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SWANSEA - ABERTAWE

Faculty of Applied Design
and Engineering

EXAMINATION SOLUTIONS: SESSION 2015/2016

School:	LOGISTICS & MANUFACTURING ENGINEERING		
Programme:	BENG MANUFACTURING SYSTEMS ENG.	Year:	2
Module/Unit:	CAE and Stress Analysis		
Author:	Kelvin lake/Rob Goodson	Page:	1 of 16

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Question No	Question	Marks
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4a

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

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Question No.	Question	Marks
(4.9) cont	$M_{xx} = 90x - 20x \cdot \frac{x}{2} + \frac{20(x-4)(x-4)}{2} - 120(x-6)$ $EI \frac{d^2 y}{dx^2} = 90x - \frac{20x^2}{2} + \frac{20(x-4)^2}{2} - 120(x-6)$ $\frac{dy^2}{dx^2} = \frac{1}{EI} \left[90x - \frac{20x^2}{2} + \frac{20(x-4)^2}{2} - 120(x-6) \right]$ $\frac{dy}{dx} = \frac{1}{EI} \left[\frac{90x^2}{2} - \frac{20x^3}{6} + \frac{20(x-4)^3}{6} - \frac{120(x-6)^2}{2} + A \right] \textcircled{1}$ $y = \frac{1}{EI} \left[\frac{90x^3}{6} - \frac{20x^4}{24} + \frac{20(x-4)^4}{24} - \frac{120(x-6)^3}{6} + Ax + B \right] \textcircled{2}$ BOUNDARY CONDITIONS: FROM $\textcircled{2}$: WHEN $x=0$ $y=0 \therefore B=0$ WHEN $x=8$ $y=0$ $\therefore$ FROM $\textcircled{2}$ $0 = \frac{1}{EI} \left[\frac{90 \cdot 8^3}{6} - \frac{20 \cdot 8^4}{24} + \frac{20 \cdot 8^4}{24} - \frac{120 \cdot 8^3}{6} + 8A \right]$ $= 7680 - 3413.3 + 213.3 - 160 + 8A$ $\therefore A = \underline{\underline{-540}}$ $\therefore$ SLOPE: $\frac{dy}{dx} = \frac{1}{EI} \left[\frac{90x^2}{2} - \frac{20x^3}{6} + \frac{20(x-4)^3}{6} - \frac{120(x-6)^2}{2} - 540 \right] \textcircled{3}$ DEFLECTION $y = \frac{1}{EI} \left[\frac{90x^3}{6} - \frac{20x^4}{24} + \frac{20(x-4)^4}{24} - \frac{120(x-6)^3}{6} - 540x \right] \textcircled{4}$	① ① ① ① ① ① ① ① ① ① ①

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Question No	Question	Marks
4a 100%	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 $x=4$) $y = \frac{1}{EI} \left[\frac{90x^3}{6} - \frac{20x^4}{24} + \frac{20(x-4)^4}{24} - \frac{120(x-6)^3}{6} - 540x \right]$ $\therefore y = \frac{1}{EI} \left[\frac{90 \times 4^3}{6} - \frac{20 \times 4^4}{24} - 540 \times 4 \right]$ $= \frac{1}{EI} [960 - 213.3 - 2160]$ $y = \frac{-1413.3}{EI}$	① ① ①

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Module/Unit	STRESS ANALYSIS & DYNAMICS	Page: 11 of 16
Question No.	Question	Marks
(3) (4)	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)	$2\theta \approx 76^\circ$ $\therefore \theta_1 = 38^\circ$: 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)

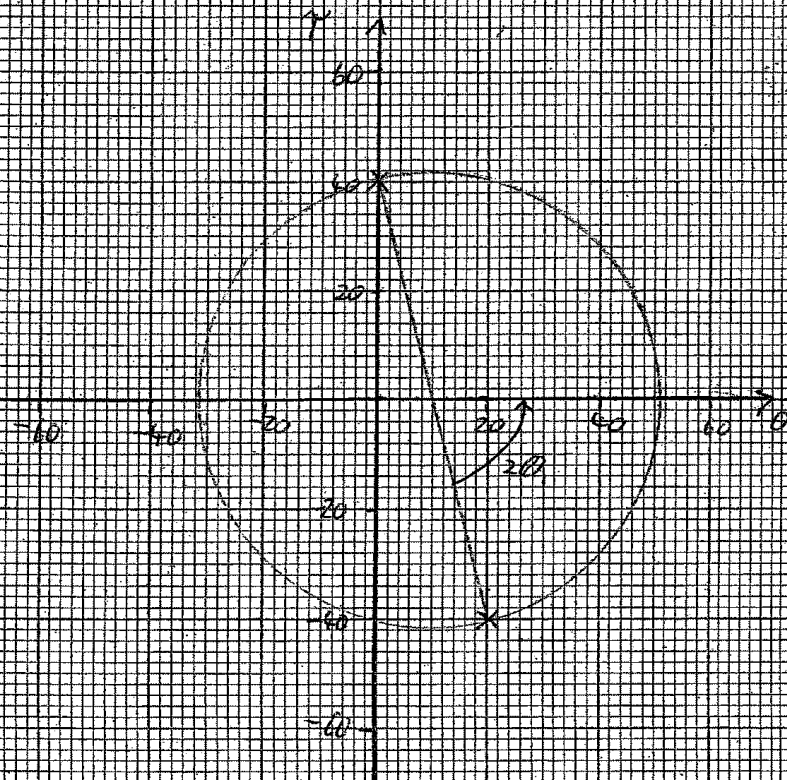
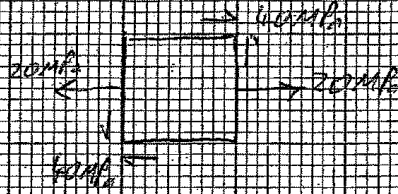
CONTINUATION SHEET

STRESS ANALYSIS

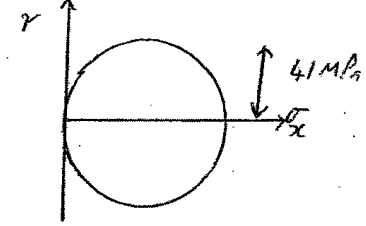
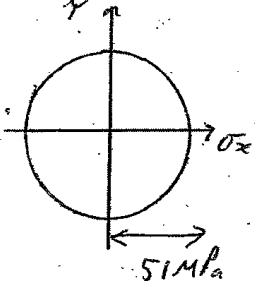
DYNAMICS

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Question No.	Question	Marks
(iv)	σ_x ONLY $\therefore \sigma_y = 0$ $\tau_{xy} = 0$ $\tau_{max} = 4 \text{ MPa}$ RADIUS OF CIRCLE IS $4 \text{ MPa} \therefore \sigma_1 = \underline{\underline{82 \text{ MPa}}}$ 	(3)
(v)	$\sigma_x = 0$ $\sigma_y = 0$ $\sigma_1 = 5 \text{ MPa}$  RADIUS OF CIRCLE IS $5 \text{ MPa} \therefore \tau_{xy} = \underline{\underline{5 \text{ MPa}}}$	(3)

1/20