



Registration Number:

Date & session:

ST. JOSEPH'S UNIVERSITY, BENGALURU -27

M.Sc (PHYSICS) – I SEMESTER

SEMESTER EXAMINATION: OCTOBER 2022

(Examination conducted in December 2022)

**PHBC 7121 – BRIDGE COURSE: MATHEMATICAL PRELIMINARIES AND NEWTONIAN
MECHANICS**

Time: 1 Hour

Max Marks: 25

This paper contains 2 printed pages and 2 parts
(Answer any 3 questions from one part and 2 questions from the other part. Each question carries 5 Marks)

PART A

1.

(a) Find the unit normal to the surface $\phi = x y^3 z^2$ at $(-1, -1, 2)$.

(b) Explain Gram-Schmidt procedure for converting a linearly independent basis into an orthonormal one. [2+3]

2.

(a) Find the curl of $\vec{V} = (x y z)\hat{i} + (3 x^2 y)\hat{j} + (x z^2 - y^2 z)\hat{k}$

(b) Derive $\vec{\nabla} \cdot \vec{A}$ in orthogonal curvilinear coordinates. [3+2]

3. If $\vec{A} = (3 x^2 + 6 y)\hat{i} - (14 y z)\hat{j} + (20 x z^2)\hat{k}$ evaluate the closed line integral $\int \vec{A} \cdot d\vec{r}$ from $(0,0,0)$ to $(1,1,1)$ along the curve $C: x=t, y=t^2, z=t^3$.

4. Find the eigenvalues and normalized eigenvectors of the matrix: $\begin{pmatrix} 1 & 3 & 1 \\ 0 & 2 & 0 \\ 0 & 1 & 4 \end{pmatrix}$. Is this matrix Hermitian? Are the eigenvectors orthogonal?



PART-B

- 5.
- (a) A ball is thrown vertically upward with a speed of 20 m s^{-1} . Draw a graph showing the velocity of the ball as a function of time as it goes up and then comes back.
 - (b) A person traveling on a straight line moves with a uniform velocity v_1 for some time Δt and with a uniform velocity v_2 , for a duration which also of equal time as the previous instance. Calculate the average velocity of the person. [3+2]
- 6.
- (a) When you jump barefooted onto a hard surface from a significant height, your legs likely get injured. However, the same fall onto a soft surface (like sand, trampoline or pillow) do not cause injury. Explain the reason for this.
 - (b) A block of mass 2 kg is suspended from the ceiling by a nylon rope. Another block of mass 5 kg is suspended from the first block using a similar rope. Find the tensions in both the ropes. [3+2]
7. A block of mass 2 kg slides from rest on an inclined plane which has a height of 1 m and inclined at an angle of 30° with respect to the horizontal. The velocity of the block as it leaves the inclined plane (parallel to the plane) is measured to be equal to $\sqrt{19} \text{ m.s}^{-1}$. Estimate the coefficient of kinetic friction of the inclined plane.
8. Find the angular angular velocity of a body rotating with an angular acceleration of 1.2 rev.s^{-2} as it completes the 7^{th} revolution after the start.