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MANIPAL UNIVERSITY, MANIPAL

FIRST SEMESTER M.Sc. (Physics)
END SEMESTER EXAMINATION-2015-16
Mathematical Methods of Physics (PHY – 601)
(CREDIT SYSTEM)

Time: 3 Hrs. **Max. Marks: 50**

NOTE: (a) Answer any FIVE full questions. (b) All questions carry equal marks.

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1. **(a)** If $\psi(r,\theta,\phi) = 2rsin\theta + r^2cos\phi$, find $\nabla\psi$ and $\nabla^2\psi$ in spherical coordinate system

(b) Obtain Laurentz expansion for

$$f(z) = \frac{1}{4+z^2}$$

which is valid in the region $|z-2i| > 4$

2. **(a)** Find a complex Fourier series for $f(x) = x$ in the range $-2 < x < 2$.

(b) State and prove Cauchy residue theorem

3. **(a)** Show that the Schrodinger equation of a quantum harmonic oscillator takes the form of Hermite differential equation

(b) The displacement of a damped harmonic oscillator as a function of time is given by,

$$f(t) = e^{-t/\tau}sin(\omega_0 t) \quad for\ t \geq 0$$

Obtain Fourier transform of $f(t)$

4. **(a)** Diagonalize the matrix given below

$$\begin{bmatrix} 1 & 0 & 0 \\ 1 & 2 & 0 \\ 2 & 3 & 3 \end{bmatrix}$$

(b) Evaluate the following integral using *residue theorem*

$$\int_0^{2\pi} \frac{d\theta}{1+cos\theta/2}$$

5. **(a)** Obtain an isomorphic representation of $C3_v$ group.

(b) Find the recurrence relation for Laguerre differential equation and obtain first four Laguerre polynomials

6. **(a)** A coordinate system (u, v, w) is related to Cartesian coordinate system by the relations

$$x = vw, \quad y = uw, \quad z = uv$$

Find the components of metric tensor and its reciprocal in this coordinate system.

(b) Find Fourier transform of the exponential decay function $f(t) = Ae^{-\beta t}$ (where $\beta > 0$) for $t \geq 0$

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