



EXAMINATIONS 2012 / 2013 AHOLIADAU 2012 / 2013

Semester 2

FACULTY OF: Applied Design & Engineering

NAME OF COURSE/PROGRAMME:	BEng Manufacturing Systems Engineering BEng Mechanical & Manufacturing Engineering
YEAR OR LEVEL:	Year 2 – Part time Resit
NAME OF MODULE/UNIT/EXAM PAPER:	Stress Analysis and Dynamics
MODULE NO:	
DATE OF EXAMINATION:	??
EXAMINATION TIMES:	
START TIME:	?? pm
FINISH TIME:	?? pm
TIME ALLOWED:	2 hours

INSTRUCTIONS TO CANDIDATES:

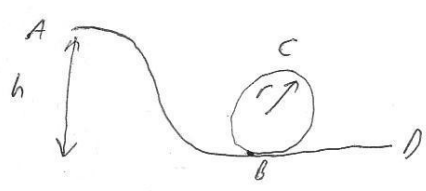
Answer 3 from 4 questions.

Assume acceleration due to gravity, $g = 9.81 \text{ ms}^{-2}$

Attach any graph paper used to your answer booklet

Continuation Sheet

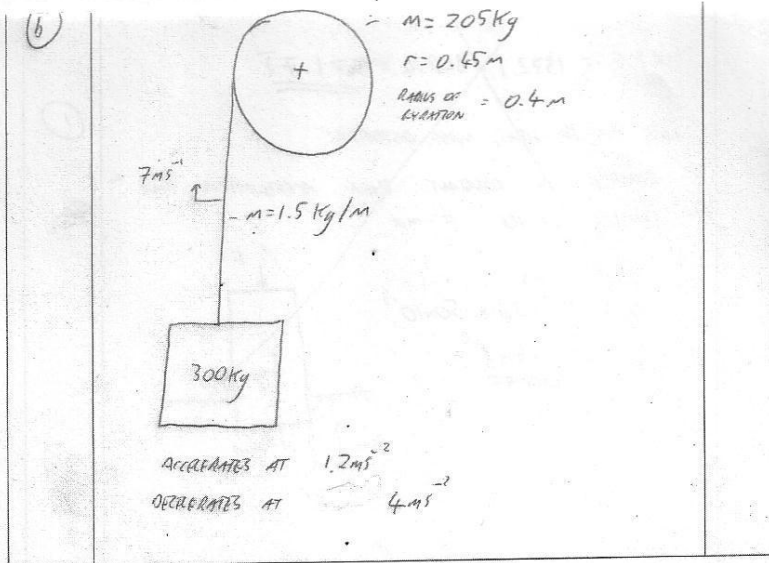
Module/Unit:	STRESS ANALYSIS & DYNAMICS	Page:	
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Question No	Question	Marks
1a	 A → C: LOSS OF P.E. = GAIN IN K.E. $mg(h-2r) = \frac{1}{2}mv^2$ $v^2 = 2g(h-2r) \quad *$ FOR THE CAR TO REMAIN IN CONTACT THE UPWARD CENTRIFUGAL FORCE MUST BE GREATER OR EQUAL TO THE WEIGHT $\frac{mv^2}{r} \geq mg$ ∴ FROM * $\frac{2mg(h-2r)}{r} \geq mg$ $2(h-2r) \geq r$ $2h-4r \geq r$ $2h \geq 5r$ $\therefore \underline{h \geq 2.5r}$	5

Continuation Sheet

Module/Unit: *STRESS ANALYSIS & DYNAMICS*

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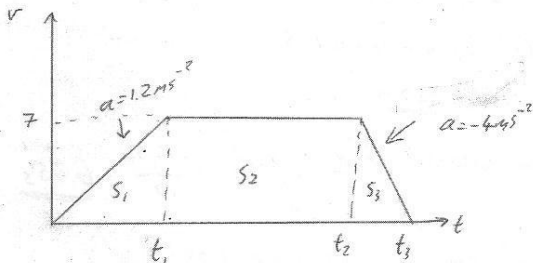


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Module/Unit:	STRESS ANALYSIS & DYNAMICS
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Question No	Question	Marks
(i)	 $S_{\text{TOTAL}} = 80\text{m}$ <u>PHASE 1 ACCELERATION</u> $u=0, v=7, a=1.2, t=?, s=?$ $v = u + at$ $v^2 = u^2 + 2as$ $t_1 = \frac{v-u}{a}$ $s = \frac{v^2 - u^2}{2a}$ $= \frac{7-0}{1.2}$ $= \frac{7^2 - 0^2}{2 \times 1.2}$ $= \underline{\underline{5.83\text{s}}}$ $= \underline{\underline{29.4\text{m}}}$ <u>PHASE 3 DECELERATION</u> $u=7, v=0, a=-4, t=?, s=?$ $t = \frac{v-u}{a}$ $s = \frac{v^2 - u^2}{2a}$ $= \frac{0-7}{-4}$ $= \frac{0^2 - 7^2}{2 \times -4}$ $= \underline{\underline{1.75\text{s}}}$ $= \underline{\underline{6.125\text{m}}}$	(1)

Continuation Sheet

Module/Unit: ST0435 ANALYSIS & DYNAMICS	Page:
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Question No	Question	Marks
(i)	$S_{TOTAL} = S_1 + S_2 + S_3$ $80 = 29.4 + S_2 + 6.125$ $\therefore S_2 = \underline{44.5m}$ 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)
(b) ii	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 $= \underline{2080.9Nm}$ HORIZONTAL TORQUE IS ALSO NEEDED TO ROTATE DRUM ITSELF $T_{DRUM} = I_{DRUM} \times \alpha_{DRUM}$ NOW $\alpha_{DRUM} = \frac{a}{r} = \frac{1.2}{0.45} = \underline{2.67 rad/s^2}$	(2)

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Module/Unit: STABS ANALYSIS & DYNAMICS

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Question No	Question	Marks
	$I_{\text{DRUM}} = m k^2$ $= 205 \times 0.4^2$ $= \underline{\underline{32.8 \text{ Kg m}^2}}$	(2)
	$\therefore T = I \alpha$ $= 32.8 \times 2.67$ $= \underline{\underline{87.6 \text{ Nm}}}$	(1)
	$\therefore \text{TOTAL TORQUE} = 2080.9 + 87.6$ $= \underline{\underline{2168.5 \text{ Nm}}}$	
(III)	ASSUMPTIONS: - THE MOTOR DRIVING THE DRUM CHANGES SPEED INSTANTLY - THERE IS ZERO FRICTION BETWEEN THE ROPE & THE DRUM - THERE IS ZERO AIR RESISTANCE ETC	(3)

Question 2

a. i.

If the velocity of a link in a mechanism can be established the acceleration can therefore be calculated and hence $F=ma$ can be used to evaluate the forces which would be exerted on the structure due to the motion of the machine.

[2 marks]

ii.

The following assumptions are made:

- Any points that are grounded do not move relative to each other – i.e. any part that the mechanism is attached to is infinitely rigid.
- Any velocity components are perpendicular to the links – i.e. the links are infinitely rigid.

[4 marks]

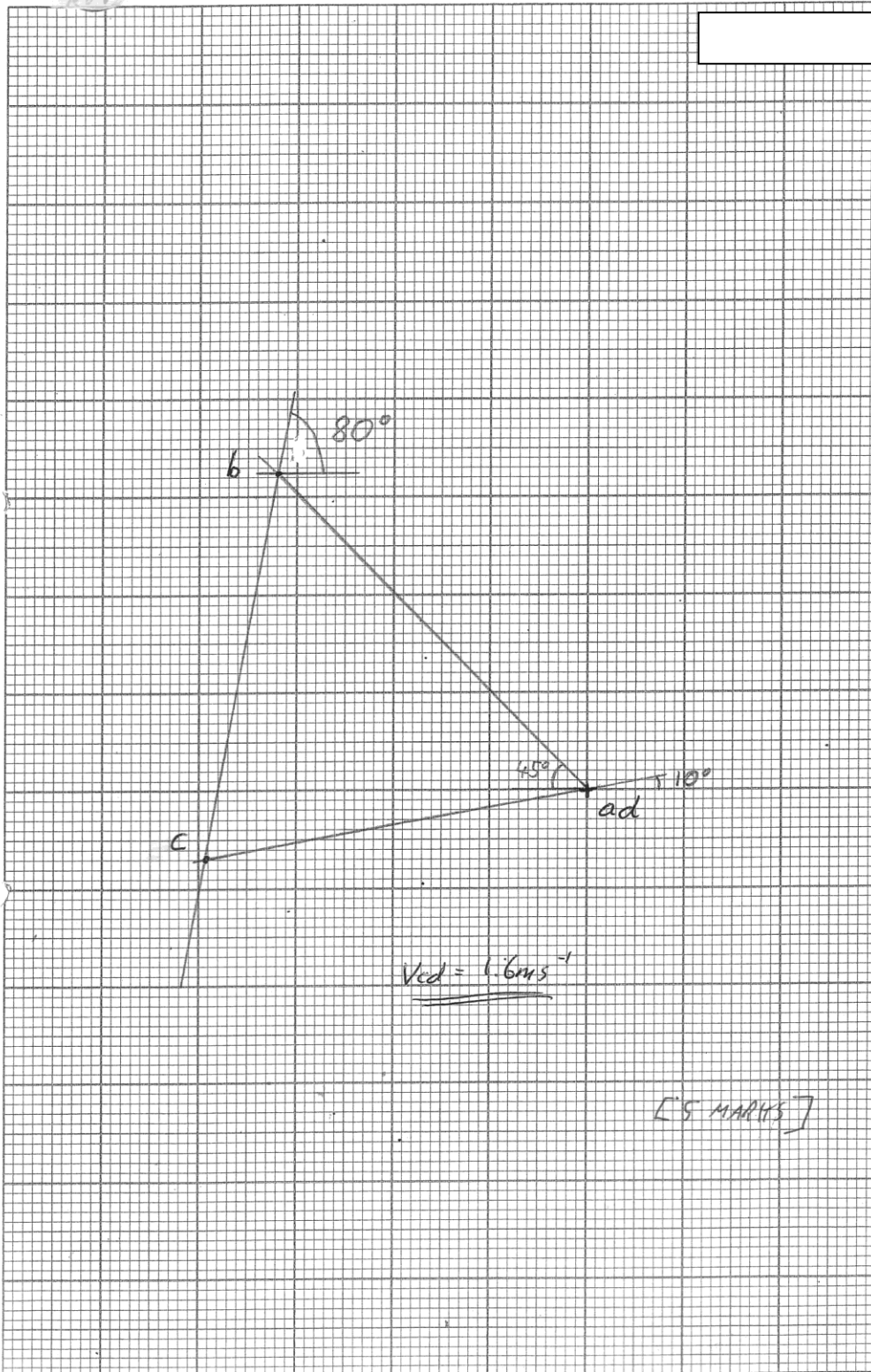


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Module/Unit:	STRBS ANALYSIS & DYNAMICS (CONT.)		
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Question No	Question	Marks
2b	POINTS A & D DO NOT MOVE RELATIVE TO EACH OTHER SO ARE REPRESENTED BY THE SAME POINT ad. • THE VELOCITY OF b RELATIVE TO a $V_{ba} = \omega_{AB} \times r_{AB}$ $= 70 \times \frac{2\pi}{60} \times 0.25 = 1.83 \text{ m/s}$ THIS ACTS <u>LT</u> TO THE LINK AB, i.e. AT 45° TO THE HORIZONTAL, HENCE $\vec{ab}$ CAN BE DRAWN • THE VELOCITY OF c RELATIVE TO b ACTS AT 90° TO BC i.e. 80° TO THE HORIZONTAL AND PASSES THROUGH b. ∴ VECTOR $\vec{cb}$ IS DRAWN OF INDEFINITE LENGTH. • THE VELOCITY OF c RELATIVE TO d ACTS AT 90° TO DC i.e. AT 10° TO THE HORIZONTAL AND PASSES THROUGH d. ∴ VECTOR $\vec{dc}$ IS DRAWN, FIXING c [DIAGRAM]	① ① ① ① ⑤

SCALE 1ms⁻¹ = 5cm



c.

The acceleration of one point on a link relative to another potentially has two components;

- A centripetal component – this is due to the angular velocity of the link.
- A tangential component – this is due to the angular acceleration of the link.

[4 marks]

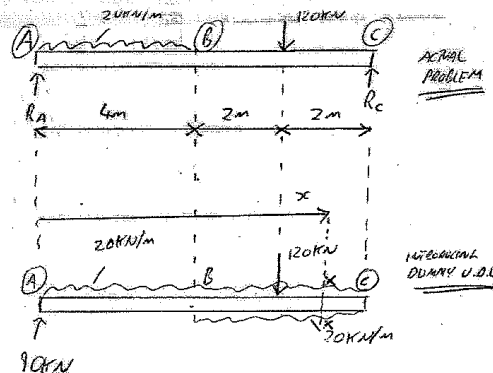
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Module/Unit: STRESS ANALYSIS & DYNAMICS

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Question No	Question	Marks
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3a



FROM ACTUAL PROBLEM:

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

$$= 720$$

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

(2)

(1)

Continuation Sheet

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[illegible]

Continuation Sheet

Module/Unit: STRESS ANALYSIS & DYNAMICS

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Question No	Question	Marks
3a	SLOPE AT A (WHEN $x=0$) $\frac{dy}{dx} = \frac{1}{EI} \left[\frac{90x^3}{2} - \frac{20x^3}{6} + \frac{20(x-4)^3}{6} - \frac{120(x-4)^2}{2} - 540 \right]$ $\frac{dy}{dx} = -540$ EI	① ① ①
3b	SLOPE AT C (WHEN $x=8$) $\frac{dy}{dx} = \frac{1}{EI} \left[\frac{90 \times 8^3}{2} - \frac{20 \times 8^3}{6} + \frac{20 \times 4^3}{6} - \frac{120 \times 2^2}{2} - 540 \right]$ $= \frac{1}{EI} [2880 - 1706.7 + 213.3 - 240 - 540]$ $\frac{dy}{dx} = 606.6$ EI	① ① ①
3c	DEFLECTION AT B (WHEN $x=4$) $y = \frac{1}{EI} \left[\frac{90x^4}{6} - \frac{20x^4}{24} + \frac{20(x-4)^4}{24} - \frac{120(x-4)^3}{6} - 540x \right]$ $\therefore y = \frac{1}{EI} \left[\frac{90 \times 4^4}{6} - \frac{20 \times 4^4}{24} - 540 \times 4 \right]$ $= \frac{1}{EI} [960 - 213.3 - 2160]$ $y = -1413.3$ EI	① ① ①

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Continuation Sheet

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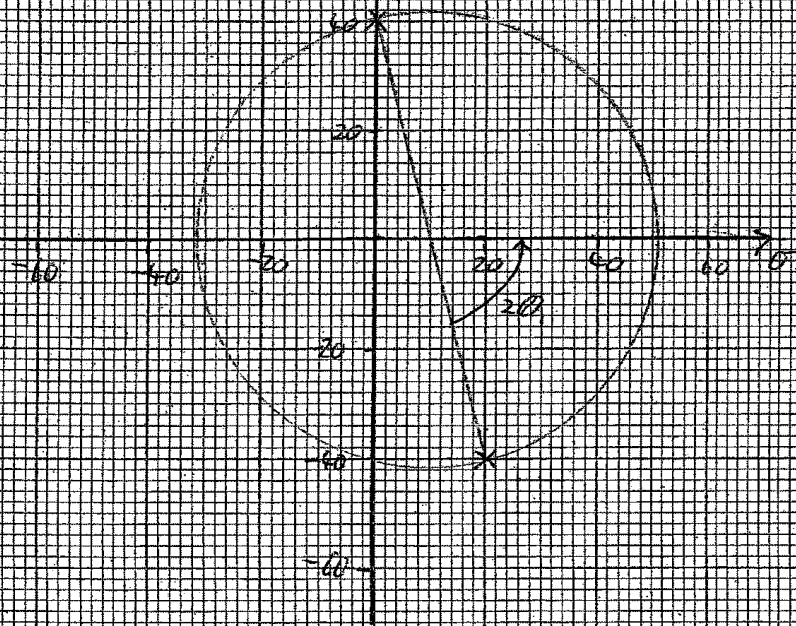
Question No	Question	Marks
3a	A PRINCIPAL STRESS IS THE <u>MAX</u> OR <u>MIN</u> VALUE OF STRESS THAT A LOADED SECTION WILL SEE. THESE OCCUR ON PRINCIPAL PLANES (b) i SEE MOHR'S CIRCLE ON NEXT PAGE BY MEASUREMENT $\sigma_1 \approx 51 \text{ MPa}$ (TENSILE) $\sigma_2 \approx -32 \text{ MPa}$ (COMPRESSIVE)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

CONTINUATION SHEET

836 ANALYSIS & DYNAMICS

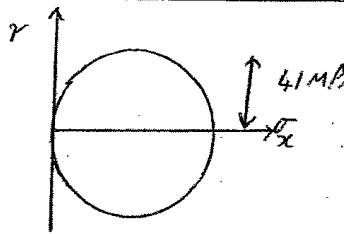
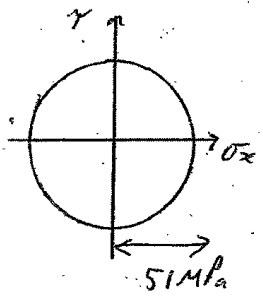


γ 60°



Continuation Sheet

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Question No	Question	Marks
(14)	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)
(15)	$\sigma_x = 0$ $\sigma_y = 0$ $\sigma_1 = 51 \text{ MPa}$  RADIUS OF CIRCLE IS $51 \text{ MPa} \therefore \tau_{xy} = \underline{\underline{51 \text{ MPa}}}$	(3)

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