



EXAMINATIONS 2010/2011 Semester 2

ARHOLIADAU 2010/2011

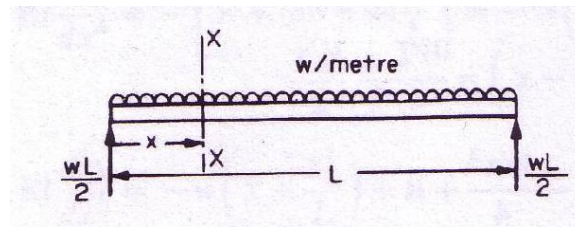
FACULTY OF: APPLIED DESIGN & ENGINEERING

NAME OF COURSE/PROGRAMME:	BEng Manufacturing Systems Engineering BEng Motorsport Manufacturing Engineering
YEAR OR LEVEL:	Year 2
NAME OF MODULE/UNIT/EXAM PAPER:	Stress Analysis & Dynamics – RESIT (FULL TIME)
MODULE NO:	M2X7195
DATE OF EXAMINATION:	5 th September 2011
EXAMINATION TIMES:	
START TIME:	9 am
FINISH TIME:	11 am
TIME ALLOWED:	2 hours

INSTRUCTIONS TO CANDIDATES:

Answer 3 from 4 questions
Assume $g = 9.81\text{ms}^{-2}$ in all calculations
Make sure you attach any graph paper to your answer booklet

Question 1



- a) Given the above diagram, and using the relationship, $M = EI \frac{d^2y}{dx^2}$, show that the deflection, y , at any point on the beam is given by;

$$y = \frac{1}{EI} \left[\frac{WLx^3}{12} - \frac{Wx^4}{24} - \frac{WL^3x}{24} \right]$$

[10 marks]

b)

i)

A 5m long simply supported beam carries a uniformly distributed load of 0.2 kN/m. What is the minimum flexural stiffness required to limit the central deflection to 2mm neglecting the weight of the beam?

[5 marks]

ii)

If the beam were to be made out of Aluminium ($E=69\text{GPa}$) what would the minimum second moment of area be?

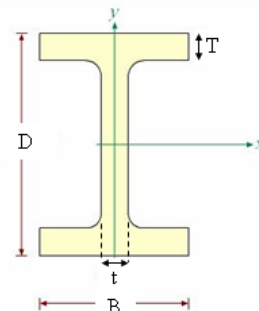
[1 mark]

iii)

Hence choose the lightest suitable beam from the below table assuming the beam is loaded about the x axis. What would the weight of this beam be over the length required?

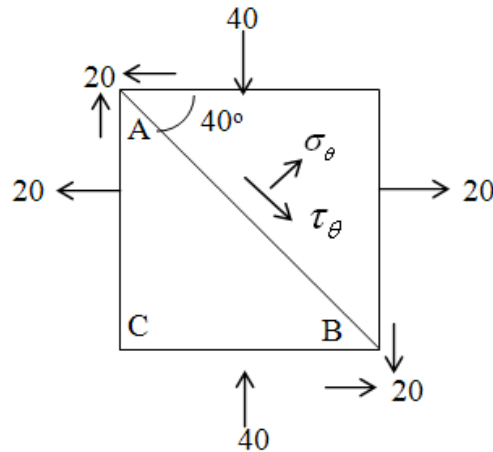
[4 marks]

Size D x B (mm)	Mass per metre (kg)	Thickness		I_{xx} (cm^4)	I_{yy} (cm^4)
		Web, t (mm)	Flange, T (mm)		
910.3 x 304.1	222	15.9	23.9	375924	11223
840.7 x 292.4	194	14.7	21.7	279450	9069
762 x 266.7	173	14.3	21.6	205177	6846
677.9 x 253.0	125	11.7	16.2	118003	4379
617.5 x 307.0	113	14.1	23.6	151631	11412
533.1 x 209.3	92	10.2	15.6	55353	2392
467.4 x 192.8	98	11.4	19.6	45717	2343
457.2 x 151.9	67	9.1	15	28577	878
402.3 x 142.4	46	6.9	11.2	15647	539
364 x 173.2	67	9.1	15.7	19522	1362
352.8 x 126.0	39	6.5	10.7	10087	357
310.9 x 166.8	54	7.7	13.7	11710	1061
312.7 x 102.4	33	6.6	10.8	6487	193
254 x 101.6	22	5.8	6.8	2867	120
203.2 x 133.4	25	5.8	7.8	2356	310



Question 2

- a. Consider the stressed element shown below. Determine what the normal and shear stresses on plane AB are using analytical methods.



All
stresses
are in
 MN/m^2

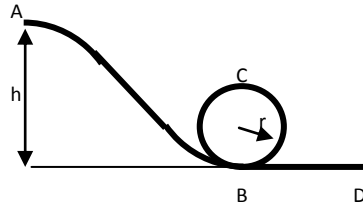
[5 Marks]

- b. What is the maximum principal stress on the above element?
[2 Marks]
- c. What is the maximum shear stress on the above element?
[2 Marks]
- d. Confirm your answers to a-c above using graphical methods on the graph paper attached to this exam paper. Make sure to mark clearly on the diagram any measurements that you take.
[8 Marks]
- e. Using graphical methods, at what angle when measured anti-clockwise from plane BC is the maximum principal plane ?
[2 Marks]
- f. Comment on the results from a-c when compared to those obtained in d.
[1 Marks]

(Make sure you attach any graph paper to your answer booklet)

Question 3

- a. A roller coaster, shown below, consists of a sloping section AB, a circular loop-the-loop section BC of radius r , and a straight horizontal section BD;



- i. By considering the transfer of energy, determine the least height, in terms of r , of A above B, from which the car can start from rest without falling off of the track at C.
[5 marks]
- ii. Briefly discuss the assumptions that you have made in your answer to part (i)
[2 marks]
- b. A winding drum raises a cage of mass 300kg through a height of 80m. The winding drum has a mass of 205kg, a radius of 0.45m and a radius of gyration of 0.4m. The mass of the rope is 1.5kg/m. The cage has at first an acceleration of 1.2ms^{-2} until a velocity of 7ms^{-1} is reached, after which the velocity is constant until the cage nears the top, then the final retardation is 4ms^{-2} . Find;
- i. The time taken for the cage to reach the top
[5 Marks]
- ii. The starting torque on the drum
[5 Marks]
- ii. Briefly discuss the assumptions that you have made in your answers to part (i) and (ii)
[3 marks]

Question 4

The diagram below shows a quick-return mechanism in which the driving crank OA rotates at 120 rev/min in a clockwise direction. Attached to this exam paper is a scale drawing of this mechanism.

a)

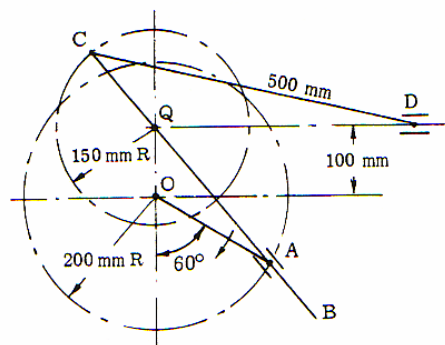
Using the graph paper attached which has point 'oq' marked on it, and a scale of 1m/s equal to 4cm, draw the velocity diagram for this mechanism in the position shown, and hence find the velocity of the block, A relative to its current position on the link A'.

[8 marks]

b)

Using the velocity diagram that you have generated, draw the acceleration diagram and hence find resultant velocity of D relative to O.

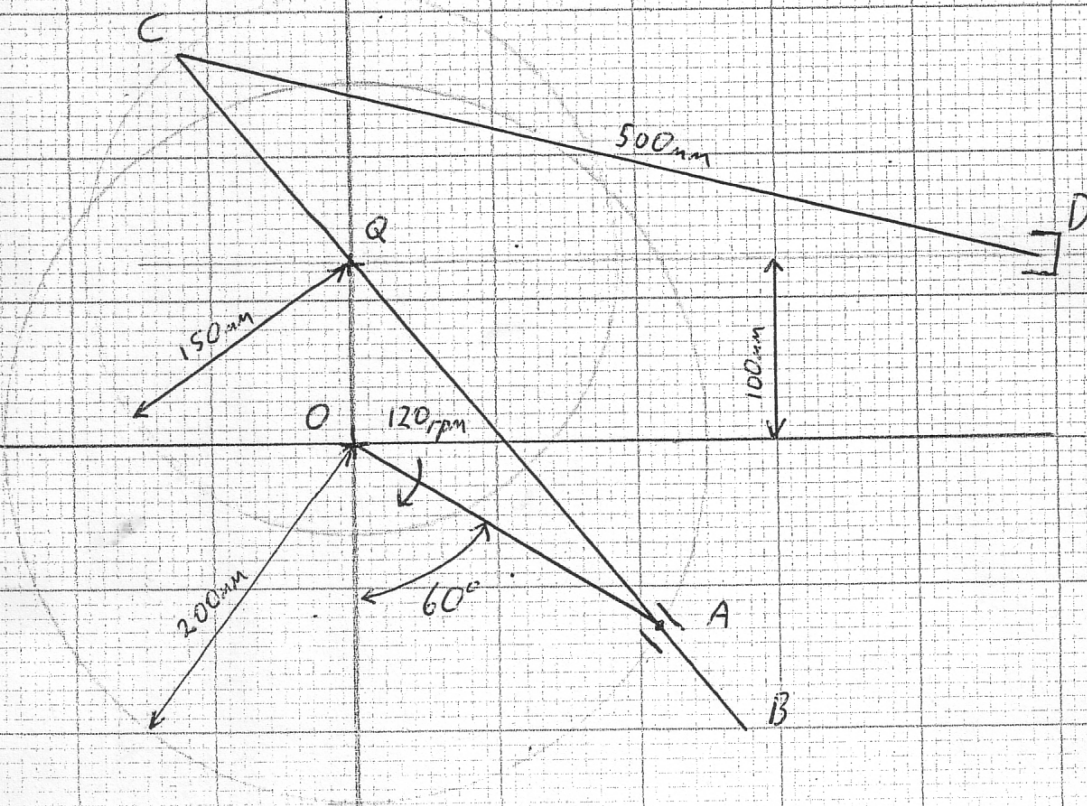
[12 marks]



Graph Paper for question 2 d

DIAGRAM OF QUICK RETURN MECHANISM FOR
QUESTION (4).

(SCALE = 4:1)



GRAPH PAPER FOR QUESTION (4)(a)

SCALE : $1\text{ m/s} = 4\text{ cm}$

09

+

GRAPH PAPER FOR QUESTION ④⑥

SCALE : $3ms^{-2} = 1cm$

09

Formula Sheet

Assume $g = 9.81\text{ms}^{-2}$ in all calculations

Complex Stress

$$\sigma_{\theta} = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y)\cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\tau_{\theta} = \frac{1}{2}(\sigma_x - \sigma_y)\sin 2\theta - \tau_{xy} \cos 2\theta$$

$$\sigma_{1,2} = \frac{1}{2}\left[(\sigma_x + \sigma_y) \pm \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}\right]$$

$$\tau_{\max} = \frac{1}{2}\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}$$

Slope and deflection of beam theory;

$$EI \frac{d^2 y}{dx^2} = M \quad \text{Bending moment.}$$

$$Q = EI \frac{d^3 y}{dx^3} \quad \text{Shear Force}$$

$$w = EI \frac{d^4 y}{dx^4} \quad \text{Load}$$

Dynamics

Assume $g = 9.81\text{ms}^{-2}$ in all calculations

$$\text{Centripetal Force} = \frac{mv^2}{r}$$

Momentum = Mass x Velocity

Force = Mass x Acceleration

$$T = I\alpha$$

$$I = mk^2$$

$$\text{Kinetic Energy} = \frac{1}{2}mv^2$$

Linear acceleration

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$