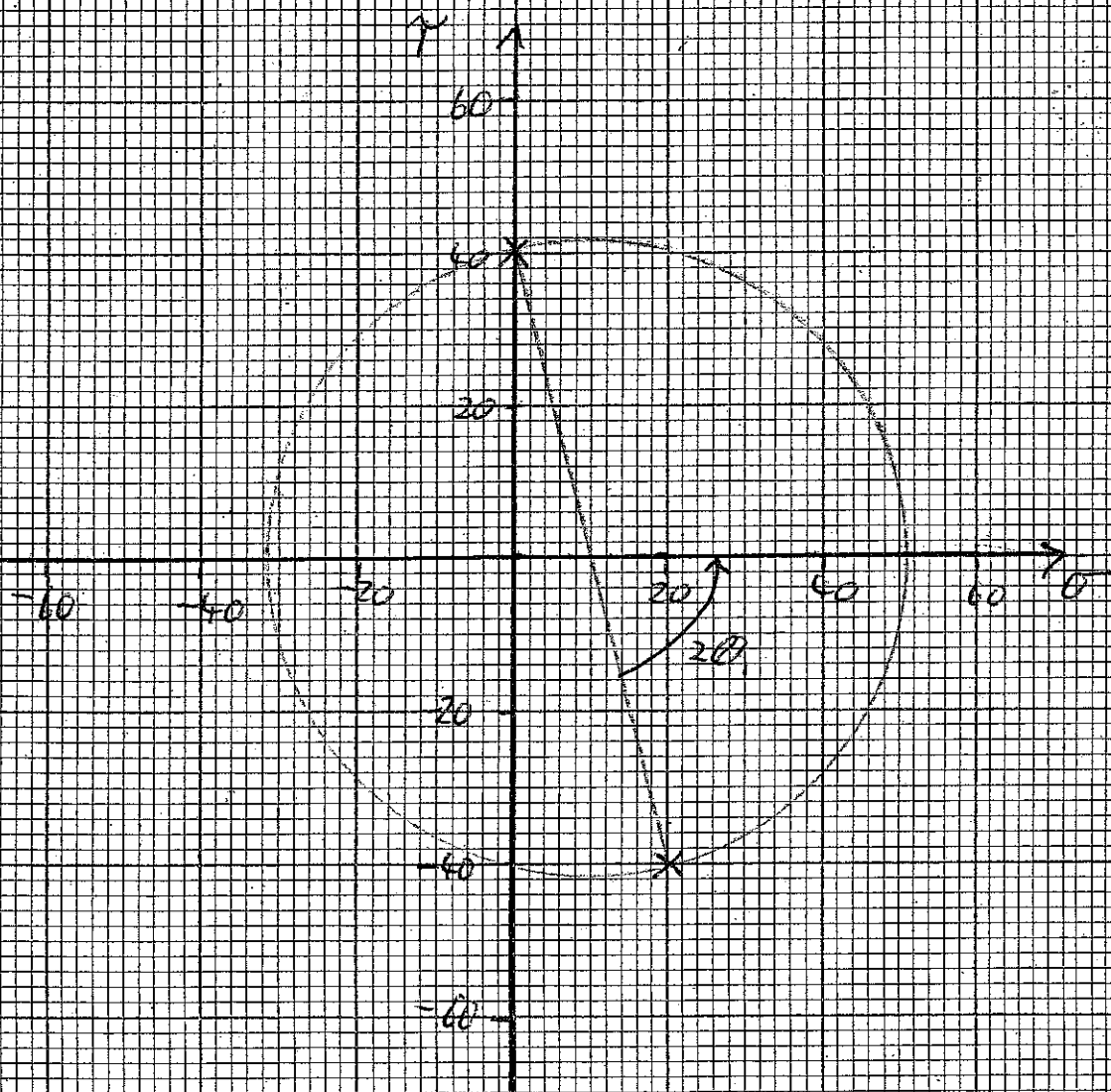
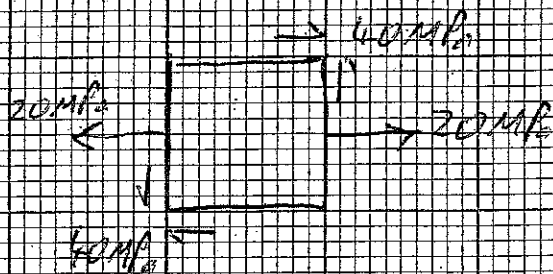
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Question No	Question	Marks
	$I_{\text{rod}} = m k^2$ $= 205 \times 0.4^2$ $= \underline{\underline{32.8 \text{ kgm}^2}}$ $\therefore T = I \alpha$ $= 32.8 \times 2.67$ $= \underline{\underline{87.6 \text{ Nm}}}$ $\therefore \text{TOTAL TORQUE} = 2080.9 + 87.6$ $= \underline{\underline{2168.5 \text{ Nm}}}$	(2) (1)

Continuation Sheet

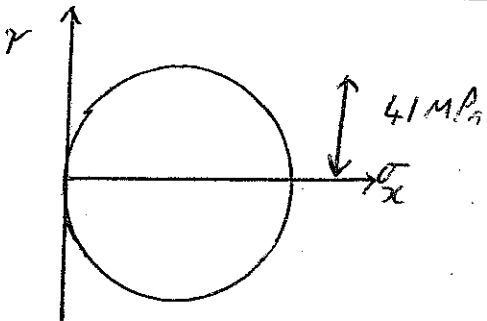
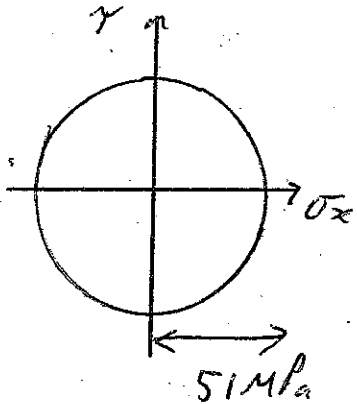
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Question No	Question	Marks
(3) (a)	A PRINCIPAL STRESS IS THE <u>MAX</u> OR <u>MIN</u> VALUE OF STRESS THAT A LOADED SECTION WILL SEE. THESE OCCUR ON PRINCIPAL PLANES	(3)
(b) (i)	SEE MOHR'S CIRCLE ON NEXT PAGE BY MEASUREMENT $\sigma_1 \approx 51 \text{ MPa}$ (TENSILE) $\sigma_2 \approx -32 \text{ MPa}$ (COMPRESSIVE)	(5) (1) (1)
(ii)	$2\theta_1 \approx 76^\circ$ $\therefore \theta_1 = 38^\circ$: MAX PRINCIPAL STRESS $\therefore \theta_2 = 38 + 90$ $= 128^\circ$ MIN PRINCIPAL STRESS	(1) (1)
(iii)	$\tau_{max} \approx 42 \text{ MPa}$ $\theta = 38^\circ + 45$ $= 83^\circ$	(1) (1)



Continuation Sheet

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Question No	Question	Marks
(iv)	σ_x ONLY $\therefore \sigma_y = 0$ $\tau_{xy} = 0$ $\tau_{max} = 41 \text{ MPa}$ RADIUS OF CIRCLE IS $41 \text{ MPa} \therefore \sigma_1 = \underline{\underline{82 \text{ MPa}}}$ 	(3)
(v)	$\sigma_x = 0$ $\sigma_y = 0$ $\sigma_1 = 51 \text{ MPa}$ RADIUS OF CIRCLE IS $51 \text{ MPa} \therefore \tau_{xy} = \underline{\underline{51 \text{ MPa}}}$ 	(3)

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Question No	Question	Marks
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(4a)

ACTUAL PROBLEM

INTEGRAL DYNAMIC U.D.L

FROM ACTUAL PROBLEM:

$$\sum M_C = 0 \therefore 8R_A = 120 \times 2 + (20 \times 4) \times 6$$

$$= 720$$

$$\therefore R_A = 90 \text{ kN}$$

(2)

(1)

Continuation Sheet

[illegible]

Continuation Sheet

Module/Unit:	STRESS ANALYSIS & DYNAMICS	Page:	17 of 17
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Question No.	Question	Marks
(4a) cont	SLOPE AT A (WHEN $x=0$) $\frac{dy}{dx} = \frac{1}{EI} \left[\frac{90x^2}{2} - \frac{20x^3}{6} + \frac{20(x-4)^3}{6} - \frac{120(x-6)^2}{2} - 540 \right]$ $\frac{dy}{dx} = \frac{-540}{EI}$	① ① ①
(4b)	SLOPE AT C (WHEN $x=8$) $\frac{dy}{dx} = \frac{1}{EI} \left[\frac{90 \times 8^2}{2} - \frac{20 \times 8^3}{6} + \frac{20 \times 4^3}{6} - \frac{120 \times 2^2}{2} - 540 \right]$ $= \frac{1}{EI} [2880 - 1706.7 + 213.3 - 240 - 540]$ $\frac{dy}{dx} = \frac{606.6}{EI}$	① ① ①
(4c)	DEFLECTION AT B (WHEN $x=4$) $y = \frac{1}{EI} \left[\frac{90x^3}{6} - \frac{20x^4}{24} + \frac{20(x-4)^4}{24} - \frac{120(x-6)^3}{6} - 540x \right]$ $\therefore y = \frac{1}{EI} \left[\frac{90 \times 4^3}{6} - \frac{20 \times 4^4}{24} - 540 \times 4 \right]$ $= \frac{1}{EI} [960 - 2133 - 2160]$ $y = \frac{-1413.3}{EI}$	① ① ①