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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)
B.E. / B. Tech (Full Time) - END SEMESTER EXAMINATIONS, APRIL/MAY 2024
Common to all branches (Except CSE)

II Semester

MA3251- Ordinary Differential Equations & Transform Techniques
(Regulation 2023)

Time: 3hrs

Max. Marks: 100

CO 1	Solve higher order ordinary differential equations which arise in engineering applications.
CO 2	Apply Laplace transform techniques in solving linear differential equations.
CO 3	Apply Fourier series techniques in engineering applications.
CO 4	Understand the Fourier transforms techniques in solving engineering problems.
CO 5	Understand the Z-transforms techniques in solving difference equations.

BL – Bloom's Taxonomy Levels

(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	What is the linearity principle in differential equations?	2	1	L2
2	Find the particular integral of $(D^2 - 2D + 1)y = xe^x \sin x$.	2	1	L1
3	Find the Laplace transform of unit step function. $1/s$	2	2	L2
4	Find $L^{-1} \left[\frac{1}{\sqrt{s+2}} \right]$	2	2	L1
5	If the Fourier series expansion of $f(x) = \begin{cases} 0, & -\pi < x < 0 \\ \frac{\pi x}{4}, & 0 < x < \pi \end{cases}$ is $\frac{\pi^2}{16} - \frac{1}{2} \sum_{n=1,3,5,\dots}^{\infty} \frac{\cos nx}{n^2} + \frac{\pi}{4} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin nx$, then find the value of the series $\sum_{n=0}^{\infty} \frac{1}{(2n+1)^2}$.	2	3	L2
6	Find the Root mean square value of $f(x) = x - x^2$ in $-1 < x < 1$.	2	3	L2

7	Express the function $f(x) = \begin{cases} 1, & x \leq 1 \\ 0, & x > 1 \end{cases}$ as a Fourier integral.	2	4	L1
8	If $f(x)$ is an even function of x , then prove that $F(s) = F[f(x)]$ is also an even function of s .	2	4	L2
9	Find the Z-transform of the sequence $\{4, 8, 16, 32, \dots\}$	2	5	L1
10	Form a difference equation by eliminating the arbitrary constant A from $y_n = A3^n$.	2	5	L2

PART- B (5 x 13 = 65 Marks)

(Restrict to a maximum of 2 subdivisions)

Q. No	Questions	Marks	CO	BL
11 (a) (i)	Solve $(D^2 + 4)y = \sec 2x$ by method of variation of parameters.	7	1	L3
(ii)	Solve $(x+2)^2 \frac{d^2y}{dx^2} - (x+2) \frac{dy}{dx} + y = 3x + 4$.	6	1	L3
(OR)				
11 (b) (i)	Solve $(D^2 - 2D - 3)y = 2e^x - 10\sin x$ by method of undetermined coefficients.	7	1	L3
(ii)	Solve: $\frac{d^2y}{dt^2} = x$ and $\frac{d^2x}{dt^2} = y$.	6	1	L3
12 (a) (i)	Find $L\left[e^{-t} \int_0^t t \cos t dt\right]$ & $L^{-1}\left[\frac{s+3}{s^2-4s+13}\right]$.	3+3	2	L4
(ii)	Verify the initial and final value theorem for the function $f(t) = 1 + e^{-t}(\sin t + \cos t)$	7	2	L4
(OR)				
12 (b) (i)	Find the Laplace transform of the periodic function $f(t) = \begin{cases} 1 + \frac{(t-a)}{a}, & 0 < t < a \\ 1 - \frac{(t-a)}{a}, & a < t < 2a \end{cases}$ with period $2a$.	6	2	L4
(ii)	Using convolution theorem, find $L^{-1}\left[\frac{s^2}{(s^2+1)(s^2+4)}\right]$	7	2	L4

13 (a) (i)	Obtain the Fourier series for the function $f(x) = 1 - \frac{2}{l} x $ in $-l \leq x \leq l$ and hence find the sum of the series $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \dots + \infty$.	7	3	L3
(ii)	Find the half range sine series for the function $f(x) = \begin{cases} x; & 0 < x < \frac{\pi}{2} \\ \pi - x; & \frac{\pi}{2} < x < \pi \end{cases}$	6	3	L3
(OR)				
13 (b) (i)	Obtain the Fourier series expansion for the function $f(x) = \begin{cases} 1; & 0 < x < 1 \\ 2; & 1 < x < 2 \end{cases}$	6	3	L3
(ii)	Find the half range cosine series for the function $f(x) = x(\pi - x)$ in $0 < x < \pi$. Hence find the value of the series $\sum_{n=1}^{\infty} \frac{1}{n^4}$. https://www.onlineanna.com	7	3	L3
14 (a) (i)	Find the Fourier transform of $f(x) = \begin{cases} x; & x \leq a \\ 0; & x > a \end{cases}$ and hence find the integral $\int_0^{\infty} \frac{\sin x - x \cos x}{x^2} \sin\left(\frac{x}{2}\right) dx$.	7	4	L4
(ii)	Obtain the Fourier sine transform of e^{-ax} and using Parseval's identity find the integral $\int_0^{\infty} \frac{x^2}{(x^2+a^2)^2} dx$.	6	4	L4
(OR)				
14 (b) (i)	Find the Fourier transform of $f(x) = \begin{cases} \frac{\sqrt{2\pi}}{2a}; & \text{for } x \leq a \\ 0; & \text{for } x > a \end{cases}$ and hence evaluate $\int_0^{\infty} \frac{\sin x}{x} dx$ & $\int_0^{\infty} \left(\frac{\sin x}{x}\right)^2 dx$.	7	4	L4
(ii)	If the Fourier cosine transform $f(x)$ is $\begin{cases} \frac{1}{2\pi} \left(a - \frac{s}{2}\right); & \text{if } s < 2a \\ 0 & ; \text{ if } s \geq a \end{cases}$, then find its function $f(x)$.	6	4	L4

15 (a) (i)	Determine the Z- transforms of $r^n \cos n\theta$ & $r^n \sin n\theta$	5	5	L3
(ii)	Find the inverse Z-transform of $\frac{z^3+3z}{(z-1)^2(z^2+1)}$ using partial fractions.	8	5	L3
(OR)				
15(b) (i)	Verify convolution theorem for $u_n = n$ & $v_n = 1$.	5	5	L3
(ii)	Solve the equation $y(n+2) + 4y(n+1) + 3y(n) = 3^n$ with $y(0) = 0$, $y(1) = 1$ by using z - transform.	8	5	L3

PART- C (1 x 15 = 16 Marks)

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL																
16 (i)	Solve $y'' - 3y' + 2y = 4t$, given $y(0) = 1$ & $y'(0) = -1$ by using Laplace transform.	8	2	L5																
(ii)	Compute the first three harmonics of the Fourier series of $f(x)$ from the following data.	7	3	L5																
	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>x</td> <td>0</td> <td>$\frac{\pi}{3}$</td> <td>$\frac{2\pi}{3}$</td> <td>π</td> <td>$\frac{4\pi}{3}$</td> <td>$\frac{5\pi}{3}$</td> <td>2π</td> </tr> <tr> <td>$f(x)$</td> <td>10</td> <td>14</td> <td>19</td> <td>17</td> <td>15</td> <td>12</td> <td>10</td> </tr> </table>	x	0	$\frac{\pi}{3}$	$\frac{2\pi}{3}$	π	$\frac{4\pi}{3}$	$\frac{5\pi}{3}$	2π	$f(x)$	10	14	19	17	15	12	10			
x	0	$\frac{\pi}{3}$	$\frac{2\pi}{3}$	π	$\frac{4\pi}{3}$	$\frac{5\pi}{3}$	2π													
$f(x)$	10	14	19	17	15	12	10													

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