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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2019 /2020 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION

COURSE CODE: **MAT 215**

COURSE TITLE: **CLASSICAL MECHANICS**

DATE: 27TH OCTOBER, 2020 **TIME: 0900 – 1200 HRS**

INSTRUCTION TO CANDIDATES

REGULAR-MAIN EXAM

MAT 215: CLASSICAL MECHANICS

STREAM: BED DURATION: 3 Hours

INSTRUCTION TO CANDIDATES

i. *Answer* ***ALL*** *questions from* ***section A*** *and any* ***THREE*** *from* ***section B***

ii. *Do not write on the question paper.*

SECTION A

Question 1 (16marks)

a) a particle moves along the space curve

$$\tilde{r} = (t^2 + t)\tilde{\imath} + (3t - 2)\tilde{\jmath} + (2t^3 - 4t^2)\tilde{k}$$

Find the

i) velocity **(2mks)**

ii) speed at $t = 2$ **(3mks)**

b) Aparticle moves along a straight line and it's distance from a fixed point on the line is given as $x = acos(\mu t + \xi)$.

Show that its acceleration varies as the distance from the origin is directed towards the origin **(4mks)**

c) Show that $F = yz\tilde{\imath} + xz\tilde{\jmath} + xy\tilde{k}$ is a conservative field and find the potential function V with a zero value at $(1,1,1)$. **(4mks)**

d) What is the force of attraction between the Earth and the Sun? Mass of the Sun = 2 x 10^{30} kg, mass of the Earth = 6 x 10^{24} kg, distance from the Earth to the Sun = 1.5 x 10^{11} m, $G = 6.67X10^{-11}NM^2/Kg^2$ **(3mks)**

Question 2 (15marks)

a) Define the following term **(2mks)**

i) amplitude

ii) periodic time

b) A body moving with simple harmonic motion has a velocity of $3m/s$ when $375mm$ from the mid position and acceleration of $1\ m/s$ when $250mm$ from the mid position.

Calculate the

i) periodic time **(3mks)**

ii) amplitude **(3mks)**

c) A mass of 5000kg moves on a straight line from a speed of 540km/hr to 720km/hr. in 2 minutes. what is the impulse developed in this time **(3mks)**

d) A particle p of mass 2 move along x axis attracted towards the origin 0 by a force whose magnitude is numerically equal to $8x$. if it is initially at rest at $x = 20$ and has also a damping force whose magnitude is numerically equal to 8 times instantaneous speed. Find the position of the particle at any given time t **(4mks)**

Question 3 (13marks)

a) A particle moves in a straight line with a constant acceleration $\tilde{a}$ .discusss the motion **(8mks)**

b) A car is travelling at $90km/hr$ while passing one lamp post at $45km/hr$ while passing another one. If the lamp post is $120m$ apart. How far further will the car travelled will come to rest if this retardation is maintained. **(5mks)**

Question 4 (13marks)

a) State the 2nd Newton's law of motion. **(2mks)**

b) A train whose mass is 20 tonnes moves at the rate of $72km/hr$. After the stream is shut-off ,it is brought to rest by the break in $500m$.find the exerted F assuming it to be uniform **(4mks)**

c) A body whose true weight is$13kg$, appeared to weighs $12kg$.when weighed by a spring balance in a moving lift. What was the acceleration of the lift at the time the body was being weighed **(4mks)**

d) Prove that if $\breve{F}$ is the force acting on a particle and $\tilde{V}$ is the velocity of the particles, then the power applied to the particle is given by

$$P = \tilde{F}.\tilde{v}$$ **(3mks)**

Question 5 (13marks)

a) The particle is projected with velocity $49m/s$ at an elevation of 30^0.find **(9mks)**
   i) The time of flight
   ii) The horizontal range
   iii) Greatest height assuming $g = 9.8m/s^2$

b) An impulse **I** changes the velocity of a particle of mass m from K_1 to K_2 .Show that the K.E gained is **(4mks)**

$$\frac{1}{2}\text{I}.(\text{V}_1 + \text{V}_2)$$

Question 6(13marks)

a) A particle of mass 2 moves in a force field depending on time t given by

$$\tilde{F} = 24t^2\tilde{\imath} + (36t - 16)\tilde{\jmath} - 12t\tilde{k}$$

Assuming at $t = 0$,the particle is located at

$\tilde{r}_0 = 3\tilde{\imath} - \tilde{\jmath} + 4\tilde{k}$ and has velocity $\tilde{v}_0 = 6\tilde{\imath} + 15\tilde{\jmath} - 8\tilde{k}$

Determine

i) Velocity **(4mks)**

ii) The position at any time t **(3mks)**

b) A particle of mass 2 units moves along the space curve define by

$$\tilde{r}_0 = (4t^2 - t^3)\tilde{\imath} + 5t\tilde{\jmath} + (t^3 - 4t)\tilde{k}$$

Find

i) the momentum **(3mks)**

ii) the force acting on it at $t = 1$ **(3mks)**

Question 7 (13marks)

a) Define the following terms

i) Velocity

ii) Acceleration **(4mks)**

b) The particle Moves in a straight line so that its distance x from a fixed point on itself at any instant time is proportional to t^n .If the velocity and acceleration are $\tilde{v}$ and $\tilde{a}$ respectively. Show that

$$\tilde{v}^2 = \frac{n\tilde{a}x}{n-1}$$

(5mks)

c) A body of mass m falls from rest through a height h and is then brought to rest by penetrating through a depth d into some sand. Show that the average resistance of the sand is $mg\left(1 + \frac{h}{d}\right)$ **(4mks)**