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TDC (CBCS) Odd Semester Exam., 2019

PHYSICS

(3rd Semester)

Course No. : PHSHCC–301T

(Mathematical Physics–II)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* questions : 2×2=4

(a) What do you mean by odd function and even function?

(b) Write down Dirichet's conditions for a Fourier series.

(c) Discuss the uses of Fourier series in Physics.

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2. Answer *(a)* or *(b)* :

(a) After writing down the orthogonality relations for sine and cosine functions find expressions for Fourier coefficients. 2+4=6

(b) *(i)* Sketch a graph from $x = -4\pi$ to 4π for the following function : 2

$f(x) = x,\ 0 < x \le 2\pi$ and $f(x+2\pi) = f(x)$

(ii) Find Fourier series for the above function. 4

UNIT—II

3. Answer any *two* questions : 2×2=4

(a) Explain the terms ordinary and singular points in the context of ODE.

(b) What do you mean by regular and irregular singular points?

(c) What do you mean by indicial equation obtained during power series solution of ODE around regular singularity?

4. Answer *(a)* or *(b)* :

(a) *(i)* Write down Legendre's differential equation and check the nature of $x = 0$. 2

(ii) Hence obtain power series solution of it. 4

(b) Discuss Frobenius method of solving a differential equation. 6

UNIT—III

5. Answer any *two* questions : 2×2=4

(a) Discuss the use of Legendre polynomials in physics.

(b) Write down the generating function of Bessel function. Hence find inversion property $J_n(-x) = (-1)^n J_n(x)$.

(c) Prove, using generating function, that a Legendre's polynomial is either an odd function or an even function.

6. Answer *(a)* or *(b)* :

(a) Prove orthogonal property of legendre's polynomial. 6

(b) Prove the following recurrence properties : 3+3=6

(i) $np_n(x) = xp'_{n+1}(x) - p'_{n-1}$

(ii) $np_n(x) = (2n-1)x\ p_{n-1}(x) - (n-1)p_{n-1}(x)$

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UNIT—IV

7. Evaluate any *two* of the following using properties of gamma function/beta function/ Dirac delta function. 2×2=4

(i) $\int_0^\infty e^{-x} x^{5/2} dx$

(ii) $\int_0^{\pi/2} \sin^4 \theta \, d\theta$

(iii) Find $\Gamma\left(\frac{1}{2}\right)$

8. Answer *(a)* or *(b)* :

(a) *(i)* Prove that

$$\beta(m, n) = \beta(n, m)$$ 2

(ii) Prove that

$$\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$$ 4

(b) *(i)* Prove that $\delta(x) = \delta(-x)$ 2

(ii) Explain how Dirac delta function can be represented as limit of a Gaussian function. 4

(Continued)

UNIT—V

9. Answer any *two* of the following questions : 2×2=4

(a) Define partial differential equation and its order.

(b) Write down Laplace's equation in spherical polar coordinates.

(c) Write down two applications of PDE in physics.

10. Answer *(a)* or *(b)* :

(a) Solve the following equation using method of variable separation : 6

$$\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} = 0$$

where

$v = 0$ for $y = 0$ and $y = a$, and

$v = v_0$ for $x = -b$ and $x = b$

(b) Write down the wave equation for vibrational modes of a stretched string. Hence solve it. 1+5=6

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