



Register Number:  
DATE:

**ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27**

**M.Sc. PHYSICS - I SEMESTER**

**SEMESTER EXAMINATION- OCTOBER 2018**

**PH 7518 – ANALYTICAL TOOLS FOR MATHEMATICAL PHYSICS**

**Time-1 hr.**

**Maximum Marks-30**

*This question paper has 2 printed pages and 1 part*

**Answer any THREE full questions.**

**(3x10=30)**

1. Consider the vectors  $|u\rangle = \begin{pmatrix} 1 \\ 3+2i \\ 8i \end{pmatrix}$  and  $|v\rangle = \begin{pmatrix} 4+3i \\ \sqrt{3}i \\ 1 \end{pmatrix}$ .

- (a) Calculate  $\| |u\rangle \|$  and  $\| |v\rangle \|$  **(2 marks)**
- (b) Compute  $\langle u|v\rangle$  **(1 mark)**
- (c) Normalize each of the vectors **(2 marks)**
- (d) Find the angle between the two vectors **(2 marks)**
- (e) Compute the outer product  $|v\rangle\langle u|$  **(3 marks)**

2. Consider a mathematician who uses the vectors  $|e_1\rangle = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$ ,  $|e_2\rangle = \begin{pmatrix} -2 \\ 0 \end{pmatrix}$  as his basis vectors.

- (a) If he wants to transform into the cartesian space, what should his transformation matrix be? **(3 marks)**
- (b) If the matrix  $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$  is the rotation matrix for a rotation of angle  $\theta = 90^\circ$ , what is the equivalent matrix in the mathematician's space? **(7 marks)**

3. Consider the vectors:  $|a\rangle = \begin{pmatrix} 1 \\ 0 \\ 3 \end{pmatrix}$ ,  $|b\rangle = \begin{pmatrix} 1 \\ -1 \\ 3 \end{pmatrix}$  and  $|c\rangle = \begin{pmatrix} 2 \\ -1 \\ -1 \end{pmatrix}$ .

(a) Perform Gram-Schmidt orthogonalization

**(6 marks)**

(b) Normalize the vectors

**(4 marks)**

4. Consider the system of linear equations

$$\begin{aligned} 0.28x + 9.24y &= 38.64 \\ 1.44x + 0.1y &= 4.62 \end{aligned}$$

(a) Can this equation be solved? If yes, find the solution using Gauss elimination and if not elucidate. **(3 marks)**

(b) Consider the coefficient matrix for the same system

i. Find the eigen values for the matrix

**(3 marks)**

ii. Find the corresponding eigen vectors

**(4 marks)**