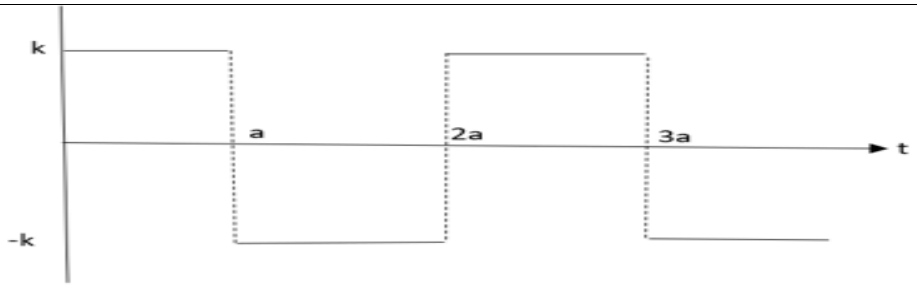
MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING
(A Unit of Rajalaxmi Education Trust®, Mangalore)
Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi
Accredited by NAAC with A+ Grade & ISO 9001:2015 Certified Institution

Model Question Paper
Third Semester B.E Degree Examination

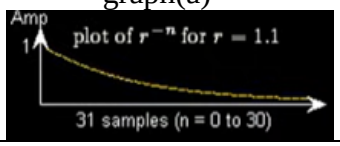
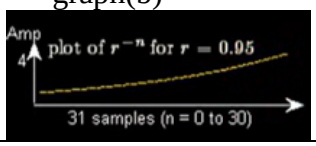
ENGINEERING MATHEMATICS III

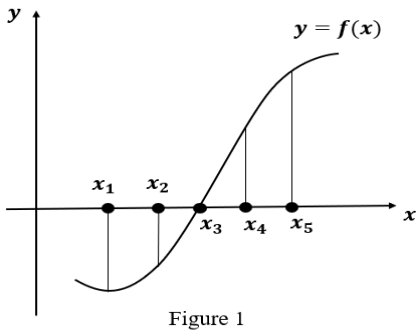
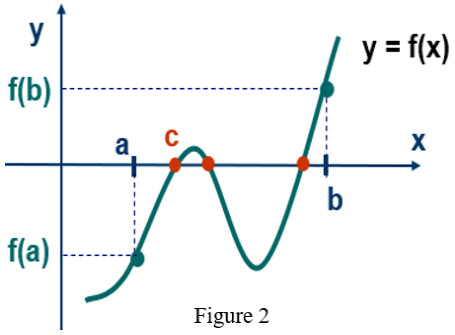
Time: 3 Hours **Max. Marks: 100**

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M: Marks, L: RBT (Revised Bloom's Taxonomy) level, C: Course outcomes.

		Module -1	M	L	C
Q1	a.	 Figure 1(a) From the square wave graph determine the $f(t)$ for different intervals.	05	L3	CO1
	b.	(i) Evaluate $L\{t\,cos3t\}$ (ii) Find the Laplace Transform of $\begin{cases} cost & 0 < t \leq \pi \\ sint & t > \pi \end{cases}$ using unit step function.	08	L3	CO2
	c.	Find the current *i(t)* in an RL circuit where $R = 1\ ohm\ , L = 1 henry$ and the applied voltage is $v(t) = u(t)(unit\ step\ function) with\ i(0) = 0$.	07	L3	CO4
		OR			
Q2	a.	(i) Given that $\frac{5}{s^2+4}$. Determine the function $f(t)$ by applying appropriate transform. (ii)) Given that $t^5 + 2t$. Determine the function $F(s)$ by applying appropriate transform.	05	L3	CO1
	b.	(i) Evaluate $L^{-1}\left(\frac{3s+2}{s^2-s-2}\right)$ (ii) Using convolution theorem, find the inverse Laplace Transform of $\frac{1}{s(s^2+a^2)}$	08	L3	CO2
	c.	Determine the displacement $x(t)$ of a mass spring damper system described by $m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F(t), where\ m = 1\ ; c = -2\ ; k = 1\ \ and$ $F(t) = 10u(t)\ (unit\ step\ function)\ \ with\ x(0) = 0\ , \frac{dx(0)}{dt} = 0$	07	L3	CO4
		Module- 2			
Q3	a.	A structural engineer is analyzing a vibrating system where the displacement follows the periodic function $f(x) = \mid x \mid\ , -2 < x < 2$, with a period of 4. By visualizing	05	L3	CO1

		this periodic behavior, the engineer can identify repeating vibration patterns, which aids in designing systems to control or dampen unwanted oscillations. (i) Plot the periodic function $f(x) = \| x \|$ (ii) Determine whether the function $f(x) = \| x \|$ is an even function or odd function. (iii) Identify the Fourier coefficient that evaluates to zero in the Fourier series of a given function $f(x) = \| x \|$.			
	b.	Obtain the Fourier series for $f(x) = e^{-x}$ in the interval $0 < x < 2\pi$.	08	L3	CO2
	c.	A mechanical engineer is analyzing the motion of a machine part connected to a flywheel. The displacement of the part, represented by y, varies with the rotation angle x of the flywheel. The engineer collects the following data points for y corresponding to various values of x: x (degrees): 0, 60, 120, 180, 240, 300, 360 y(displacement): 1.98, 2.15, 2.77, -0.22, -0.31, 1.43, 1.98 Deter mine the value of the displacement y when the angle $x = 70$	07	L3	CO4
		OR			
Q4	a.	A mechanical engineer studies the linear displacement of a robotic arm modeled by the function $f(x) = sinx$ for the interval $-\pi < x < \pi$. Understanding this relationship is crucial for optimizing the arm's movement and control. (i) Plot the function $f(x) = sinx$ for the interval $-\pi < x < \pi$. (ii) Determine whether the function $f(x) = sinx$ is an even function, an odd function, or neither. (iii) Calculate the average value of the function over the specified interval.	05	L3	CO1
	b.	Find the Fourier series expansion for $f(x) = \begin{cases} -\pi, & -\pi < x < 0 \\ x, & 0 < x < \pi \end{cases}$ and hence deduce that $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \cdots = \frac{\pi^2}{8}$	08	L3	CO2
	c.	The turning moment 'M' units of a crank shaft of a steam engine are given for a series of values of the crank angle 'θ' in degrees. Obtain first two terms of sine series to represent M. Also verify the value M from obtained function at $\theta = 60^0$ θ: 0^0, 30^0, 60^0, 90^0, 120^0, 150^0 M: 0, 5224, 8097, 7850, 5499, 2656	07	L3	CO4
		Module - 3			
Q5	a.	You are a physicist studying the heat distribution along an infinitely long metal rod. Initially, a localized heat source is applied at the center of the rod, causing the temperature to be highest there and gradually decrease as you move away from the center. Over time, the heat dissipates along the rod, creating a temperature distribution that decreases exponentially $e^{-\|t\|}$ with distance from the center. (i) Find the transformation involved in the heat distribution. (ii) Identify $f(t)$ value for $t \geq 0$ *and* $t < 0$. (iii) Determine the discontinuous point for the function $f(t)$.	05	L3	CO1
	b.	Find the inverse Fourier transform of $e^{-\omega^2}$	08	L3	CO2

	c.	Consider a suspension bridge subject to periodic forces, like wind or traffic. The bridge can experience oscillations, especially when external forces are applied at certain intervals. For the oscillations $u_{n+2} + u_n = 0$ determine its behavior.	07	L3	CO4
		OR			
Q6	a.	In modern smart homes, digital thermostats are used to regulate the temperature by adjusting heating or cooling systems based on user preferences and real-time environmental conditions. The thermostat continuously samples the room temperature at regular intervals, Using a thermostat control system Find the transformation involved in the thermostat control system and obtain the mathematical expression involved. Specify the nature of the graph of Transformation . graph(a)  graph(b) 	05	L3	CO1
	b.	Using Taylor's series method, obtain the values of y at $x = 0.1, 0.2, 0.3$ to four significant figures if y satisfies the equation $y'' = -xy$ given that y'=0.5 and $y = 1$ $when$ $x = 0$ taking the first five terms of the Taylor's series expansion.	08	L3	CO2
	c.	Imagine you are an electrical engineer tasked with designing a low- pass filter for a communication system. The filter needs to allow signals with frequencies up to a certain limit to pass through while attenuating higher frequencies. The impulse response of the ideal low-pass filter in the time domain is given by a function $f(x)$, which is 1 for a certain range of $\|x\| < 1$ and 0 outside this range obtain the spectrum of signals of the above low pass filter.	07	L3	CO4
		Module – 4			
Q7	a.	A market researcher is analyzing customer satisfaction ratings for a product. It is observed that the customer satisfaction ratings for the product are increasing over several years. The ratings are recorded for the years 2015, 2017, 2019, and 2021 as follows 75%, 82%, 88% and 91% respectively. i) Determine the likely customer satisfaction rating for 2020 based on the trend from 2019 to 2021. ii) Compute the differences of the satisfaction ratings and conclude whether the last difference is zero or nonzero.	05	L3	CO1
	b.	From the following table estimate the number of students who have obtained marks between 40 and 45 Marks | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 No. of Students | 31 | 73 | 124 | 159 | 190	08	L3	CO3
	c.	A weather station records the daily maximum temperature at specific intervals during the first week of January. However, due to equipment limitations, they could only record temperature every third day. Date | 1/1/2024 | 4/1/2024 | 7/1/2024 | 10/1/2024 | 13/1/2024 Temp (C) | 5 | 8 | 7 | 10 | 9 (i) Determine the temperature for the missing day 2/1/2024 in the recorded data. Determine the temperature for the day 14/1/2024 based on the given data.	07	L3	CO4
		OR			
Q8	a.	A mechanical engineer is analyzing the stress-strain relationship of a particular material under varying load conditions. The following data points represent the measured strain at different stress levels:	05	L3	CO1

		Stress (MPa) | 10 | 15 | 25 | 40 Strain ($\times 10^{-3}$) | 1.5 | 2.3 | 4.2 | 8.0 (i) Determine the first divided differences for the given stress-strain. i. (ii) Determine the class intervals of stress values that are used to calculate the second finite difference values.			
	b.	Find the polynomial $f(x)$ using Lagrange's interpolation formula for the following data and hence find $f(3)$ x | 0 | 1 | 2 | 5 $f(x)$ | 2 | 3 | 12 | 147	08	L3	CO3
	c.	While analysing the fuel efficiency of a car based on test data are collected at irregular intervals, the following measurements were recorded: (i) At 10 minutes: 15 miles per gallon (mpg) (ii) At 25 minutes: 20 mpg (iii) At 50 minutes: 22 mpg Determine the car's fuel efficiency at 30 minutes to assist the driver.	07	L3	CO4
Module – 5					
Q9	a.	 Figure 1  Figure 2 (i) Determine the real root of the equation $f(x) = 0$ from Figure 1. (ii) Determine the nearest class interval to find real root from Figure 1. Determine the number of real roots from Figure 2.	05	L3	CO1
	b.	Apply Newton-Raphson's method to obtain the smallest positive root of the equation $cosx = x\,e^{x}$ correct to four decimal places.	08	L3	CO3
	c.	A slider in a machine moves along a fixed straight rod. Its distance $x\ cm.$ along the rod is given below for various values of the time t seconds. Find the velocity of the slider and its acceleration when $t = 0.3$ second. Also, interpret the obtained velocity and acceleration for the given slider. t | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 x | 30.13 | 31.62 | 32.87 | 33.64 | 33.95 | 33.81 | 33.24	07	L3	CO4
OR					
Q10	a.	The velocity $v\ (km/min)$ of a person participating in marathon which starts from rest, is given at fixed intervals of time $t\ (min)$ as follows: t | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 v | 10 | 18 | 25 | 29 | 32 | 20 | 11 | 5 | 2 | 0 (i) Determine lower and upper limit of time t. (ii) Determine the n value for the above scenario. Interpret the relation between velocity and time from the given data.	05	L3	CO1

<table>
<tr><td></td><td>b.</td><td>Evaluate $\int_0^1 \frac{x}{1+x^2} dx$ by using the Simpson's $\frac{1}{3}^{rd}$ rule taking six equal strips, and hence deduce an appropriate value of $log2$.</td><td>08</td><td>L3</td><td>CO3</td></tr>
<tr><td></td><td>c.</td><td>A rocket is launched from the ground. Its acceleration is registered during the first eighty seconds and is given in the table below. Applying appropriate rule, find the velocity of the rocket at $t = 80\ seconds$.
<table>
<tr><td>t</td><td>0</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td><td>70</td><td>80</td></tr>
<tr><td>f</td><td>30</td><td>31.63</td><td>33.34</td><td>35.47</td><td>37.75</td><td>40.33</td><td>43.25</td><td>46.69</td><td>50.67</td></tr>
</table></td><td>07</td><td>L3</td><td>CO4</td></tr>
</table>

-*****-