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SARDAR PATEL UNIVERSITY

Fifth SemesterB. Sc. Examination

Under CBCS

Friday, 15thNov-2013

Time: From 10:30 am to 1:30 pm

Subject: PHYSICS [**US05CPHY02**]

Mathematical Physics

N.B :(i) All the symbols have their usual meanings. **Total Marks 70**

Q:1 Multiple Choice Questions **[10]**

1. A square matrix A=[a_{ij}] is known as singular matrix if its determinant is:
   (a) One (b) Zero (c) Any Number (d) infinite
2. The curvilinear coordinates u$_i$ are said to be orthogonal if the coordinate curves are mutually perpendicular at _____ point P(x,y,z) of space
   (a) Every (b) One (c) Two (d) Three
3. The curvilinear coordinate system will be orthogonal if the _______ of two perpendicular vectors is zero:
   (a) Cross Product (b) Dot Product (c) Multiplication (d) Summation
4. If the infinite series as the solution of a given differential equation is reduced into a finite series, then the solution is called:
   (a) Polynomial (b) Function (c) Generating Function (d) Integrals
5. If x = uvcosω, y = uvsinω, z = $\frac{1}{2}(u^2 - v^2)$ then h_1 = ______
   (a) uv (b) u + v (c) $\sqrt{u^2 + v^2}$ (d) $u^2 + v^2$
6. Fourier equation of heat flow is:
   (a) $\frac{d^2y}{dt^2} = a^2\frac{\partial^2 y}{\partial x^2}$ (b) $\frac{\partial u}{\partial t} = h^2\nabla^2 u$ (c) $\frac{\partial^2 u}{\partial t^2} = c^2\frac{\partial^2 u}{\partial x^2}$ (d) $\frac{\partial u}{\partial t} = c\frac{\partial u}{\partial x}$
7. Terminology of Eigen value and characteristics value is:
   (a) Same (b) Different (c) Mixed (d) None
8. In forward difference table, the first term in the table is called
   (a) Leaders (b) Leading Term (c)Leading Differences (d) Followers
9. Newton's interpolation formulae developed when the values of the _______ variable x are equally spaced.
   (a) Independent (b) Dependent (c) Opposite (d) Same
10. In the Simpson's $\frac{1}{3}^{rd}$ rule, we have to used two sub-intervals of equal _________
    (a) Length (b) Height (c) Width (d) None

Q:2 Short Questions (Attempt any 10) **[20]**

1. Define: (i) Inverse Matrix (ii) Orthogonal Matrix
2. Define curvilinear co-ordinates.
3. Obtain an expression of Laplacian∇^2 in terms of orthogonal curvilinear co-ordinates.
4. Show that: $\frac{d}{dx}\{x^n J_n(x)\} = x^n J_{n-1}(x)$
5. Show that: $2nH_{n-1}(x) = H_n'(x)$.
6. Write down Legendre, Bessel's and Hermite's differential equations.
7. Define Fourier series.
8. Find a sin series for f(x) when$0 \le x \le \pi$.

Continue...

9. Write down one, two and three dimensional diffusion equations.

10. Using the methods of least squares, find an equation of the form $y = a_e bx$ that fits an exponential curve.

11. Write successive four steps of power method.

12. Name any three differential operators and state Stirling's formulae for computing the derivatives of a tabular function.

Q:3 Answer the following

(A) Define transformation and explain: [7]

(a) Linear Transformation (b) Similarity Transformation (c) Orthogonal Transformation

(B) Deduce $\left[\frac{\partial r}{\partial u} \frac{\partial r}{\partial v} \frac{\partial r}{\partial w}\right] = h_1 h_2 h_3$ for orthogonal curvilinear co-ordinate system. [3]

OR

(A) Explain cylindrical co-ordinates as a special curvilinear co-ordinate system and obtain expressions for $\nabla\phi$, $\nabla^2\phi$, ∇F and ∇ X F in terms of cylindrical co-ordinates. [5]

(B) Determine the Eigen values and Eigen vectors of the matrix: [5]

$$\begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$$

Q:4 Solve differential equation $y'' + \frac{1}{x}y' + (1 - \frac{n^2}{x^2})y = 0$ and discuss generating function for $J_n(x)$ in detail. [10]

OR

Q:4 Solve differential equation y''-2xy'+2 ν y = 0 and discuss orthogonal properties of Hermite polynomials. [10]

Q:5 Answer the following:

(A) Give the physical interpretation of complex Fourier's series with reference to thermal state. [5]

(B) Solve one dimensional wave equation by method of separation of variables [5]

OR

(A) Define and expand the Fourier's series f(x) which is a function of x; when $-\pi \le x \le \pi$ [5]

(B) Find the Fourier series for the periodic function f(x) defined by: [5]

f(x) = $-\pi$ if $-\pi < x < 0$

= x if $0 < x < \pi$

Hence prove that $\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \cdots$

Q:6 Answer the following:

(A) In order to compute all the Eigen values and the corresponding Eigen vectors of a real symmetric matrix, describe Jacobi's method. [6]

(B) Explain Simpson's $\frac{1}{3}rd$ rule for approximate value of integration. [4]

OR

(A) Obtain Newton's backward difference formula for interpolation of function y=f(x) with equi spaced values of x with spacing h. [6]

(B) Deduce Lagrange's interpolation polynomial of degree n. [4]

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