2017-2018

B.TECH. AUTUMN (III SEMESTER) EXAMINATION
(ELECTRONICS ENGINEERING)
HIGHER MATHEMATICS - 1
AM 251
Credits-04

Maximum Marks: 60
Duration: Two Hours

Note: Answer all the questions.

Q1. (a) Evaluate the following:
   (i) \( L \left\{ \sqrt{t} + e^{-2u} \int_0^t \left( \frac{\sin u}{u} \right) du \right\} \) OR \( L[t^2 \cos 3t - e^{-t} \{1 - u(t - 2)\}] \). \[5+5\]
   (ii) \( L^{-1} \left[ \ln \left( \frac{s^2+1}{(s-1)^2} \right) + \frac{4e^{-(8\pi/16)}}{s^2+16} \right] \) OR \( L^{-1} \left[ \frac{s}{s^4 + s^2 + 1} + \frac{e^{-2t}}{s^2} \right] \).

(b) Solve, by Laplace transform method, the initial value problem:
\[
\frac{dx}{dt} + 3x + 2 \int_0^t x \, dt = t, \quad x(0) = 0.
\]

Q2 (a) Find the directional derivative of \( \phi = (x^2 + y^2 + z^2)^{-1/2} \) at the point (3, 1, 2) in the direction of the vector \( yz\hat{i} + xz\hat{j} + xy\hat{k} \).

(b) Find the angle between the surfaces \( \phi_1 \equiv x^2 + y^2 + z^2 - 9 = 0 \) and \( \phi_2 \equiv x^2 + y^2 - z - 3 = 0 \) at the point (2, -1, 2).

OR (a') Find the angle between the surfaces \( \phi_1 \equiv x^2 + y^2 + z^2 - 9 = 0 \) and \( \phi_2 \equiv x^2 + y^2 - z - 3 = 0 \) at the point (2, -1, 2).

Q3 (a) Find the work done in moving a particle from \((a,0,0)\) to \((0,a,0)\) along the circular path \(x^2 + y^2 = a^2, z = 0\). The force field is given by \( \vec{F} = (\sin y)\hat{i} + x(1 + \cos y)\hat{j} \).

CO1

CO2

CO3

contd...
OR (a') Evaluate \( \int \int_S \phi \, \hat{n} \, ds \), where \( \phi = \frac{3}{8}xyz \) and \( S \) is the surface of the cylinder \( x^2 + y^2 = 16 \) included in the first octant between \( z = 0 \) and \( z = 5 \).

(b) Verify divergence theorem for the function \( \vec{A} = x\hat{i} - y\hat{j} + (z^2 - 1)\hat{k} \), taken over the cylinder formed by the surfaces \( z = 0, z = 1, x^2 + y^2 = 4 \).

Q4 (a) Twenty items, 12 of which are defective and 8 are nondefective, are inspected one after the other. If these items are chosen at random, what is the probability that
(i) the first two items inspected are defective?
(ii) the first two items inspected are nondefective?
(iii) among the first two items inspected there is one defective and one nondefective?

OR (a') In a bolt factory, machines \( A, B, \) and \( C \) manufacture 25, 35, and 40 percent of the total output, respectively. Of their outputs 5, 4, and 2 percent, respectively, are defective bolts.
(i) A bolt is chosen at random, what is the probability that it is defective?
(ii) A bolt is chosen at random and found to be defective, what is probability that the bolt came from machine \( B \)?

(b) Let \( X \) be a continuous random variable with probability density function \( f \) given by:

\[
f(x) = \begin{cases} 
ax, & 0 \leq x \leq 1, \\
3a, & 1 \leq x \leq 2, \\
-ax + 3a, & 2 \leq x \leq 3, \\
0, & \text{elsewhere}
\end{cases}
\]

(i) Determine the constant \( a \).
(ii) If \( X_1, X_2 \) and \( X_3 \) are three independent observations from \( X \), what is the probability that exactly one of these three numbers is larger than 1.5?
(iii) Compute \( E(X) \).
2017-18
B.TECH. AUTUMN (III SEMESTER) EXAMINATION
(ELECTRONICS ENGINEERING)
HIGHER MATHEMATICS-II
(AM-252)

Maximum Marks: 60 Credit: 04 Duration: Two Hours

Note: Attempt all the questions.

Q.No. Questions M.M.

1(a)(i) Determine the points where the function \( f(z) = z \text{Re} \, z \) is not differentiable. \[2 + 6\]

(ii) Consider two functions \( f(z) = e^{-y} \sin x - ie^{-y} \cos x \) and \( g(z) = e^y \cos x + ie^y \sin x \). Using Cauchy-Riemann equations show that \( f \) is analytic in the whole complex plane but \( g \) is nowhere analytic.

OR

1(a') Find the analytic function \( f(z) = u + iv \) given that \[2 + 6\]

\[2u + 3v = e^x(\cos x - \sin y)\].

1(b)(i) Evaluate \( \int_C (x^2 - iy^2) \, dz \) along the parabola \( y = 2x^2 \) from \((1, 1)\) to \((2, 8)\). \[3 + 4\]

(ii) Evaluate the integral \[\int_C \frac{z + 4}{z^2 + 2z + 5} \, dz\], where \( C \) is the circle \(|z + 1 + i/2| = 2\).

2(a) Expand \( f(z) = \frac{z}{(z-1)(2-z)} \) in Laurent series about its poles. \[6\]

2(b) Using contour integration, prove that \[9\]

\[\int_0^\pi \frac{d\theta}{1 - 2r \sin \theta + r^2} = \frac{2\pi}{1 - r^2} \quad (0 < r < 1)\].

OR

2(b') Evaluate the following integral by contour integration \[9\]

\[\int_{-\infty}^{\infty} \frac{\cos x}{(x^2 + a^2)(x^2 + b^2)} \, dx, \quad a > b > 0\].

Contd... - 2.
3(a) Find the polynomial of degree three which takes the same values as \( y = 2^x + 2x + 1 \) at \( x = -1, 0, 1, 2 \), using Newton’s forward difference interpolation formula. [7]

3(b) Find a real root of the equation \( x^3 - 2x + 5 = 0 \) correct to 5 decimal places by using iteration method. [8]

OR

3(b') Perform three iterations of the Gauss-Seidel iteration method for solving the system of linear equations:

\[
\begin{align*}
x + 10y + 9z &= 7, \\
2x - 7y - 10z &= -17, \\
10x + 2y + 6z &= 28.
\end{align*}
\]

4(a) The velocity of a train which starts from rest is given by the following table, time being reckoned in minutes from the start and speed in miles per hour:

<table>
<thead>
<tr>
<th>Minutes</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles per hour</td>
<td>10</td>
<td>18</td>
<td>25</td>
<td>29</td>
<td>32</td>
<td>20</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Estimate approximately the total distance run in 20 minutes. [7]

4(b) Apply the fourth order Runge-Kutta method to find an approximate value of \( y \) when \( x = 0.2 \), given that \( y' = x + y, y(0) = 1 \) (Take \( h = 0.1 \)). [8]

OR

4(b') Solve the boundary value problem

\[
y'' - 64y + 10 = 0
\]

with \( y(0) = y(1) = 0 \)

by the finite-difference method. Find the value of \( y(0.5) \) with \( h = 0.25 \). [8]
2017-2018
B.TECH AUTUMN (III SEMESTER) EXAMINATION
(ELECTRONICS ENGINEERING)
EL-211 N
ELECTRONIC DEVICES
CREDITS: 04

Maximum Marks: 60

Instructions:
1. Attempt all questions
2. Make appropriate assumptions if required
3. Symbols and abbreviations have their usual meanings.

Values of some constants: Energy gap for Si = 1.12 eV; Thermal voltage (kT/e = 25 mV at room Temp.); Permittivity of free space (ε₀ = 8.85x10⁻¹² F/m); Permittivity of silicon (εᵣ = 12 ε₀);
Permittivity of oxide (εₓₒ = 3.9 ε₀); μᵥ = 400 cm²/V.s μᵥ = 800 cm²/V.s nᵢ = 1x10¹⁰ cm⁻³

Nᵣ = 1.04x10¹⁹ cm⁻³ ; Nᵥ = 2.8x10¹⁹ cm⁻³

1. (a) A Silicon PN Junction is forward biased with the constant current at room temperature. When temperature is increased by 10 degree Celsius, what will be the effect on forward biased voltage to maintain the same current, why?  
   (Marks = 05)

(b) Derive the diode equation starting from basics and hence determine the expression of diffusion capacitance.  
   (Marks = 10)

2. (a) For a particular npn transistor operating at base to emitter voltage of 670 mV and collector current of 3 mA, the Iᵥ - Vᵥₑ characteristic has a slope of 3x10⁻⁵ mho. To what value of output resistance does this correspond? What is value of Early voltage for this transistor? For operation at 30 mA, what would be the output resistance become?  
   (Marks = 07)

(b) A common emitter amplifier circuit operated with Vᵥₑ = 10 V is biased at Vᵥₑ = +1 V. Find the voltage gain, the maximum allowed negative swing without the transistor entering saturation, and the corresponding maximum input signal permitted.  
   (Marks = 08)

OR

2’. What is the small signal approximation in BJT? Derive the expression of the transconductance. Determine the small signal resistance (between collector and emitter) of a BJT connected in CE configuration (operating in active region) if its collector is connected to its base. How the internal capacitance in BJT affect the performance of BJT amplifiers? Derive the expression for unity gain bandwidth (ωᵣ).  
   (Marks = 15)
3. Derive the expression of drain current $i_D$ of MOSFET operating in triode and saturation region and how it is modified for accounting the channel length modulation. Derive the small signal model of a MOSFET operating in saturation region and convert it into the T-model. (Marks = 15)

OR

3'. (a) A particular MOSFET operating in the saturation region at a constant $v_{GS}, i_D$ is found to be 2 mA for $v_{DS} = 4V$ and 2.2 mA for $v_{DS} = 8V$. Determine $r_O, V_A$ and $\lambda$ for this MOSFET? (Marks = 06)

(b) For each of the circuits shown in Figure 1, find the labeled node voltages. The NMOS transistors have threshold voltage of 1 volt and process trasconductance as $K_n\frac{W}{L} = 2mA/V^2$.

Neglect channel length modulation.

![Figure 1](image)

(Marks = 09)

4. (a) What is feedback? What are the effects of negative feedback on amplifier characteristics? (Marks = 05)

(b) Draw the diagram of Wein's bridge oscillator and derive the expression for condition of oscillation as well as frequency of oscillation. (Marks = 05)

(c) The noninverting buffer op-amp shown in Figure 2. Assuming that the op-amp has infinite input resistance, what is $\beta$? If $A = 100$, what is closed loop voltage gain? What is amount of feedback (in dB)? For Voltage Signal Source of 1 V, find output voltage and input voltage. If $A$ decreases by 10%, what is the corresponding decrease in gain with feedback. (Marks = 05)

![Figure 2](image)
Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

Answer all the questions. Assume suitable data if missing. Notations used have their usual meaning.

Q.No. Question M.M. (06)
1(a) Determine the voltage across the (1/3)Ω resistor shown in Fig. 1a using Thevenin's theorem. [06]
1(b) Determine the mesh currents for the network shown in Fig. 1b.

2(a) The switch in Fig. 2 has been in position 1 for a long time. If the switch is thrown into position 2 at \( t=0 \), determine \( v_c \) and \( i_c \) for \( t>0 \). [06]

2(a') What do you understand by frequency domain analysis in relation to time domain analysis? [06]

Contd... 2.
2 (b) Using suitable diagrams, explain how phasor domain analysis is equivalent to time domain analysis of sinusoidal circuits.

3(a) Describe the relationship between the following in context of Graph theory
   i. Branch Voltage & Node Voltage
   ii. Branch Current & Loop Current

3(b) Write the matrix loop equations for the network shown in Fig 3 and determine the loop currents.

4(a) In the context of mathematical description of systems, explain the difference between internal and external descriptions. Give relative merits and suitable examples.

4(b) Write the state variable equations for the circuit given in Fig 4.

4(b') Give the state variable representation of the circuit given in Fig 5. What is the order of complexity of this circuit and why?
5(a) Derive the expression of y-parameters in terms of z-parameters.

5(b) For a linear, passive 2-port reciprocal network, obtain an equivalent T-network. How will the equivalent model be modified for the case of a non-reciprocal network.

OR

5(b') Give the 2-port representation of a transformer.
Maximum Marks: 60  Credits: 04  Duration: Two Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.  Question  M.M.

1(a)  Explain the methods of providing controlling torque in indicating instruments.  [08]

OR

1(a)*  Explain the principle and construction of attraction-type moving iron instruments. Discuss their merits and demerits.  [08]

1(b)  It is found that 10 A current passes through a resistor of 10 ohm value. The resistor has 5% tolerance. The error in measurement of current can be as high as 5%. What is the maximum error in the measurement of power calculated from the measured value of current and the nominal value of resistor?  [07]

2(a)  Describe the construction and working principle of a dynamometer-type wattmeter and show how its deflecting force is proportional to the average value of power.  [08]

OR

2(a)*  Describe the construction details of a single-phase induction-type energy meter, with the help of a circuit diagram.  [08]

2(b)  Explain the working of a Hall effect wattmeter.  [07]

3(a)  An ac bridge has the following constants.  
Arm 1 = capacitor of 0.5uF in parallel with 1 kohm resistance.  
Arm 2 = 2 k ohm resistance.  
Arm 3 = capacitor of 0.5uF.  
Arm 4 = unknown capacitor and resistor in series.  
Determine the unknown values.  [07]

3(b)  Define Q factor of a coil. Explain with circuit diagram the construction and working of a basic Q meter.  [08]

OR

3(b)*  Draw the basic block diagram of an oscilloscope and explain the functions of each block.  [08]

4(a)  Define a transducer and give classifications of transducers on the basis of various factors.  [07]

4(b)  Explain the principle of working of a strain gauge and mention its applications.  [08]

OR

4(b)*  Explain the working of a LVDT and mention its advantages and disadvantages.  [08]
2(a). Consider the signal \( x(t) = e^{-5t}u(t) \)
Determine the Fourier transform of the even function of \( x(t) \). [CO2]

2(b). Consider the discrete time sequence \( x[n] = n \left( \frac{1}{2} \right)^n u[n] \).
Using discrete time Fourier transform (DTFT), compute the value of \( \sum_{n=-\infty}^{\infty} x[n] \). [CO2]

2(c). Consider the signal \( x(t) = \left( \frac{\text{sine } 50\pi t}{\pi t} \right)^2 \)
which is to be sampled with a sampling frequency of \( w_s = 150\pi \) to obtain a signal \( g(t) \) with Fourier transform \( G(w) \). Determine the maximum value of \( w_0 \) for which it is guaranteed that \( G(w) = 75 \cdot X(w) \) for \( |w| \leq w_0 \).
where $X(w)$ is the Fourier transform of $x(t)$. [CO3]

OR

2'(a). Consider a causal LTI system with frequency response

$$H(w) = \frac{1}{jw + 3}$$

For a particular input $x(t)$ this system is observed to produce the output

$$y(t) = e^{-3t}u(t) - e^{-4t}u(t)$$

Determine $x(t)$. [CO2]

2'(b). Consider the discrete time sequence

$$x[n] = a^n, \quad |a| < 1$$

Determine the DTFT of $x[n]$. [CO2]

2'(c). Let $x(t)$ be a signal with Nyquist rate $w_o$. Also, let $y(t) = x(t)p(t - 1)$ where

$$p(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT), \quad T < \frac{2\pi}{w_o}$$

Specify the constraints on the magnitude response of a filter that gives $x(t)$ as its output when $y(t)$ is the input. [CO3]

3(a). Consider the LTI system with transfer function

$$H(s) = \frac{1}{(s + 2)(s - 2)}$$

(i) Determine all possible choices for the ROC.
(ii) Determine the impulse response if the system is causal.
(iii) Determine the impulse response if the system is non-causal. [CO4]

3(b) The sequence $x[n] = a^n u[n], 0 < a < 1$, is applied at the input of an LTI system with the impulse response $h[n] = b^n u[n], 0 < b < 1$. Using the z-transform approach, calculate the output of the system. [CO4]

3(c) The input $x(t)$ and output $y(t)$ of a causal LTI system are related through the following block diagram.
Determine a differential equation relating $y(t)$ and $x(t)$. Also, check the stability of the system. [CO4]

OR

3(c'). The input $x[n]$ and output $y[n]$ of a causal LTI system are related through the following block diagram.

Determine a difference equation relating $y[n]$ and $x[n]$. Also, check the stability of the system. [CO4]

4(a) The probability density function of a random variable $X$ is $f(x) = ae^{-bx^2}$. Find
i. the relationship between the parameter $a$ and $b$.
ii. the probability that $X$ lies in the range between 1 and 2. [CO5]

4(b) Suppose that $X$ and $Y$ are independent zero mean Gaussian random variables with unit variance. Find the pdf of $Z = X + Y$. [CO5]

4(c) Define power spectral density of a random process and list its properties. [CO5]
1. The single tone modulating signal \( m(t) = A_m \cos(2\pi f_m t) \) is used to generate the VSB signal

\[
s(t) = \frac{1}{2} A_m A_c \cos[2\pi (f_c + f_m) t] + \frac{1}{2} A_m A_c (1 - \alpha) \cos[2\pi (f_c - f_m) t]
\]

where \( \alpha \) is a constant, less than unity, representing the attenuation of the upper side frequency.

a. If we represent this VSB signal as a quadrature carrier multiplex

\[
s(t) = A_c m_1(t) \cos[2\pi f_c t] + A_c m_2(t) \sin[2\pi f_c t]
\]

Find out \( m_2(t) \).

b. The VSB signal, plus the carrier \( A_c \cos(2\pi f_c t) \) is passed through an envelope detector. Determine the output of the detector and the distortion produced by the quadrature component.

OR

1' a. Draw the block diagram of an AM Superheterodyne Radio Receiver and explain the function of AGC in it. [7]

1' b. The carrier \( c(t) = A \cos(2\pi 10^6 t) \) is angle modulated (PM or FM) by the sinusoid signal \( m(t) = 2 \cos(2000\pi t) \). The deviation constants are \( k_p = 1.5 \text{ rad/V} \) and \( k_f = 3000 \text{ Hz/V} \).

a. Determine the modulation index for PM and FM signals.

b. Determine the bandwidth in each case using Carson's rule.

2 a. An ASCII code '1011001' corresponding to 'Y' is to be transmitted using line coding. [2.5 + 2.5]

Draw the waveform and calculate the DC content if:

a. Unipolar coding is used.

b. Manchester coding is used.

2 b. The signal \( g(t) = 10 \cos(20\pi t) \cos(200\pi t) \) is sampled at the rate of 250 samples per second. [2.5 + 2.5]

a. Determine the spectrum of the resulting sampled signal.
b. Calculate the Nyquist rate and specify the cut-off frequency of the ideal reconstruction filter so as to recover \( g(t) \) from its sampled version.

2 c Explain how companding is useful in improving the performance of a PCM communication system.

3 a Prove that Figure of Merit of a DSB-SC receiver using coherent detection is equal to unity.

3 b Explain the different types of noise encountered in a communication system?

OR

3' a A signal can be modelled as a lowpass stationary process \( X(t) \) whose PDF at any time \( t_0 \) is given in Figure 1. The bandwidth of this process is 5 kHz, and it is desired to transmit it using a PCM system. If sampling is done at the Nyquist rate and a uniform quantizer with 32 levels is employed, what is the resulting SQNR? What is the resulting bit rate?

![Figure 1](image)

3' b A Gaussian random variable with zero mean and \( \sigma^2 \) variance is quantized using \( n \) bit uniform quantizer. Assuming that the random variable has negligible value beyond \( \pm 4\sigma \), find the signal to quantization noise ratio.

4 a Prove that the output SNR of a matched filter depends only on the ratio of the signal energy to the power spectral density of the white noise at the filter input.

4 b An example of eye pattern is shown is shown in Figure 2 below. Identify the marked regions 'A', 'B' and 'C' and explain their significance.

![Figure 2: An example of eye pattern](image)