FINAL
Examination Paper
(COVER PAGE)

Session : April 2000
Programme : University Foundation Programme (Engineering)
Course : EGR 165 : Engineering Mechanics II : Dynamics
Date of Examination : 08 - 08 - 2000
Time : 12.00 Noon - 2.30 p.m Reading Time : Nil
Duration : 2 ½ Hours
Special Instructions :

This paper consists of EIGHT (8) questions. Answer any FIVE (5) questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :
Nil

Materials provided :
Nil

Examiner(s) : Jariah Kalan
Moderator : Dr. Wan Mohd Ashri Wan Daud

This paper consists of 8 printed pages, including the cover page.
This paper consists of **EIGHT (8)** questions. Answer any **FIVE (5)** questions in the answer booklet provided. All questions carry equal marks.

1. a) The ball at $A$ is kicked with a speed $v_A = 24.5 \text{ m/s}$ and at an angle $\theta_A = 30^\circ$. Determine the point $(x, -y)$ where it strikes the ground. Assume the ground has the shape of a parabola as shown. (10 marks)

![Figure Q1(a)](image)

b) Train $A$ travels with a constant speed $v_A = 120 \text{ km/h}$ along the straight and level track. The driver of car $B$, anticipating the railway grade crossing $C$, decreases the car speed of 90 km/h at the rate of 3 m/s$^2$. Determine the velocity and acceleration of the train relative to the car. (10 marks)

![Figure Q1(b)](image)
2. a) The sliders $A$ and $B$ are connected by a light rigid bar and move with negligible friction in the slots, both of which lie in a horizontal plane. For the position shown, the velocity of $A$ is 0.4 m/s to the right. Determine the acceleration of each slider and the force in the bar at this instant.

(12 marks)

Figure Q2(a)

b) A sphere with a mass of 3 kg slides along a rod in Figure Q2(b), which is bent in a vertical plane into a shape that can be described by the equation $y = 8 - \frac{1}{2} x^2$, where $x$ and $y$ are measured in meters. When $x = 2$ m, the collar is moving along the rod at a speed of 5 m/s and the speed is increasing at a rate of 3 m/s$^2$. Determine the normal $F_n$ and tangential $F_t$ components of the force being exerted on the sphere by the rod at this time.

(8 marks)

Figure Q2(b)
3. a) Blocks $A$ and $B$ have masses of 11 kg and 5 kg, respectively, and they are both at a height $h = 2$ m above the ground when the system is released from rest. Just before hitting the ground block $A$ is moving at a speed of 3 m/s. Determine
i) the amount of energy dissipated in friction by the pulley
ii) the tension in each portion of the cord during the motion

(12 marks)

Figure Q3(a)

b) A 3-kg collar can slide without friction on a vertical rod and is resting in equilibrium on a spring. It is pushed down, compressing the spring 150 mm, and released. Knowing that the spring constant is $k = 2.6 \text{ kN/m}$, determine
i) the maximum height $h$ reached by the collar above its equilibrium position,
ii) the maximum velocity of the collar.

(8 marks)

Figure Q3(b)
4. a) Block A has a mass of 3 kg and B has a mass of 5 kg. If the system is released from rest, determine the velocity of each block in $t = 4 \text{ s}$. Neglect the mass of the pulleys.

Figure Q4(a)

b) In a pool shot, the cue ball knocks the 1-ball into the corner pocket as shown in Figure Q4(b). If the coefficient of restitution is $e = 0.95$, determine the velocity of the cue ball after the collision.

Figure Q4(b)
5. In the four-bar linkage shown, control link $OA$ has a constant counterclockwise angular velocity $\omega_b = 10 \text{ rad/s}$, calculate

a) the angular velocity of link $AB$ and $BC$  \hspace{1cm} (8 marks)

b) the angular acceleration of link $AB$ for the position where the coordinates of $A$ are $x = -60 \text{ mm}$ and $y = 80 \text{ mm}$. Link $BC$ is vertical for this position. Solve by vector algebra. \hspace{1cm} (12 marks)

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{figure.png}
\caption{Figure Q5}
\end{figure}

6. The uniform 3.6m pole is hinged to the truck bed and released from the vertical position as the truck starts from rest with an acceleration of 0.9 m/s$^2$. If the acceleration remains constant during the motion of the pole, calculate the angular velocity $\omega$ of the pole as it reaches the horizontal position. \hspace{1cm} (20 marks)

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{figure.png}
\caption{Figure Q6}
7. In the mechanism shown, each of the two wheels has a mass of 30 kg and a centrodial radius of gyration of 100 mm. Each link \(OB\) has a mass of 10 kg and may be treated as a slender bar. The 7-kg collar at \(B\) slides on the fixed vertical shaft with negligible friction. The spring has a stiffness \(k = 30 \text{ kN/m}\) and is contacted by the bottom of the collar when the links reach the horizontal position. If the collar is released from rest at the position \(\theta = 45^\circ\) and if friction is sufficient to prevent the wheels from slipping, determine

a) the velocity \(v_B\) of the collar as it first strikes the spring and 

b) the maximum deformation \(x\) of the spring. 

Figure Q7
8. The sheave $E$ of the hoisting rig shown has a mass of 30 kg and a centroidal radius of gyration of 250 mm. The 40-kg load $D$ which is carried by the sheave has an initial downward velocity $v_0 = 1.2$ m/s at the instant when a clockwise torque is applied to the hoisting drum $A$ to maintain essentially a constant force $F = 380$ N in the cable at $B$.

a) Compute the angular velocity $\omega$ of the sheave 5s after the torque is applied to the drum. (12 marks)

c) Find the tension $T$ in the cable at $O$ during the interval. Neglect all friction. (8 marks)

Figure Q8

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