CBCS SCHEME

USN | | | | | | | | | |

21MAT31

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Transform Calculus Fourier Series & Numerical Techniques

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Find the Laplace transform of, (i) $e^{-3t}\sin 5t.\cos 3t$ (ii) $\dfrac{e^{at}-e^{bt}}{t}$. **(06 Marks)**

b. If a periodic function of period 'a' is defined by $f(t)=\begin{cases} E, & \text{for } 0<t<\frac{a}{2} \\ -E, & \text{for } \frac{a}{2}<t<a \end{cases}$ then show that $L\{f(t)\}=\dfrac{E}{S}\tanh\left(\dfrac{as}{4}\right)$. **(07 Marks)**

c. Using convolution theorem find the inverse Laplace transform of $\dfrac{s}{(s+2)(s^2+9)}$. **(07 Marks)**

OR

2 a. Express the function $f(t)=\begin{cases} \cos t & \text{for } 0<t<\pi \\ \cos 2t & \text{for } \pi<t<2\pi \\ \cos 3t & t>2\pi \end{cases}$ interms of unit step function and hence find its Laplace transform. **(07 Marks)**

b. Find the inverse laplace transform of $\dfrac{2s^2-6s+5}{s^3-6s^2+11s-6}$. **(06 Marks)**

c. Solve the differential equation $\dfrac{d^2y}{dt^2}+4\dfrac{dy}{dt}+4y=e^{-t}$ with $y(0)=y'(0)=0$ by using Laplace transform. **(07 Marks)**

Module-2

3 a. Find a Fourier series to represent $f(x)=|x|$ in $-\pi\le x\le\pi$. **(06 Marks)**

b. Obtain the half-range cosine series for $f(x)=x\sin x$ in $(0,\pi)$ and hence show that $\dfrac{\pi-2}{4}=\dfrac{1}{1.3}-\dfrac{1}{3.5}+\dfrac{1}{5.7}-\ldots\ldots\infty$ **(07 Marks)**

c. Express y as a Fourier series up to second harmonics for the following data :

x:	0	$\frac{\pi}{3}$	$\frac{2\pi}{3}$	π	$\frac{4\pi}{3}$	$\frac{5\pi}{3}$	2π
y:	1	1.4	1.9	1.7	1.5	1.2	1.0

(07 Marks)

OR

4 a. Obtain the Fourier series expansion for the function, $f(x) = 2x - x^2$ in (0, 2). **(06 Marks)**

b. Find the half range sine series for the function, $f(x) = \begin{cases} \frac{1}{4} - x & \text{for } 0 < x < \frac{1}{2} \\ x - \frac{3}{4} & \text{for } \frac{1}{2} < x < 1 \end{cases}$ **(07 Marks)**

c. The following table gives the variation of periodic current over period :

t sec :	0	$\frac{T}{6}$	$\frac{T}{3}$	$\frac{T}{2}$	$\frac{2T}{3}$	$\frac{5T}{6}$	T
A (amp) :	1.98	1.30	1.05	1.30	– 0.88	– 0.25	1.98

Show that there is a direct current part of 0.75 amp in the variable current and obtain the amplitude of the first harmonic. **(07 Marks)**

Module-3

5 a. Find the Fourier transform of the function $f(x) = \begin{cases} 1 - x^2 & \text{for } |x| \le 1 \\ 0 & \text{for } |x| > 1 \end{cases}$. Hence evaluate $\int_0^\infty \left(\frac{x\cos x - \sin x}{x^3}\right) dx$. **(06 Marks)**

b. Find the Fourier sine and cosine transform of $f(x) = \begin{cases} x & \text{if } 0 < x < 1 \\ 2 - x & \text{if } 1 < x < 2 \\ 0 & \text{otherwise} \end{cases}$. **(07 Marks)**

c. Find the z-transform of $\cosh\left(n\frac{\pi}{2} + \theta\right)$. **(07 Marks)**

OR

6 a. Find the Fourier sine transform of $f(x) = e^{-ax}$, a>0. **(06 Marks)**

b. Find the inverse z transform of $\frac{18z^2}{(2z-1)(4z+1)}$. **(07 Marks)**

c. Solve the difference equation $u_{n+2} + 6u_{n+1} + 9u_n = z^n$ with $u_0 = u_1 = 0$ using z-transform. **(07 Marks)**

Module-4

7 a. Classify the following partial differential equations :

(i) $\frac{\partial^2 u}{\partial x^2} + 4\frac{\partial^2 u}{\partial x \partial y} + 4\frac{\partial^2 u}{\partial y^2} - \frac{\partial u}{\partial x} + 2\frac{\partial u}{\partial y} = 0$.

(ii) $x^2\frac{\partial^2 u}{\partial x^2} + (1 - y^2)\frac{\partial^2 u}{\partial y^2} = 0$, $-\infty < x < \infty$, $-1 < y < 1$.

(iii) $(1 + x^2)\frac{\partial^2 u}{\partial x^2} + (5 + 2x^2)\frac{\partial^2 u}{\partial x \partial t} + (4 + x^2)\frac{\partial^2 u}{\partial t^2} = 0$.

(iv) $(x + 1)\frac{\partial^2 u}{\partial x^2} - 2(x + 2)\frac{\partial^2 u}{\partial x \partial y} + (x + 3)\frac{\partial^2 u}{\partial y^2} = 0$. **(10 Marks)**

b. Evaluate the values at the mesh points for the equation $u_{tt} = 16u_{xx}$ taking h = 1 upto t = 1.25. The boundary conditions are u(0, t) = u(5, t) = 0 and the initial conditions are $u(x, 0) = x^2(5 - x)$ and $u_t(x, 0) = 0$. **(10 Marks)**

OR

8 a. Using Schmidt two-level formula to solve the equation $\frac{\partial^2 u}{\partial x^2} = \frac{\partial u}{\partial t}$ under the conditions,

(i) $u(0, t) = u(1, t) = 0 \quad t \geq 0$

(ii) $u(x, 0) = \sin \pi x, \quad 0 < x < 1$ by taking $h = \frac{1}{4}$ and $\alpha = \frac{1}{6}$ co. **(10 Marks)**

b. Solve the two-dimensional Laplace equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ at the interior mesh points of the square region and the values of u at the mesh points on the foundary are shown in Fig.Q8 (b).

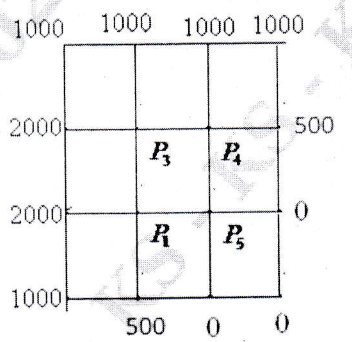


Fig. Q8 (b) **(10 Marks)**

Module-5

9 a. Using Runge-Kutta method of 4^{th} order to solve the differential equation $\frac{d^2y}{dx^2} + 2x\frac{dy}{dx} - 4y = 0$ with $y(0) = 0.2$ and $y'(0) = 0.5$ for $x = 0.1$. Correct to four decimal places. **(07 Marks)**

b. State and prove Euler's equation. **(07 Marks)**

c. Find the extremal of the functional $I = \int_0^{\frac{\pi}{2}} \left(y^2 - y'^2 - 2y \sin x\right) dx$ under the end conditions $y(0) = 0, \; y\left(\frac{\pi}{2}\right) = 0$ **(06 Marks)**

OR

10 a. Apply Milne's method to compute y(0.3). Given that $\frac{d^2y}{dx^2} = 1 - 2y\frac{dy}{dx}$ and $y(0) = 0$, $y(0.2) = 0.02$, $y(0.4) = 0.0795$, $y(0.6) = 0.1762$, $y'(0) = 0$, $y'(0.2) = 0.1996$, $y'(0.4) = 0.3937$, $y'(0.6) = 0.5689$ **(07 Marks)**

b. Prove that the shortest distance between two points in a plane is a straight line. **(07 Marks)**

c. Find the extremal of the functional $I = \int_{x_1}^{x_2} \left(y^2 + y'^2 + 2ye^x\right) dx$ **(06 Marks)**

* * * * *

CBCS SCHEME

USN | | | | | | | | | | |

21EC32

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Digital System Design using Verilog

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following terms with an example
(i) Maxterms
(ii) Miniterms
(iii) Combinational logic circuit **(06 Marks)**

b. Place the following equations into the proper canonical form:
(i) $P = f(a, b, c) = ab' + ac' + bc$
(ii) $J = f(A, B, C, D) = (A + B' + C)(A' + D)$ **(06 Marks)**

c. Design a combinational circuit to output the 2's complement of a 4-bit binary number. **(08 Marks)**

OR

2 a. Simplify the following Boolean function by using Q.M. method:
$S = f(w, x, y, z) = \sum(1, 3, 13, 15) + \sum d(8, 9, 10, 11)$ **(08 Marks)**

b. Obtain the simplified expression for the given four-variable equation using K-map and identify prime implicant and essential prime implicant.
$K = f(w, x, y, z) = \sum(0, 1, 4, 5, 9, 11, 13, 15)$ **(06 Marks)**

c. Explain briefly K-map, incompletely specified functions, essential prime implicants. **(06 Marks)**

Module-2

3 a. Implement $f(a, b, c, d) = \sum m(0, 1, 5, 6, 7, 9, 10, 15)$ using:
i) 8 : 1 MUX with a, b, c as select lines
ii) 4 : 1 MUX with a, b as select lines **(08 Marks)**

b. Explain the carry look ahead adder with necessary diagram and relevant expressions. **(06 Marks)**

c. Design 4:2 line priority encoder which gives MSB the highest priority and LSB least priority. **(06 Marks)**

OR

4 a. Design 2-bit comparator using gates. **(08 Marks)**

b. Explain the structure of programmable logic arrays with an example. **(06 Marks)**

c. List the applications of decoder. Implement a full adder circuit using 3:8 decoder. **(06 Marks)**

Module-3

5 a. Explain Master-Slave SR flipflop with necessary truth table and timing waveforms. **(06 Marks)**

b. Find characteristic equations for J-K and T flip-flops with the help of function tables. **(06 Marks)**

c. Describe with neat diagrams the working and truth table of twisted ring counter and Mod-4 ring counter. **(08 Marks)**

OR

6 a. Explain serial-in serial out and serial-in parallel out unidirectional shift register with neat diagrams. **(06 Marks)**

b. Explain 4 bit synchronous binary counter with necessary timing waveforms. **(06 Marks)**

c. Design a synchronous Mod-6 counter using clocked JK flipflops. **(08 Marks)**

Module-4

7 a. Describe the structure of the verilog module with an example. **(06 Marks)**

b. Briefly explain the different data types in verilog. **(08 Marks)**

c. Write a verilog data flow description for full adder circuit. **(06 Marks)**

OR

8 a. Write a verilog code for 2:1 miltiplexer with active low enable. **(06 Marks)**

b. Explain with an example how signal declaration and constant declaration is done is verilog. **(06 Marks)**

c. Discuss the shift operators and bitwise logical operators in verilog with examples. **(08 Marks)**

Module-5

9 a. Explain if-else structure and design a behavioral description of a D-latch using if statement. **(06 Marks)**

b. Realize 3:8 decoder using verilog behavioral description. **(06 Marks)**

c. Write a verilog description of a 4 × 4 bit Booth algorithm. **(08 Marks)**

OR

10 a. Write a structural description of a Half adder by describing the built in gates in verilog. **(06 Marks)**

b. Write a verilog structural description of ripple carry adder. **(06 Marks)**

c. Realize binary up/down counter using verilog behavioral description. **(08 Marks)**

* * * * *

CBCS SCHEME

USN | | | | | | | | | | |

21EC33

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Basic Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Write the complete solution $x = x_p + x_n$. to

$$A = \begin{bmatrix} 1 & 2 & 2 & 2 \\ 2 & 4 & 6 & 8 \\ 3 & 6 & 8 & 10 \end{bmatrix}.$$ **(10 Marks)**

b. Define the four fundamental vector spaces and find the Dimension and basis for four fundamental subspaces for :

$$A = \begin{bmatrix} 1 & 2 & 3 & 5 \\ 2 & 4 & 8 & 12 \\ 3 & 6 & 7 & 13 \end{bmatrix}.$$ **(10 Marks)**

OR

2 a. Illustrate the transformation of the plane that comes from four matrices and list the transformations T(x) that are not possible with Ax. **(10 Marks)**

b. Compute A^TA and their eigen values and unit eigen vectors for V and u. Then check $AV = u\Sigma$.

$$A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \\ -1 & 1 \end{bmatrix}.$$ **(10 Marks)**

Module-2

3 a. What is an orthogonal matrix. Apply the gram Schmidt process to

$$a = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad b = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} \quad c = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$ and write the result in the form of A = QR. **(10 Marks)**

b. Find the projection of b onto the column space of A.

$$A = \begin{bmatrix} 1 & 1 \\ 1 & -1 \\ -2 & 4 \end{bmatrix} \quad b = \begin{bmatrix} 1 \\ 2 \\ 7 \end{bmatrix}.$$ **(10 Marks)**

OR

4 a. Find eigen values and eigen vectors for the matrix. A can the matrix be diagonalized.

$$A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}.$$ **(10 Marks)**

b. i) What is a positive definite matrix? Mention the methods of testing positive definiteness. **(04 Marks)**

ii) Decide for or against the positive definiteness of

$$A = \begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{bmatrix} \quad B = \begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & 1 \\ -1 & 1 & 2 \end{bmatrix}.$$ **(06 Marks)**

Module-3

5 a. Define a signal. List the elementary signals. Differentiate between even and odd signals, energy and power signals. **(10 Marks)**

b. Sketch the even the odd part of the signals shown in Fig.Q5(b)(i) and 5(b)(ii).

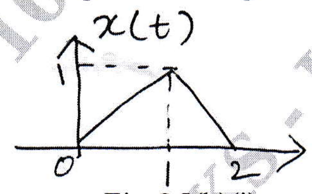
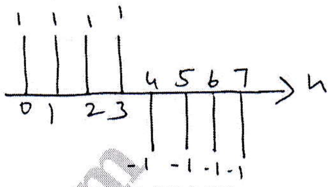


Fig.Q5(b)(i)



Fig,Q5(b)(ii) **(08 Marks)**

c. Determine whether the following signal is periodic or not. If periodic find the fundamental period $x(n) = \cos\left(\frac{n\pi}{5}\right)\sin\left(\frac{n\pi}{3}\right)$. **(02 Marks)**

OR

6 a. Determine whether the following systems are memoryless, causal time invariant, linear and stable. i) $y(n) = nx(n)$ ii) $y(t) = x(t/2)$. **(08 Marks)**

b. For the signal x(t) and y(t) shown in Fig.6(a) sketch the following signals :
i) $x(t+1)y(t-2)$ ii) $x(t)y(t-1)$

Fig.Q6(b) **(08 Marks)**

c. Sketch the waveform of the signal : $x(t) = u(t+1) - 2u(t) + u(t-1)$. **(04 Marks)**

Module-4

7 a. Compute the following convolution :

i) $y(t) = e^{-2}u(t-2) * \{u(t-2) - u(t-12)\}$

ii) $y(n) = \alpha^n\{u(n) - u(n-6)\} * 2\{u(n) - 4(n-15)\}$. **(14 Marks)**

b. Prove the following :

i) $x(t) * \delta(t - t_0) = x(t - t_0)$

ii) $x(n) * u(n) = \sum_{k=-\infty}^{n} X(k)$. **(06 Marks)**

OR

8 a. Evaluate the step response for LTI system represented by the following impulse response :

i) $h(t) = u(t + 1) - u(t - 1)$

ii) $h(n) = (1/2)^n u(n)$. **(08 Marks)**

b. Determine whether the following system defined by their impulse response are causes memoryless and stable.

i) $h(t) = e^{-2t}u(t-1)$

ii) $h(n) = 2u(n) - 2u(n-5)$. **(08 Marks)**

c. A system consists of several subsystems connected as shown in Fig.Q8(c). Find the operator H relating x(t) to y(t) for the following subsystem operators.

$H1 : Y_1(t) = X_1(t)X_1(t-1)$

$H2 : Y_2(t) = |X_2(t)|$

$H3 : Y_3(t) = 1 + 2X_3(t)$

$H4 : Y_4(t) = \cos(X_4(t))$.

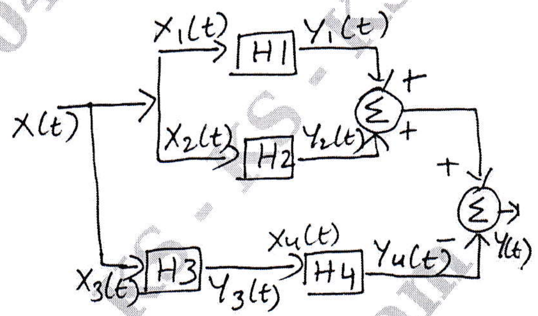


Fig.Q8(c) **(04 Marks)**

Module-5

9 a. Describe the properties of region of convergence and sketch the ROL of two sided, ,right sided and lift sided sequence. **(08 Marks)**

b. Find Z – tranform of the following and specify its ROC

$x(n) = \sin\left(\frac{\pi}{4}^{n} - -\frac{\pi}{2}\right)u(n-2)$

$x(n) = \left(\frac{2}{3}\right)^{n}u(n) * 2^{n}u(-n-3)$. **(08 Marks)**

c. Find inverse Z-transform if $X(z) = \dfrac{\left(\frac{1}{4}\right)Z^{-1}}{\left(1-\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}$. **(04 Marks)**

OR

10 a. Describe the transfer function and the impulse response for the causal LTI system described by the differential equation :

$y(n) - \frac{1}{4}y(n-1) - \frac{3}{8}y(n-2) = -x(n) + 2x(n-1)$. **(10 Marks)**

b. Determine the impulse response of the following transfer function if :

i) The system is causal

ii) The system is stable

iii) The system is stable and causal at the same time : $H(z) = \dfrac{3z^{+2} - z}{(z-2)\left(z+\frac{1}{2}\right)}$. **(10 Marks)**

* * * * *

CBCS SCHEME

USN | | | | | | | | | | 21EC34

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Analog Electronic Circuits

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Explain biasing of BJT by collector to base feedback resistor for a CE amplifier. **(08 Marks)**

b. A BJT having $\beta = 100$ is biased at a DC collector current of 1 mA. Find the value of g_m, r_e, r_π at the bias point. Assume $V_T = \frac{1}{40} V$. **(04 Marks)**

c. Draw the small signal equivalent circuit model for MOSFET and obtain the expression for voltage gain. **(08 Marks)**

OR

2 a. Explain biasing of MOSFET using drain to gate feedback resistor. **(06 Marks)**

b. What is transconductance of a MOSFET and mention the three different expression used to calculate the g_m. **(06 Marks)**

c. For the circuit shown in Fig. Q2 (c), find the required value of V_{GS} to establish a dc bias current $I_D = 0.5$ mA. Device parameters are $V_t = 1$ V, $K_n' \frac{\omega}{L} = 1$ mA/V^2 and $\lambda = 0$. What is the percentage change in I_D obtained when the transistor is replaced with another having $V_t = 1.5$ V. **(08 Marks)**

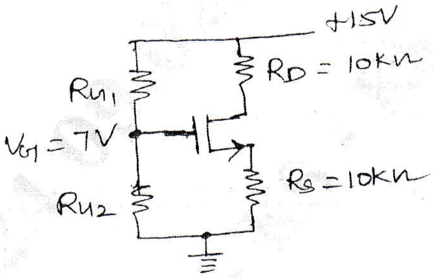


Fig. Q2 (c)

Module-2

3 a. With mathematical equations, explain the different internal capacitances in the MOSFET. **(10 Marks)**

b. Explain the high frequency response of a CS amplifier using MOSFET and derive its upper cut off frequency. **(10 Marks)**

OR

4 a. Draw the circuit of a RC phase shift oscillator using MOSFET and explain the working. **(06 Marks)**

b. A 2 MHz quartz crystal is specified to have L = 0.52 H, $C_S = 0.012$ PF, $C_P = 4$ PF and R = 120 Ω. Find f_S, f_P. **(04 Marks)**

c. Derive the expression of R_{in}, R_O, A_{VO} and A_V using T model for the common source amplifier with a source resistance circuit. **(10 Marks)**

Module-3

5 a. What are the properties of negative feedback and explain it briefly. **(10 Marks)**

b. What are the topologies of basic feedback circuit? **(04 Marks)**

c. For the block diagram, shown in Fig. Q5 (c), a signal of 1 V from the source results in a difference signal of 10 mV being provided to the amplifier (A) and 10 V applied to the load. For this arrangement identify the value of A and β that apply. **(06 Marks)**

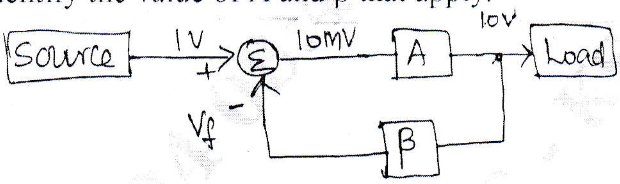


Fig. Q5 (c)

OR

6 a. Draw the circuit of a transformer coupled class-A power amplifier. Prove that the maximum conversion efficiency is 50%. **(08 Marks)**

b. What is output stage and discuss the classification of output stages based on the collector current? **(06 Marks)**

c. Neatly draw the schematic diagram of class C tuned amplifier and discuss the input and output waveforms at the collector terminal. **(06 Marks)**

Module-4

7 a. Derive the expression of output voltage and explain the operation of 4-bit DAC using R-2R circuit. **(10 Marks)**

b. What is meant by precision rectification? Explain with a neat circuit diagram, the working of a small signal half wave precision rectifier using Op-Amp. **(10 Marks)**

OR

8 a. With the help of a neat circuit diagram and relevant waveforms, explain the working of astable multivibrator circuit operation using 555 timer IC. Derive expression for T_{ON}, T_{OFF} and T. **(10 Marks)**

b. Explain the working of a second order lowpass butterworth filter. Write the design equations. Design the circuit for cut off frequency of 1 kHz. **(10 Marks)**

Module-5

9 a. With the help of the static V-I characteristics, explainthe three modes of operation of the thyristor. **(10 Marks)**

b. Explain the working of a UJT firing circuit using SCR with necessary circuit diagram and waveforms. **(10 Marks)**

OR

10 a. Discuss various power converter circuits with necessary sketches and applications of each. **(08 Marks)**

b. List different turn on methods, explain all in brief. **(08 Marks)**

c. Enumerate the applications of power electronics. **(04 Marks)**

* * * * *