SEAT No._____ No. of Printed Pages : 2

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SARDAR PATEL UNIVERSITY
B.Sc.(SEMESTER-V)EXAMINATION-2018
16-04-2018, Monday
2.00 p.m. to 5.00 p.m.
US05CMTH06(MATHEMATICS)(MECHANICS-I)
Maximum Marks: 70

Q.1 Choose the correct option in the following questions, mention the correct option in the answerbook. [10]

(1) Unit of Force in C.G.S. is=.....
(a) Newton (b) Poundal (c) Dyne (d) none of these

(2) 1 Poundal=.....Dynes.
(a) 13862 (b) 13682 (c) 13826 (d) none of these

(3) Moment of vector (X, Y, Z) about the perpendicular to the plane O_{xy} at origin O is $M = ...$
(a) $xY + yX$ (b) $Xy - Yx$ (c) $Xy + Yx$ (d) $xY - yX$

(4) If a particle is in equilibrium then vector sum of all external forces is.....
(a) 0 (b) 1 (c) -1 (d) none of these

(5) A branch of mechanics which deals with the motion of system is known as.....
(a) Statics (b) Dynamics (c) acceleration (d) none of these

(6) The work done by the force $\overline{F}$ is $\delta W = ...$
(a) $\cos\theta\ \delta s$ (b) $F\cos\theta$ (c) $\overline{F}\cos\theta\ \delta s$ (d) $F\cos\theta\ \delta s$

(7) $V(A) = ...$
(a) $W(A, A_0)$ (b) $W(A_0, A)$ (c) $-W(A, A_0)$ (d) none of these

(8) If density ρ is constant, then the body is said to be.....
(a) homogeneous (b) heterogeneous (c) rigid (d) none of these

(9) Tangential component of velocity is
(a) $\frac{ds}{dt}$ (b) $\frac{dv}{dt}$ (c) $\frac{v^2}{\rho}$ (d) $\frac{da}{dt}$

(10) Radial component of acceleration of a particle moving in a plane is.....
(a) $\ddot{r} + r\dot{\theta}^2$ (b) $\dot{r} - r\dot{\theta}$ (c) $\ddot{r} + r\dot{\theta}^2$ (d) $\ddot{r} - r\dot{\theta}^2$

Q.2 Attempt any Ten. [20]

(1) If $V = x^2 + y^2$, then find components of grad V. Also find gradiant at point $(1, 0)$ in the direction making angle 45^o with X-axis.
(2) Explain gradient vector.
(3) Define: (1) Free vector (2) Bound vector.
(4) Let a force with components (X, Y, Z) be acting at a point (x, y, z), then its moment along a line perpendicular to $XY - Plane$ along the origin O is given by $M = xY - yX$.
(5) $ABCD$ is a square of side 2 unit, forces 1, 2, 3, 4 lb wt act along $\overline{AB}, \overline{CB}, \overline{DC}, \overline{DA}$ respectively. find the algebraic sum of their moments about Center of a square.
(6) If O is the incenter of $\triangle ABC$ and forces $\overline{P}, \overline{Q}, \overline{R}$ are acting along $\overline{OA}, \overline{OB}, \overline{OC}$ respectively, then show that $P : Q : R = \cos A/2 : \cos B/2 : \cos C/2$.
(7) Define: (i) Couples (ii) Moment of couple.
(8) Forces of magnitude 2, 4, 6, 8, $4\sqrt{2}$ are acting along $\overline{AB}, \overline{BC}, \overline{CD}, \overline{DA}$ and diagonal $\overline{AC}$ respectively of the $\square ABCD$, then show that the resultant force is a couple.
(9) State Newton's law of gravitation.

C.P.T.O.)

(10) In usual notations prove that $c^2 + s^2 = y^2$.
(11) Define: (i) Catenary (ii) Span.
(12) Prove that $T = \omega Y + H$, where $\omega = H/C$.

Q.3
(a) What curves are described by a particle moving in accordance with the equation $\overline{r} = b\cos pt\,\hat{i} + c\sin pt\,\hat{j}$, where p, c and b are constants and $\hat{i}$, $\hat{j}$ are fixed unit vectors perpendicular to one another. Also prove that the direction of acceleration is towards the origin. [6]

(b) The resultant force of $\overline{P}$ and $\overline{Q}$ is $\overline{R}$. If $\overline{R}$ is doubled, $\overline{Q}$ is doubled and if $\overline{Q}$ is reversed, $\overline{R}$ is again doubled then show that $P : Q : R = \sqrt{2} : \sqrt{3} : \sqrt{2}$. [4]

OR

Q.3
(c) State and prove equation of motion of a particle moving in a straight line. [6]

(d) Two forces acting in opposite direction on a particle have a resultant of $34 lbwt$. If they act at right angle to one another, their resultant would be $50 lbwt$. Find the magnitude of these two forces. [4]

Q.4
(a) Three forces $\overline{P}$, $\overline{Q}$ and $\overline{R}$ acting at a point are in equilibrium and the angle between $\overline{P}$ and $\overline{Q}$ is doubled of angle between $\overline{P}$ and $\overline{R}$. Prove that $R^2 = Q(Q - P)$. [5]

(b) State and prove theorem of Varignon . [5]

OR

Q.4
(c) State and prove Lamy's theorem. [5]

(d) A body of mass 140 $lbwt$ is suspended by two strings of length 5 ft and 12 ft. Their ends are attached to a rod of length 13 ft. Find the tension in the strings. [5]

Q.5
(a) Prove that the mass center of a system exists and is unique. [6]

(b) Explain the principle of virtual work by illustration. [4]

OR

Q.5
(c) Prove that the increment in potential energy is equal to the work done, with its sign changed. [6]

(d) Find the center of gravity of the area bounded by the curve $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$ in the first quadrant. [4]

Q.6
(a) Derive the differential equation of suspension bridge and show that it represents the equation of parabola. [5]

(b) In usual notations prove that $s = c\tan\psi$. [5]

OR

Q.6
(c) Obtain radial and transverse components of velocity and acceleration of a particle moving in a plane. [5]

(d) A uniform chain AB of length l hangs in the same horizontal line, so that the tension is n times that of the lowest point. Show that the span AB must be $\frac{l}{\sqrt{n^2-1}} \log\left[n + \sqrt{n^2-1}\right]$. [5]

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