

Name :

Roll No. :

Invigilator's Signature :

**CS / B.TECH(NEW)APM / TT / AUE / CHE / ME /
PE / CE / SEM-4 / M-402 / 2012**

2012

MATHEMATICS-III

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Short Answer Type Questions)

Answer any *ten* questions : $10 \times 2 = 20$

1. a) If $f(x) = x + x^2$, $-\pi \leq x \leq \pi$ be represented in a Fourier series as $a_0 + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$, then find the value of a_0 .
- b) State Fourier Integral theorem.
- c) If $F(s)$ is the Fourier transform of $f(x)$, then find the Fourier transform of $f(ax)$.
- d) Find the residue of $f(z) = \frac{2 + 3 \sin \pi z}{z(z-1)^2}$ at $z = 1$.
- e) Find the value of $\int_C \frac{z}{z-1} dz$ where C is the curve defined by $|z| = \frac{1}{2}$.
- f) Find the poles of the function $f(z) = z^2 / \left\{ (z-1)^2 (z+2) \right\}$.



- g) If a Poisson variate X is such that $P(X=1) = P(X=2)$, Find $P(X=4)$.
- h) For any two events A and B (may not be mutually exclusive), prove that $P(A+B) = P(A) + P(B) - P(AB)$.
- i) Find the value of p so that the function $(2x - x^2 + py^2)$ is harmonic.
- j) Find the value of $J_{\frac{1}{2}}(x)$.
- k) Prove that $(2n+1)x P_n = (n+1)P_{n+1} + nP_{n-1}$
- l) Find the ordinary and singular points of the differential equation $x^2(1+x)^2 \frac{d^2y}{dx^2} + (x^2-1) \frac{dy}{dx} + 2xy = 0$.
- m) Find the bilinear transformation which maps $z = 0, 1, \infty$ onto $\omega = -1, -i, 1$ respectively.
- n) Find the value of $\int_{-1}^1 P_0(x) dx$ where $P_n(x)$ is a Legendre's polynomial of degree n .
- o) Write down the Bessel's equation of order 2.

GROUP - B

Answer any *five* questions taking at least *one* question from each Modules. : $5 \times 10 = 50$

Module I : Fourier Series and Fourier Transform

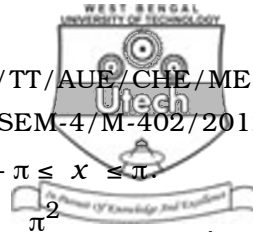
2. a) Expand $f(x) = x, -\pi \leq x \leq \pi$ in Fourier series. Hence deduce that $\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \dots$ 4 + 1

- b) Find the Fourier sine transform of $f(x)$, where

$$f(x) = \begin{cases} 1, & 0 < x \leq \pi \\ 0, & x > \pi \end{cases}$$

and hence evaluate the integral $\int_0^{\infty} \left(\frac{1 - \cos p\pi}{p} \right) \sin px \, dp$.

3 + 2



3. a) Find the Fourier series of $f(x) = x^2$, $-\pi \leq x \leq \pi$.
Hence prove that $1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \dots = \frac{\pi^2}{12}$. 4 + 1

- b) Find the function whose Fourier cosine transform is $\frac{\sin as}{s}$. 5

Module II : Calculus of Complex variable

4. a) Using Cauchy's Residue theorem, prove that $\int_0^{2\pi} \frac{d\theta}{2 + \cos \theta} = \frac{2\pi}{\sqrt{3}}$. 5

- b) Evaluate $\oint_C \frac{e^{2z}}{(z+1)^4} dz$
where C is the circle $|z| = 3$. 5

5. a) If $u = x^2 - y^2$ and $v = -\frac{y}{x^2 + y^2}$, then prove that both u and v are harmonic. 5

- b) Find the zeros and their orders of the function $f(z) = \frac{z^5 - 1}{z^2 + 5}$. 5

6. a) Expand $f(z) = \frac{z}{(z-1)(z-2)}$ in Laurent's series for $1 < |z| < 2$. 5

- b) Show that the function $f(z) = \sqrt{|xy|}$ is not analytic at the origin, although the Cauchy-Riemann conditions are satisfied at that point. 5

Module III : Probability

7. a) Two urns contain respectively 5 white, 7 black balls and 4 white, 2 black balls. One of the urns is selected by the toss of a fair coin and then 2 balls are drawn without replacement from the selected urn. If both balls are white, what is the probability that the first urn is selected? 5



b) X is a continuous random variable having probability

$$f(x) = \begin{cases} \frac{4x}{5}, & 0 < x \leq 1 \\ \frac{2(3-x)}{5}, & 1 < x \leq 2 \\ 0, & \text{elsewhere} \end{cases}$$

Find the mean value of x and the distribution function.

3 + 2

8. a) An integer is chosen at random from the first 200 positive integers. What is the probability that the integer chosen is divisible by 6 or by 8 ?

5

b) A random variable X has the following probability function :

X	0	1	2	3	4	5	6	7
$P(x)$	0	K	$2K$	$2K$	$3K$	K^2	$2K^2$	$7K^2 + K$

Obtain the value of K and estimate $P(X < 6)$ and $P(0 < X < 5)$.

5

Module IV : PDE and Series solution of ODE.

9. Use Laplace transform to solve the one dimensional wave

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2} \quad (x > 0, t > 0)$$

$$\text{where } u(x, 0) = 0, \quad \frac{\partial u}{\partial t}(x, 0) = 0, \quad x > 0$$

$$\text{and } u(0, t) = F(t), \quad u(\infty, t) = 0, \quad t \geq 0.$$

10

10. Solve the one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ by the method of separation of variables.

10

11. a) Find the series solution of ODE

$$\frac{d^2 y}{dx^2} + x \frac{dy}{dx} + x^2 y = 0 \quad \text{about } x = 0.$$

5

b) Show that $\int_{-1}^1 x^2 p_{n-1}(x) p_{n+1}(x) dx = \frac{2n(n+1)}{(2n-1)(2n+1)(2n+3)}$

5