ADITYA COLLEGE OF ENGINEERING AND TECHNOLOGY
Kamakshipura, Hesaraghatta Hobli, Yelahanka, Bengaluru, Karnataka, 560089
Affiliated to VTU, Belagavi, Approved by AICTE, New Delhi

Department of Engineering Mathematics
QUESTION BANK

Course	Transform Techniques and Optimization Theory	**Course Code**	1BMATEC301
Semester	III	**Scheme**	2025
Modules	Module 1: Fourier Series & Module 2: Fourier Transforms	**Credits**	4

Q. No.	Question	Level	CO
	Module 1: Fourier Series (CO1)		
1	Obtain the Fourier series of $f(x) = (\pi - x)/2$ in $0 < x < 2\pi$. Hence deduce that $\pi/4 = 1 - 1/3 + 1/5 - 1/7 + \cdots$	L2	CO1
2	Find the Fourier series of $f(x) = \lvert x \rvert$ in $-\pi < x < \pi$. Hence deduce that $\pi^2/8 = 1/1^2 + 1/3^2 + 1/5^2 + \cdots$	L2	CO1
3	Expand $f(x) = x - x^2$ as a Fourier series in $(-\pi, \pi)$. Hence deduce that $\pi^2/12 = 1/1^2 - 1/2^2 + 1/3^2 - 1/4^2 + \cdots$	L3	CO1
4	Obtain the Fourier series of the function $f(x) = \begin{cases} -\pi, & -\pi < x < 0 \\ x, & 0 < x < \pi \end{cases}$ Hence show that the sum of the reciprocals of the squares of the odd integers is $\pi^2/8$.	L3	CO1
5	Obtain the Fourier series of $f(x) = e^{-ax}$ in the interval $(-\pi, \pi)$. Hence, taking $a = 1$ and $x = 0$, deduce that $\pi/\sinh \pi = 1 + 2\sum_{n=1}^{\infty} (-1)^n/(n^2 + 1)$.	L3	CO1
6	Find the Fourier series expansion of $f(x) = \begin{cases} x, & 0 \le x \le \pi \\ 2\pi - x, & \pi \le x \le 2\pi \end{cases}$ Hence deduce that $\pi^2/8 = 1/1^2 + 1/3^2 + 1/5^2 + \cdots$	L2	CO1
7	Find the Fourier series of the periodic function $f(x) = 2x - x^2$ in the interval $0 < x < 3$ (arbitrary period $2l = 3$).	L3	CO1
8	Obtain the Fourier series for the function (period 2) $f(x) = \begin{cases} \pi x, & 0 \le x \le 1 \\ \pi(2 - x), & 1 \le x \le 2 \end{cases}$ Hence deduce that $\pi^2/8 = \sum_{n=1}^{\infty} 1/(2n - 1)^2$.	L3	CO1
9	Expand $f(x) = 2x - 1$ as a cosine half range Fourier series in $0 < x < 1$.	L2	CO1
10	Find the cosine half range Fourier series of $f(x) = (x - 1)^2$ in $0 < x < 1$. Hence deduce that $\pi^2/6 = 1/1^2 + 1/2^2 + 1/3^2 + \cdots$	L3	CO1

<table>
<tr><th>Q. No.</th><th>Question</th><th>Level</th><th>CO</th></tr>
<tr><td>11</td><td>Obtain the cosine half range Fourier series of $f(x) = x^2$ in $0 < x < \pi$.</td><td>L3</td><td>CO1</td></tr>
<tr><td>12</td><td>Obtain the constant term and the coefficients of the first cosine and sine terms in the Fourier series expansion of y (period 6) from the following data:
<table>
<tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>y</td><td>9</td><td>18</td><td>24</td><td>28</td><td>26</td><td>20</td></tr>
</table></td><td>L3</td><td>CO1</td></tr>
<tr><td>13</td><td>Compute the constant term and the first two harmonics of the Fourier series of f(x) from the following table:
<table>
<tr><td>x</td><td>0</td><td>$\pi/3$</td><td>$2\pi/3$</td><td>π</td><td>$4\pi/3$</td><td>$5\pi/3$</td><td>2π</td></tr>
<tr><td>f(x)</td><td>1.0</td><td>1.4</td><td>1.9</td><td>1.7</td><td>1.5</td><td>1.2</td><td>1.0</td></tr>
</table></td><td>L3</td><td>CO1</td></tr>
<tr><td>14</td><td>Obtain the constant term and the coefficients of the first cosine and sine terms in the Fourier series expansion of y from the following table:
<table>
<tr><td>x</td><td>0°</td><td>60°</td><td>120°</td><td>180°</td><td>240°</td><td>300°</td><td>360°</td></tr>
<tr><td>y</td><td>7.9</td><td>7.2</td><td>3.6</td><td>0.5</td><td>0.9</td><td>6.8</td><td>7.9</td></tr>
</table></td><td>L3</td><td>CO1</td></tr>
<tr><td>15</td><td>The following table gives the variation of a periodic current A over a period T. Show that there is a direct current part of 0.75 amp in the variable current and obtain the amplitude of the first harmonic:
<table>
<tr><td>t (sec)</td><td>0</td><td>T/6</td><td>T/3</td><td>T/2</td><td>2T/3</td><td>5T/6</td><td>T</td></tr>
<tr><td>A (amp)</td><td>1.98</td><td>1.30</td><td>1.05</td><td>1.30</td><td>−0.88</td><td>−0.25</td><td>1.98</td></tr>
</table></td><td>L3</td><td>CO1</td></tr>
</table>

Q. No.	Question	Level	CO
	Module 2: Fourier Transforms (CO2)		
16	Find the Fourier transform of $f(x) = e^{-\lvert x\rvert}$.	L2	CO2
17	Find the Fourier transform of f(x) = $\{ 1, \lvert x\rvert \le a$ $\{ 0, \lvert x\rvert > a$ Hence evaluate (i) $\int_0^\infty (\sin ax \cos sx)/x\, dx$ and (ii) $\int_0^\infty (\sin x)/x\, dx$.	L2	CO2
18	Find the Fourier transform of f(x) = $\{ 1 - \lvert x\rvert, \lvert x\rvert \le 1$ $\{ 0, \lvert x\rvert > 1$ Hence deduce that $\int_0^\infty (\sin^2 t)/t^2\, dt = \pi/2$.	L2	CO2
19	Find the Fourier transform of f(x) = $\{ 1 - x^2, \lvert x\rvert < 1$ $\{ 0, \lvert x\rvert > 1$ Hence evaluate (i) $\int_0^\infty (x \cos x - \sin x)/x^3\, dx$ and (ii) $\int_0^\infty ((x \cos x - \sin x)/x^3) \cos(x/2)\, dx$.	L3	CO2

Q. No.	Question	Level	CO
20	Find the complex Fourier transform of $f(x) = e^{-a^{2}x^{2}}$, $a > 0$. Hence show that $e^{-x^{2}/2}$ is self-reciprocal under the Fourier transform.	L3	CO2
21	Find the Fourier sine and cosine transforms of $f(x) = e^{-ax}$, $a > 0$. Hence deduce that $\int_0^\infty \cos mx/(a^2 + x^2)\, dx = (\pi/2a)\, e^{-am}$.	L3	CO2
22	Find the Fourier sine transform of $f(x) = e^{-ax}/x$, $a > 0$.	L3	CO2
23	Obtain the Fourier cosine transform of the function $f(x) = \begin{cases} x, & 0 < x < 1 \\ 2 - x, & 1 < x < 2 \\ 0, & x > 2 \end{cases}$	L3	CO2
24	Solve the integral equation $\int_0^\infty f(\theta) \cos \alpha\theta\, d\theta = \begin{cases} 1 - \alpha, & 0 \le \alpha \le 1 \\ 0, & \alpha > 1 \end{cases}$ Hence evaluate $\int_0^\infty (\sin^2 t)/t^2\, dt$.	L3	CO2
25	Obtain the inverse Fourier cosine transform of $F_c(s) = (\sin as)/s$, $a > 0$.	L3	CO2
26	Find the Discrete Fourier transform (DFT) of the sequence $f = [3, 4, 5, 5]^T$. Also find the inverse DFT of the sequence so obtained.	L3	CO2
27	Find the transform of the sequence $f = [0, 1, 4, 9]^T$ of four values using the Fast Fourier Transform (FFT).	L3	CO2