

國立中山大學九十四學年度碩士班招生考試試題

科目：工程概論【機電系碩士在職專班】

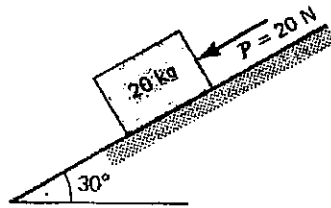
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一、 工程力學：靜力部份 (單選題；每題 5 分，共 25 分)

1. Two forces \vec{T}_A and \vec{T}_B act at a point where $\vec{T}_A = (4\vec{i} - 7\vec{j} + 5\vec{k}) N$ and $\vec{T}_B = (-7\vec{i} - 8\vec{j} + 9\vec{k}) N$.
What is the magnitude of the resultant of the two forces ?

(A) 8.77 N (B) 19.70 N (C) 62.12 N (D) 37.89 N (E) None

2. Consider a force $P = 20 N$ acts on the 20-kg block initially at rest as shown in following figure. If the static friction coefficient $\mu_o = 0.45$ between the block and the inclined surface, does the block move down the plane ? ($\cos 30^\circ = 0.866$; $\sin 30^\circ = 0.5$)



(A) Yes (B) No (C) It is independent of the friction coefficient. (D) It is dependent on the height of the block (E) None

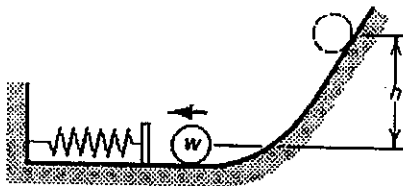
3. Determine the moment about the origin O of the force $\vec{F} = 4\vec{i} + 10\vec{j} + 6\vec{k}$ which acts at a point A.

Assume that the position vector of A is $\vec{r} = 2\vec{i} - 3\vec{j} + 4\vec{k}$.

(A) $\vec{M}_O = -58\vec{i} + 4\vec{j} + 32\vec{k}$ (B) $\vec{M}_O = 8\vec{i} - 30\vec{j} + 24\vec{k}$ (C) $\vec{M}_O = 12\vec{i} + 20\vec{j} - 24\vec{k}$

(D) $\vec{M}_O = 0$ (E) None

4. A 100-lb sphere strikes a spring as illustrated in following figure. If the spring is compressed by 0.25 ft, how far does the sphere rise? Assume the spring constant of the spring is $k=7000 \text{ lb/ft}$.



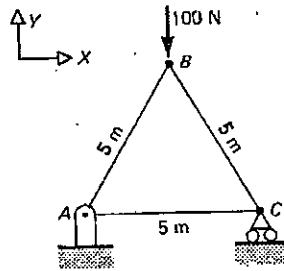
(A) 2.19 ft (B) 21.8 ft (C) 124.7 ft (D) 88.1 ft (E) None

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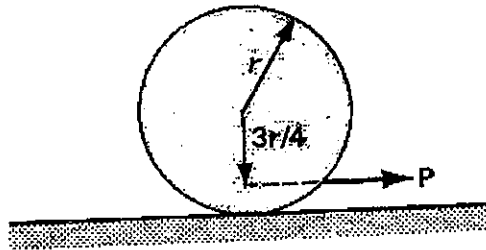
5. The tensile force in the member AC of the following truss is ($\cos 60^\circ = 0.5$; $\sin 60^\circ = 0.886$)



- (A) $F_{AC} = 18.87 \text{ N}$ (B) $F_{AC} = 28.87 \text{ N}$ (C) $F_{AC} = 38.87 \text{ N}$ (D) $F_{AC} = 58.87 \text{ N}$ (E) None

二、工程力學：動力部份 (單選題；每題 5 分，共 25 分)

- Consider a particle moving in a straight line, and assume that its position is defined by the equation $s = 6t^2 - t^3$ (m) where the time variable t is in second. The acceleration a at $t = 2$ second is
 (A) $a = 12 \text{ m/sec}^2$ (B) $a = 0 \text{ m/sec}^2$ (C) $a = -12 \text{ m/sec}^2$ (D) $a = 9.80 \text{ m/sec}^2$ (E) None
- The position of a point A describes a spiral such that $\vec{A}(t) = 5t^2(\cos 2t \vec{i} + \sin 2t \vec{j})$ m. What is the magnitude of the velocity of point A at $t = \pi/4$ sec.
 (A) 6.985 m/sec (B) 9.985 m/sec (C) 19.985 m/sec (D) 29.985 m/sec (E) None
- A cylinder of mass m has a force P applied to it as shown in following figure. Determine the minimum coefficient of friction μ for the cylinder to roll without slipping. The gravity is g .



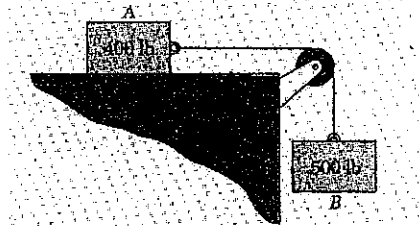
- (A) $\mu = \frac{5P}{6mg}$ (B) $\mu = \frac{4P}{3mg}$ (C) $\mu = \frac{9P}{16mg}$ (D) $\mu = \frac{5P}{8mg}$ (E) None

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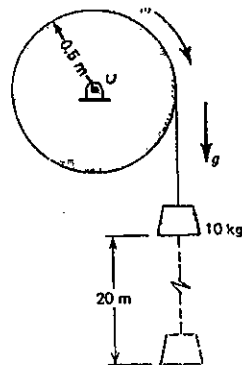
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4. The two blocks shown start from rest; block A moves on a horizontal frictionless plane. The weights of block A and B are 400 and 500 lbs, respectively. The gravity is 32.2 ft/sec^2 . The tension in the cord is



- (A) $T = 522 \text{ lbf}$ (B) $P = 422 \text{ lbf}$ (C) $T = 322 \text{ lbf}$ (D) $T = 222 \text{ lbf}$ (E) None
5. A 10-kg mass, connected to a drum as shown in following figure, starts from rest and moves down a distance of 20 meters. Assume that the drum is 100 kg and has a radius of 0.5 meter. The gravity is $g = 9.81 \text{ kg/sec}^2$. The polar mass moment of inertia of this drum is $I_o = 4 (\text{kg} \cdot \text{m}^2)$ about point O . The magnitude of the velocity of the 10-kg mass is



- (A) $v = 42.3 \text{ m/sec}$ (B) $v = 140.3 \text{ m/sec}$ (C) $v = 12.3 \text{ m/sec}$ (D) $v = 150.8 \text{ m/sec}$ (E) None

三、工程數學部份 (單選題；每題 5 分，共 50 分)

1. The order of the differential equation $3y'' + 5(y')^3 - 4y^4 = x^2 - 2$ is
 (A) 1 (B) 2 (C) 3 (D) 4 (E) None
2. Which one is the solution of $x'' + 16x = 0$, with $x\left(\frac{\pi}{2}\right) = -2$; $x'\left(\frac{\pi}{2}\right) = 1$
 (A) $x = 5e^{-t} \sin t + t^2 - 2t$ (B) $x = 2t \cos 4t + 4e^{-t} \sin 4t$ (C) $x = -2 \cos 4t + \frac{1}{4} \sin 4t$

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(D) $x = te^{-t}(4t \cos t + \pi \sin^2 t)$ (E) None

3. Which one in the following differential equations is the homogeneous equation?

(A) $2(1-x^3)y'' - 2x^2y' + 6y + 12e^x = 0$ (B) $y'' - y + 4 \sin x = 0$ (C) $y'' + 4y = e^{-x} \sin x$

(D) $x^2(2y''y + 3y'^2) + 2y'y = 0$ (E) None

4. Which one in the following differential equations is nonlinear?

(A) $3(y-x)dx - 4xdy = 0$ (B) $2y'' - 5y' + 3y = 2xe^x$ (C) $5 \frac{d^2y}{dx^2} + 2x \frac{dy}{dx} - 7y = 9x + e^{-x} \sin x$

(D) $2y'(3-y) + 7y = 0$ (E) None

5. Which one is the solution of the initial value problem $y'' - y = 0$ with $y(0) = 4$ and $y'(0) = -2$?

(A) $y = 3t^2 \sin t - 2e^t \cot t$ (B) $y = e^t + 3e^{-t}$ (C) $y = 2te^{2t} - t \sin^2 t + 2t^2$

(D) $y = 4te^{2t} - \sin t + 2t^2$ (E) None

6. If matrices A and B are defined as $A = \begin{bmatrix} 9 & -5 \\ -2 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 0 & 5 \end{bmatrix}$, then the product $C = A^T B^{-1}$ is

(A) $\begin{bmatrix} 9 & -1 \\ 3 & 0 \end{bmatrix}$ (B) $\begin{bmatrix} 5 & -6 \\ -13 & 8 \end{bmatrix}$ (C) $\begin{bmatrix} -5 & 2 \\ -21 & -7 \end{bmatrix}$ (D) $\begin{bmatrix} 15 & -21 \\ 21 & 8 \end{bmatrix}$ (E) None

7. If matrices A and B are defined as $A = \begin{bmatrix} 9 & 3 \\ -2 & 0 \end{bmatrix}$, $B = \begin{bmatrix} 1 & 0 \\ 0 & 5 \end{bmatrix}$ and $C = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$, then the product

$D = -(C^T A^T B)^T$ is (A) $\begin{Bmatrix} 8 \\ -21 \end{Bmatrix}$ (B) $\begin{Bmatrix} -21 \\ 8 \end{Bmatrix}$ (C) $\begin{Bmatrix} 20 \\ -8 \end{Bmatrix}$ (D) $\begin{Bmatrix} -21 \\ 20 \end{Bmatrix}$ (E) None

8. Which one is the eigen value solution pair of the matrix $A = \begin{bmatrix} 3 & 4 \\ -1 & 7 \end{bmatrix}$?

(A) $(\lambda_1 = -3; \lambda_2 = 7)$ (B) $(\lambda_1 = \lambda_2 = 5)$ (C) $(\lambda_1 = 1; \lambda_2 = 4)$ (D) $(\lambda_1 = 4; \lambda_2 = -7)$ (E) None

9. Consider A , B and C are $n \times n$ matrices, which one in the following matrix operations is wrong?

(A) $(AC^T)^T B = CA^T B$ (B) $(B(AB)^{-1})^{-1} = A$ (C) $B(AC)^{-1} = BA^{-1}C^{-1}$

(D) in general, $AB \neq BA$ (E) None

10. Let $v(x, y, z) = 3x^2z\bar{i} + 2xy^2\bar{j} - xyz^2\bar{k}$ be a differentiable vector function, then the

divergence of the vector $\nabla \cdot v$ is

(A) $3z\bar{i} + 2x\bar{j} - yz\bar{k}$ (B) $6z\bar{i} + 4x\bar{j} - 2yz^2\bar{k}$ (C) $3xz + 2xy^2 - 2xyz^2$ (D) $6xz + 4xy - 2xyz$ (E) None