Sanjay Ghodawat University, Kolhapur 2018-19

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M.Sc. I **School of Science** **Department of Physics**

PHS 507 **Mathematical Methods in Physics** **Semester – I**

End Semester Examination **Time: 30 Minutes**

Max Marks: 20

Seat No.:	**PRN No.:**	**Student Sign:**
Invigilator Sign:	**Examiner Sign:**	**Marks Obtained:**

Instructions:
1) All Questions are compulsory.
2) Mark √ to the correct option. Do not circle.
3) More than one options marked will not be considered for assessment.
4) Rough calculations on paper are not allowed
5) Use non-programmable calculator is allowed.

Q.1 Select correct alternatives	**Marks (20)**	**Bloom's Level**	**CO**
1. All diagonal elements of anti-symmetric matrix are,	01	L1	507.1

a) one b) zero
c) Any scalar d) None of the above

2. If $A = [a_{ij}]_{mxn}$ is a scalar matrix if, (where k is any scalar)	01	L1	507.1

a) $a_{ij} = 0, when\ i \neq j$ b) $a_{ij} = 0, when\ i = j$
c) $a_{ij} = k, when\ i \neq j$ d) $a_{ij} = -k, when\ i = j$

3.	A square matrix $A = (a_{ij})$ is called _____, if every i-jth element of A is equal to conjugate complex of j-ith element of A.	01	L2	507.1

a) Hermitian matrix b) Anti-hemitian matrix

c) None of the above

4.	The value of element a_{23} in matrix form of quadratic equation, $x_1^2 + x_2^2 - 3x_3^2 + 2x_1x_2 - 4x_1x_3 + 6x_2x_3$ is	01	L2	507.1

a) 1 b) -2

c) 3 d) -3

5.	If $f(z)$ has a simple pole at $z = a$, then residue $Res\ f(a) =$	01	L1	507.2

a) $\lim_{z \to a}(z + a)f(z)$ b) $\lim_{z \to a}(2z + a)f(z)$

c) $\lim_{z \to a}(z - a)f(z)$ d) $\lim_{z \to a}(2z - a)f(z)$

6.	In complex plane, multiplication of i^2 rotates the direction of axis through angle	01	L2	507.2

a) 90° b) 180°

c) 270° d) 360°

7. If $f(z)$ is analytic within and on a closed curve 'c', and if a is any point within 'c' then Cauchy's integral formula can be written as, 01 L1 507.2

a) $f(a) = \frac{1}{2\pi}\int_c \frac{f(z)}{z-a}dz$

b) $f(a) = \frac{1}{2\pi}\int_c \frac{f(z)}{z+a}dz$

c) $f(a) = \frac{1}{2\pi i}\int_c \frac{f(z)}{z-a}dz$

d) $f(a) = \frac{1}{2\pi i}\int_c \frac{f(z)}{z+a}dz$

8. The function $\frac{1}{z-2}$ has a singular point at, 01 L2 507.2

a) +2

b) -2

c) 0

d) None of the above

9. The coefficient b_n of Fourier series in interval$(-\pi, \pi)$ can be written as, 01 L1 507.3

a) $\frac{1}{2\pi}\int_{-\pi}^{\pi} f(x)\,dx$

b) $\frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\cos nx\,dx$

c) $\frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\sin nx\,dx$

d) 0

10. Cosine series in the interval $(0,\pi)$ is given as, 01 L1 507.3

a) $f(x) = \frac{1}{\pi}\int_0^{\pi} f(v)dv - \frac{2}{\pi}\sum_{n=1}^{\infty}\left\{\int_0^{\pi} f(v)\cos nv\,dv\right\}\cos nx$

b) $f(x) = \frac{1}{\pi}\int_0^{\pi} f(v)dv + \frac{2}{\pi}\sum_{n=1}^{\infty}\left\{\int_0^{\pi} f(v)\cos nv\,dv\right\}\cos nx$

c) $f(x) = \frac{1}{\pi}\int_0^{\pi} f(v)dv - \frac{1}{\pi}\sum_{n=1}^{\infty}\left\{\int_0^{\pi} f(v)\cos nv\,dv\right\}\cos nx$

d) $f(x) = \frac{1}{\pi}\int_0^{\pi} f(v)dv + \frac{1}{\pi}\sum_{n=1}^{\infty}\left\{\int_0^{\pi} f(v)\cos nv\,dv\right\}\cos nx$

11. In extended interval from $(-\pi, \pi)$ to $(-l, l)$, The coefficient a_n can be written as, 01 L1 507.3

a) $\frac{1}{2l}\int_{-l}^{l} f(x)\,dx$

b) $\frac{1}{l}\int_{-l}^{l} f(x)\cos nx\,dx$

c) $\frac{1}{l}\int_{-l}^{l} f(x)\sin nx\,dx$

d) 0

12. The function of the square wave in the interval $-\pi \le x \le 0$ can be written as, 01 L3 507.3

a) $f(x) = \frac{\pi}{2} + 2\left[\sin 2x + \frac{\sin 4x}{4} + \frac{\sin 6x}{6} + \frac{\sin 8x}{8} + \cdots\right]$

b) $f(x) = \frac{\pi}{2} + \left[\sin 2x + \frac{\sin 4x}{4} + \frac{\sin 6x}{6} + \frac{\sin 8x}{8} + \cdots\right]$

c) $f(x) = \frac{\pi}{2} + 2\left[\sin x + \frac{\sin 3x}{3} + \frac{\sin 5x}{5} + \frac{\sin 7x}{7} + \cdots\right]$

d) $f(x) = \frac{\pi}{2} + \left[\sin x + \frac{\sin 3x}{3} + \frac{\sin 5x}{5} + \frac{\sin 7x}{7} + \cdots\right]$

13. The function $f(x)$, which is periodic in the interval $(0,2l)$ with the period $2l$, i.e. $f(x+2l) = f(x)$, may be expanded into the following Fourier series: 01 L2 507.3

a) $f\left(\frac{\pi x}{l}\right) = a_0 + \sum_{n=1}^{\infty} a_n \cos\left(\frac{\pi x}{l}\right) + \sum_{n=1}^{\infty} b_n \sin\left(\frac{\pi x}{l}\right)$

b) $f\left(\frac{\pi x}{l}\right) = a_0 + \sum_{n=1}^{\infty} a_n \cos\left(\frac{n\pi x}{l}\right) + \sum_{n=1}^{\infty} b_n \sin\left(\frac{n\pi x}{l}\right)$

c) $f\left(\frac{\pi x}{l}\right) = a_0 + \sum_{n=0}^{\infty} a_n \cos\left(\frac{\pi x}{l}\right) + \sum_{n=0}^{\infty} b_n \sin\left(\frac{\pi x}{l}\right)$

d) $f\left(\frac{\pi x}{l}\right) = a_0 + \sum_{n=0}^{\infty} a_n \cos\left(\frac{n\pi x}{l}\right) + \sum_{n=0}^{\infty} b_n \sin\left(\frac{n\pi x}{l}\right)$

14. The coefficient a_n of Fourier series in interval $(-\pi, \pi)$can be written as, 01 L1 507.3

a) $\frac{1}{2\pi}\int_{-\pi}^{\pi} f(x)\, dx$

b) $\frac{1}{\pi}\int_{-\pi}^{\pi} f(x) \cos nx\, dx$

c) $\frac{1}{\pi}\int_{-\pi}^{\pi} f(x) \sin nx\, dx$

d) 0

15. The Legendre's differential equation can be written as, 01 L1 507.4

a) $(1+w^2)\frac{d^2\Theta}{d\theta^2} - 2w\frac{d\Theta}{d\theta} + \lambda\Theta = 0$

b) $(1-w^2)\frac{d^2\Theta}{d\theta^2} - 2w\frac{d\Theta}{d\theta} + \lambda\Theta = 0$

c) $(1+w)\frac{d^2\Theta}{d\theta^2} - 2w\frac{d\Theta}{d\theta} + \lambda\Theta = 0$

d) $(1-w)\frac{d^2\Theta}{d\theta^2} - 2w\frac{d\Theta}{d\theta} + \lambda\Theta = 0$

16. In spherical polar coordinates, Helmholtz's equation is given by, 01 L1 507.4

a) $\left[\nabla^2 = \nabla r + \frac{1}{r^2}\nabla^2_{\theta,\phi}\right]\psi(r,\theta,\phi) + k^2(r)\psi(r,\theta,\phi) = 0$

b) $\left[\nabla^2 = \nabla r^2 + \frac{1}{r^2}\nabla_{\theta,\phi}\right]\psi(r,\theta,\phi) + k^2(r)\psi(r,\theta,\phi) = 0$

c) $\left[\nabla^2 = \nabla r^2 + \frac{1}{r^2}\nabla^2_{\theta,\phi}\right]\psi(r,\theta,\phi) + k^2(r)\psi(r,\theta,\phi) = 0$

d) $\left[\nabla^2 = \nabla r^2 + \frac{1}{r}\nabla^2_{\theta,\phi}\right]\psi(r,\theta,\phi) + k(r)\psi(r,\theta,\phi) = 0$

17. The generating function for the Legendre's polynomial is, 01 L1 507.4

a) $\sum_{l=0}^{\infty} P_l(w)t^l = (1 - 2wt - t^2)^{-1/2}$

b) $\sum_{l=0}^{\infty} P_l(w)t^l = (1 - 2wt + t^2)^{-1/2}$

c) $\sum_{l=0}^{\infty} P_l(w)t^l = (1 + 2wt + t^2)^{-1/2}$

d) $\sum_{l=0}^{\infty} P_l(w)t^l = (1 + 2wt - t^2)^{-1/2}$

18. The radial equation can be written as, 01 L1 507.4

a) $\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dR}{dr}\right) + \left[k^2(r) + \frac{\lambda}{r^2}\right]R = 0$

b) $\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dR}{dr}\right) + \left[k^2(r) - \frac{\lambda}{r^2}\right]R = 0$

c) $\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dR}{dr}\right) + \left[k^2(r) + \frac{\lambda}{r}\right]R = 0$

d) $\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dR}{dr}\right) + \left[k^2(r) - \frac{\lambda}{r}\right]R = 0$

19. The Legendre's polynomial $P_0(w) =$ 01 L1 507.4

a) $\frac{1}{2}[3w^2 - 1]$ b) w

c) 0 d) 1

20. The Azimuthal equation can be written as, 01 L1 507.4

a) $\frac{d^2\Phi}{d\phi^2} - m^2\Phi = 0$ b) $\frac{d^2\Phi}{d\phi^2} - m\Phi = 0$

c) $\frac{d^2\Phi}{d\phi^2} + m^2\Phi = 0$ d) $\frac{d^2\Phi}{d\phi^2} + m\Phi = 0$

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EXM/P/09/00

M.Sc. I | **School of Science** | **Department of Physics**

PHS 507 | **Mathematical Methods in Physics** | **Semester – I**

Examination: End Semester Examination

Time: 2 Hours 30 Minutes

Max Marks: 80

Instructions:
1)All Questions are compulsory
2) Rough calculations on paper are not allowed
3) Use non-programmable calculator is allowed.

Q.2.	**Attempt the following**	**Marks (16)**	**CO**
1.	Find the inverse of the following matrix A by Gauss-Jordan method, $A=\begin{bmatrix}1 & 3 & 3 & 2 & 1\\ 1 & 4 & 3 & 3 & -1\\ 1 & 3 & 4 & 1 & 1\\ 1 & 1 & 1 & 1 & -1\\ 1 & -2 & -1 & 2 & 2\end{bmatrix}$	12	507.1
2.	Form the cofactor matrix of following matrix, $A=\begin{bmatrix}7 & 3 & 1\\ 2 & 1 & 9\\ 1 & 5 & 8\end{bmatrix}$	4	507.1
	Or		
2.	Form the cofactor matrix of following matrix, $B=\begin{bmatrix}9 & 1 & 7\\ 8 & 2 & 6\\ 1 & 7 & 3\end{bmatrix}$	4	507.1

Q.3.	Attempt the following	Marks (16)	CO
1.	Expand following functions in Taylor's series, A] $f(z) = \frac{1}{2}$ about z=2 B] $f(z) = \frac{1}{z^2-3z+2}$ about $\lvert z\rvert>2$ C] $f(z) = \frac{1}{z^2-3z+2}$ about $\lvert z\rvert<1$	12	507.2
2.	Find the first three terms of the Taylor's series expansion of $f(z) = \frac{1}{z^2+4}$, about z=-i.	4	507.2
	Or		
2.	Discuss and show the graphical representation of multiplication of complex numbers.	4	507.2

Q.4.	Attempt the following	Marks (24)	CO
1.	Explain the Fourier Integral and obtain the expression of the same for odd and even function.	12	507.3
2.	Extend the interval of Fourier series from $(-\pi, \pi)$ to$(-l, l)$.	8	507.3
	Or		
2.	Derive Parseval's theorem from Fourier series.	8	507.3
3.	Derive the expression for cosine and sine series.	4	507.3

Q.5.	Attempt the following	Marks (24)	CO
1.	State the Legendre's differential equation and obtain its solution.	12	507.4

2.	Develop the three ordinary differential equations from Helmholtz's equation in spherical polar coordinates.	8	507.4
	Or		
2.	Starting from solution of the Legendre's differential equation in the form of some variable w=cos θ, construct a solution which will be valid for the interval -1<w< +1.	8	507.4
3.	Obtain the Legendre's differential equation from theta equation.	4	507.4