



EXAMINATION SOLUTIONS: SESSION 2001/2

School:	LOGISTICS & MANUFACTURING ENGINEERING		
Programme:		Year:	
Module/Unit:	STRESS ANALYSIS & DYNAMICS		
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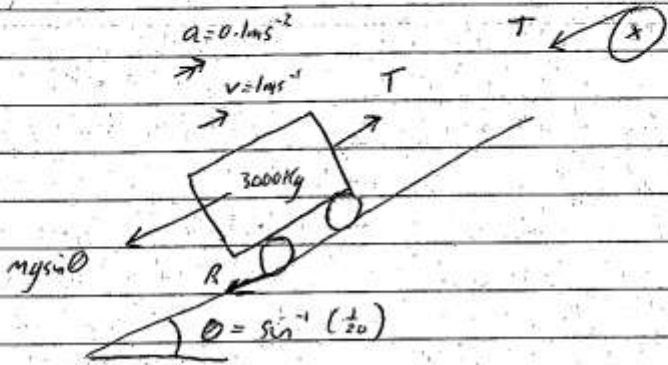
Question No	Question	Marks
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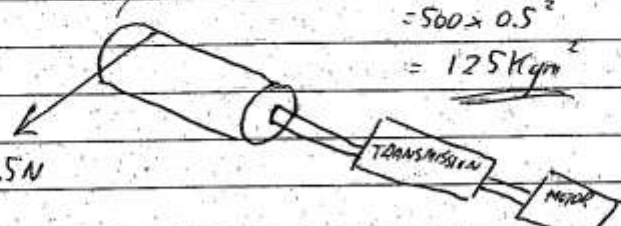
Module/Unit: STRESS ANALYSIS & DYNAMICS

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Question No.	Question	Marks
1	 $a = 0.1 \text{ m/s}^2$ $v = 1 \text{ m/s}$ 3000 kg $m g \sin \theta$ R $\theta = \sin^{-1} \left(\frac{1}{20} \right)$ NET ACCELERATING FORCE, $F_{\text{NET}} = T - (R + m g \sin \theta)$ $\therefore m a = T - (R + m g \sin \theta)$ $3000 \times 0.1 = T - (1000 + 3000 \times 9.81 \left(\frac{1}{20} \right))$ $300 = T - (1000 + 1471.5)$ $T = 300 + 2471.5$ $\therefore T = \underline{\underline{2771.5 \text{ N}}}$	1

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Question No.	Question	Marks
1	CONSIDER WINDING DRUM	
cont.	 $D = 1.2m$ $I_D = M_D \times k_D^2$ $= 500 \times 0.5^2$ $= 125 \text{ Kg m}^2$ $T = 2771.5N$ $\text{TORQUE FROM ROPE} = T \times r_D$ $= 2771.5 \times 0.6$ $= 1662.9 \text{ Nm}$ $\text{ANGULAR ACC OF DRUM } \alpha = \frac{a}{r_D} = \frac{0.1}{0.6} = 0.167 \text{ rad/s}^2$ $\text{TORQUE TO ACC DRUM} = I_D \alpha = 125 \times 0.167 = 20.8 \text{ Nm}$ $\text{TOTAL TORQUE} = 1662.9 + 20.8 = 1683.7 \text{ Nm}$ $\text{ANGULAR SPEED OF DRUM } \omega_D = \frac{v}{r_D} = \frac{1}{0.6} = 1.67 \text{ rad/s}$ $\text{POWER AT DRUM} = \text{TORQUE} \times \omega_D$ $= 1683.7 \times 1.67$ $= 2811.8 \text{ W}$ $\text{TRANSMISSION IS 85\% EFFICIENT}$ $\text{WAT MTR} = \frac{2811.8}{0.85} = 3308 \text{ W}$	1

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Question No.	Question	Marks
1b	Velocity-Time graph showing acceleration, constant velocity, and deceleration phases.	2
	$t_1: v = u + at$ $\therefore t_1 = \frac{v-u}{a} = \frac{1.5-0}{0.1} = \underline{\underline{15 \text{ sec}}}$	1
	$t_2: t_2 = t_1 + 15 = \underline{\underline{30 \text{ sec}}}$	1
	$t_3: \text{DECELERATING FORCE: } F = 1000 + mg \sin \theta$ $= 1000 + 3000 \times 9.81 \left(\frac{1}{20}\right)$ $= \underline{\underline{2471.5 \text{ N}}}$	1
	$\therefore F = ma \therefore a = \frac{F}{m} = \frac{2471.5}{3000} = 0.82 \text{ ms}^{-2}$	
	$t = \frac{v-u}{a} = \frac{0-1.5}{-0.82} = \underline{\underline{1.82 \text{ seconds}}}$	
	$\therefore t_3 = t_2 + 1.8 = \underline{\underline{31.8 \text{ sec}}}$	1

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Question No	Question	Marks			
1b ii	= AREA UNDER GRAPH TOTAL DISTANCE = $\frac{15 \times 1.5}{2} + 15 \times 1.5 + \frac{1.8 \times 1.5}{2}$ = $11.25 + 22.5 + 1.35$ = <u><u>35.1m</u></u>	21			
(11)	$v = 1$ $a = 0.1$ $t = \frac{v-u}{a} = \frac{1-0}{0.1} = \underline{\underline{10 \text{ sec}}}$ (X MARKED ON GRAPH)	1			
(12)	~~QUESTION~~				

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Question No.	Question	Marks
1b	POWER OUTPUT FROM MOTOR:	
(IV)	A hand-drawn graph on grid paper. The y-axis is labeled "POWER" and has a tick mark labeled "4962w". The x-axis is labeled "TIME" and has tick marks labeled "15" and "30". A solid line starts at the origin (0,0) and goes up linearly to the point (15, 4962). From t = 15 to t = 30, the power remains constant at 4962 W, represented by a horizontal line. Dashed vertical lines connect the points (15, 4962) and (30, 4962) to their respective values on the time axis.	
	FROM (iii) $3308 \text{ W} = 1 \text{ ms}^{-1}$	1
	CINBAR RELATIONSHIP : $1.5 \text{ ms}^{-1} = 3308 \times 1.5$ $= \underline{\underline{4962 \text{ W}}}$	
	$\text{POWER} = \frac{\text{ENERGY}}{\text{TIME}}$	*
	ENERGY = POWER × TIME = AREA UNDER GRAPH $= \frac{4962 \times 15}{2} + 15 \times 4962$ $= 37215 + 74430$ $= 111645 \text{ J}$ $= \underline{\underline{111.6 \text{ KJ}}}$	1 /20

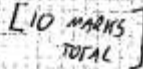
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Question No.	Question	Marks
	SEE DIAGRAM ON NEXT PAGE CONSTRUCTION IS AS FOLLOWS: ~~CONSTRUCTION~~ (DESCRIPTION NOT NEEDED)	(2)
(2a)	10	
	VELOCITY OF A RELATIVE TO O $V_{AO} = OA \times \omega_A$ $= 60 \times 10^{-3} \times 120 \times \frac{2\pi}{60}$ $= 0.754 \text{ m/s}$	1
	HENCE $\vec{OA}$ DRAWN $0.754 \text{ m} = 7.54 \text{ cm}$ LONG AT 75° FROM HORIZONTAL.	
	11 SLIDER B	
	• SLIDER B CONSTRAINED TO MOVE ALONG AXIS 30° TO O $\therefore \vec{OB}$ DRAWN WITH INDETERMINATE LENGTH.	1
	• V_{BA} (TANGENTIAL OF B RELATIVE TO A): ANGLE OF TANGENT A MEASURED FROM HORIZONTAL = 19.5° $\therefore \vec{AB}$ DRAWN 19.5° FROM HORIZONTAL, WITH INTERSECTION WITH $\vec{OB}$ FIXING B.	1
	12 PIN JOINT C	
	• IS POSITIONED SUCH THAT $\frac{ac}{ab} = \frac{AC}{AB} = \frac{80}{210} = 0.38$ $\therefore ac = 0.38ab$	
	BY MEASUREMENT $ab = 82 \text{ mm} \therefore ac = 31.2 \text{ mm}$	1

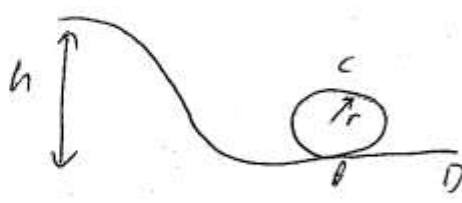
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Question No.	Question	Marks
3	SLIDER D - SLIDER D CONSTRAINED TO MOVE ALONG HORIZONTAL AXIS ~~at~~ TO O $\therefore$ $\vec{od}$ DRAWN WITH INDEFINITE LENGTH. V_{dc} (TANGENTIAL OF D RELATIVE TO A): ANGLE OF TANGENT FROM VERTICAL MEASURED FROM DIAGRAM = $5^\circ \therefore \vec{cd}$ DRAWN 5° FROM VERTICAL, WITH INTERSECTION WITH $\vec{od}$ <u>FIXED</u> VELOCITY DIAGRAM COMPLETE! - SLIDER B: $\vec{ob}$ (MEASURED) = 11.7 cm $\therefore V_{ob} = 11.7 \times 0.1$ $= \underline{\underline{1.17 \text{ m/s}}}$ 30° 'DOWNWARD AND LEFT' IN SENSE $O \rightarrow b$ - SLIDER D: $\vec{od}$ (MEASURED) = 1.9 cm $\therefore V_{od} = 1.9 \times 0.1$ $= \underline{\underline{0.19 \text{ m/s}}}$ TO 'LEFT' IN SENSE $O \rightarrow d$	1 1 1



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Question No	Question	Marks
2b	 A → C LOSS OF P.E. = GAIN IN K.E. $mg(h-2r) = \frac{1}{2}mv^2$ $v^2 = 2g(h-2r) *$ FOR THE CAR TO REMAIN IN CONTACT THE CENTRIFUGAL FORCE MUST BE $\geq$ WEIGHT $\frac{mv^2}{r} \geq mg$ ∴ FROM * $\frac{2mg(h-2r)}{r} \geq mg$ $2(h-2r) \geq r$ $2h-4r \geq r$ $2h \geq 5r$ $h \geq 2.5r$	(5)

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Question No	Question	Marks
(ii)	ASSUMPTIONS - ALL P.E. IS CONVERTED TO K.E. - NEGLECTING - ROLLING RESISTANCE - DRAG - NOISE - DEFORMATION OF WHEELS/TRACKS - FRICTION - HEIGHT OF C.O.G. FROM TRACK NOT ACCOUNTED FOR	5