1. (a) If \( \mathbf{r} = xi + yj + zk \), show that,
(i) \( \text{div}(\mathbf{r} \phi) = 3\phi + \mathbf{r} \cdot \text{grad} \phi \)
(ii) \( \text{div}(\mathbf{r}) = 0 \)

(b) Find the directional derivative of \( \nabla \cdot (\nabla \phi) \) at the point \( P(1, -2, 1) \) in the direction of the normal to surface \( xy^2z = 3x + z^3 \) at \( P \), where \( \phi = 2x^3y^2z^4 \).

(c) Find the value of \( n \) for which the Vector \( r^3 \) is solenoidal, where \( r = xi + yj + zk \)

(c') Show that the Vector field given by
\[ \mathbf{A} = (2xy + z^2)i + (2yz + x^2)j + (2xz + y^2)k \] is irrotational. Find the Scalar function \( f \) such that \( \mathbf{A} = \text{grad} f \).

2. (a) Find the circulation of \( \mathbf{F} \) round the curve \( C \), where \( \mathbf{F} = e^x \sin y i + e^x \cos y j \) and \( C \) is rectangle whose vertices are \((0,0), (1,0), \left(\frac{\pi}{2}, 0\right), \left(\frac{\pi}{2}, \frac{\pi}{2}\right)\).

(b) Apply Green’s theorem to evaluate \( \int_C (2x^2 - y^2)dx + (x^2 + y^2)dy \), where \( C \) is the boundary of the area enclosed by the x-axis and upper half of the circle \( x^2 + y^2 = a^2 \).

(c) Verify Stokes theorem for the function \( \mathbf{F} = x^2i + xyj \) integrated round the square in the \( z = 0 \) plane whose sides are along the line \( x = 0, y = 0, x = a, y = a \).

(c') Use the divergence theorem in Cartesian form to evaluate
\[ \int \left[ x^3 - yz \right] dydz - 2x^2yzdx + 2dx dy \] over the surface of a cube bounded by the co-ordinate planes and the planes \( x = a, y = a, z = a \).

3. (a) Evaluate
(i) \( L \left[ \frac{1 - \cos t}{t} \right] \) OR \( L \left[ t^2 e^t \sin 4t \right] \)
(ii) \( L^{-1} \left[ \frac{2s^2 - 1}{(s^2 + 1)(s^2 + 4)} \right] \)

(b) Solve the equation by Laplace transform method.
\[ (D^2 - 3D + 2)x = 1 - e^{2t}, \quad x_0 = 1, x_1 = 0. \]
(c) In an electrical circuit with e.m.f. \( E(t) \), resistance \( R \) and inductance \( L \), the current \( I \) builds up at the rate given by \( L \frac{di}{dt} + \pi R i = E(t) \). If the switch is connected at \( t = 0 \) and disconnected at \( t = a \), find the current \( i \) at any instant.

4. (a) The probability that a man aged 50 will live to be 70 is 0.65. What is the probability that out of 10 men, now 60, at least 7 will live to be 70?

(b) Suppose that the two dimensional continuous random variable \((X, Y)\) has joint pdf given by \( f(X, Y) = X^2 + \frac{XY}{3} \), \( 0 \leq X \leq 1, \ 0 \leq Y \leq 1 \)

- 0, else where

Find the marginal pdf of \( X \) and \( Y \).

(c) A random variable \( X \) may assume four values with probabilities \( \frac{1+3x}{4}, \ \frac{1-x}{4} \), \( \frac{1+2x}{4} \), and \( \frac{1-4x}{4} \), for what values of \( x \) is this a probability distribution.

*****
Answer all the questions. Symbols have their usual meanings. Use appropriate notations wherever required.

1(a) What is Electromagnetics? [01]
1(b) If \( \mathbf{A} = 5\hat{a}_r + 2\hat{a}_\phi - \hat{a}_z \) and \( \mathbf{B} = \hat{a}_r - 3\hat{a}_\phi + 4\hat{a}_z \), find: \( \mathbf{A} \times \mathbf{B} \) and \( \mathbf{A} \cdot \mathbf{B} \). [02]
1(c) In spherical coordinates, a volume charge density \( \rho = 10e^{-2r} \text{ C/m}^3 \) is present. Determine electric flux density, \( \mathbf{D} \). [02]
1(d) State Stoke's theorem and its physical significance. Verify it for the open surface defined by \( z = 1, 0 < \rho < 2, 0 < \phi < \frac{\pi}{2} \) for the field \( \mathbf{F} = 2\rho z \hat{a}_\rho + 3z \sin \phi \hat{a}_\phi - 4\rho \cos \phi \hat{a}_z \). [05]
1(e) Produce a solution for Laplace's and Poisson's equations each, for physical problems of your choice by assuming appropriate boundary conditions. [05]

2(a) What do you mean by filamentary, surface and volume currents? Planes \( z = 0 \) and \( z = 4 \) carry current \( \mathbf{K} = -10\hat{a}_z \ A/m \) and \( \mathbf{K} = 10\hat{a}_z \ A/m \) respectively. Determine magnetic field intensity \( \mathbf{H} \) at \((1,1,1)\) and \((0,-2,10)\). OR [04]

2(a') Let the regions \( 0 < z < 0.3 \text{ m} \) and \( 0.7 < z < 1.0 \text{ m} \) be conducting slabs carrying uniform current densities of \( 10 \text{ A/m}^2 \) in opposite directions. Find \( \mathbf{H} \) at \( z = -0.2, 0.2, 0.4, 0.75 \) and \( 1.2 \text{ m} \). OR [04]

2(b) Establish magnetic boundary conditions for the Magnetic field intensity, magnetic flux density and magnetization between two different magnetic materials. [03]

2(c) Two magnetic media with permeabilities \( \mu_1 = 4 \text{ H/m} \) in region 1 \((z > 0)\) and \( \mu_2 = 7 \text{ H/m} \) in region 2 \((z < 0)\) are separated by a surface current \( \mathbf{K} = 80\hat{a}_z \ A/m \) on the surface \( z = 0 \). Determine the magnetic flux density \( \mathbf{B}_2 \) in the region 2 if \( \mathbf{B}_1 = 2\hat{a}_x - 3\hat{a}_y + \hat{a}_z \text{ mT} \). [04]

2(d) How the magnetic properties of materials are governed by orbiting electron and electron spin? Is there any role of nuclear spin in determining the magnetic behaviour of materials? Write a brief note on various magnetic materials. OR [04]
2(d') A coaxial transmission line consists of an inner conductor of radius 1.2 cm and an outer conductor of radius 1.8 cm. The two conductors are separated by an insulating medium of magnetic permeability four times that of the vacuum. If the transmission line is 3 km long and carries 25 mA current, calculate the energy stored in the medium.

3(a) State and explain Faraday's law of electromagnetic induction and write it in differential form. What are the properties of electric field that come in differential form of Faraday's law? A conducting loop of radius 20 cm lies in the z = 0 plane in a magnetic field \( \vec{B} = 10 \cos(377t) \hat{a}_z \) mWb/m². Calculate the induced voltage in the loop.

3(b) Derive an expression for modified Ampere's law. In what sense displacement current is same as conduction current.

3(c) In a medium characterized by \( \sigma = 0, \mu = \mu_0, \epsilon = \epsilon_0 \) and \( \vec{E} = 20 \sin(10^3 t - \beta z) \hat{a}_y \) V/m, find \( \beta \) and \( \vec{H} \).

3(d) Discuss radio wave propagation in ionosphere through reflection and refraction.

4(a) Define Poynting vector? Show that the net power coming out from a surface is equal to the rate of decrease of electromagnetic energy within that surface in non-conducting medium.

4(b) Obtain the relation for the intrinsic impedance, \( \eta = \frac{j \pi \mu}{\sqrt{\sigma + j \omega \mu}} \).

4(c) Deduce the expressions for reflection and transmission coefficients for normal incidence of a plane wave at interface between two different media.

4(e') A plane electromagnetic wave incident at oblique angle at the interface of a lossless dielectric media and whose electric field vector \( \vec{E} \) is polarized parallel to the incident plane. Obtain the Fresnel's equations.

4(d) Explain the propagation of plane electromagnetic waves through lossy dielectric medium and find the expressions for \( \vec{E} \) and \( \vec{H} \).
2014-15
B.Tech. (Winter Semester) Electronics Engineering Examination
Electrical Engineering
EE-202N

Maximum Marks: 60
Credits: 04

Duration: 3 hrs.

Note: 1. Attempt all the questions.
2. Assume suitable data wherever necessary.
3. All symbols have their usual meaning.

1(a) Derive the emf equation of a dc motor. Calculate the speed of the motor for a 500 V dc motor having 40 slots with 12 conductors per slot, flux per pole of 50 mWb, 8-pole lap connected armature.

1(b) Explain how the speed can be controlled by the variation of field flux. Draw the speed-torque characteristics both for series and shunt motors.

2(a) Draw the power flow diagram of a 3-phase induction motor. Derive the following relationship:

\[ T = \frac{3\,\Phi^2 R_s}{4\,s} \]

2(b) Develop the equivalent circuit of a 3-phase induction motor and explain how the torque is developed in the motor.

OR

2'(a) The power input to the rotor of a 440 V, 50 Hz, 6-pole, 3-phase induction motor is 80 kW. The rotor emf is observed to make 100 complete alternations per min. Calculate (a) the slip; (b) the rotor speed; (c) the mechanical power developed; (d) the rotor copper loss per phase; (e) the rotor resistance per phase; if the rotor current is 65 A.

2'(b) Why starters are used with 3-ph induction motors? Explain any two type of starters with the help of diagram.

3(a) Explain with the help of diagram the construction of a 3-ph synchronous machine. Also explain how the voltage is generated in these machine.

3(b) What is a stepper motor? Explain with the help of a diagram the working of variable reluctance stepper motor.

OR

3(b)' Why the servomotors are also known as control motors? Also explain different types of servomotors with the help of diagram and their characteristics.
4(a) A single-core lead covered cable is to be designed for a line voltage of 66 kV. Its conductor radius is 10 mm, three different insulating materials A, B and C with relative permittivities of 5.4 and 3 and corresponding maximum permissible stresses of 3.8, 2.6 and 2.0 kV/mm (rms) respectively have been provided in the cable. The nearest material to the power conductor is A while C is nearest to the sheath. Determine the minimum diameter of the lead sheath.

OR

4(a') Derive the A, B, C and D constants for a nominal η-circuit model of a medium transmission line. Also draw the phasor diagram of the same network.

4(b) Why the HVDC link is used? Also write the advantages and disadvantages of HVDC transmission system.

5(a) Show that ratio of the volume of conductor in a three phase, four wire system to single phase, two wire system is 4:3.

5(b) What is illumination? Derive the cosine cube law of illumination. Calculate the illumination at a point on the working plane 6 m away from the foot of the lamp when the lamp gives 1200 lumens in all direction is suspended 8 m above the working plane.

OR

5(b') What is electric lamp? Discuss any two types of luminous lamp with the help of a diagram.
Q.No. 1(a) What is the highest frequency of a triangular wave of 20V peak-to-peak, which can be reproduced by an opamp whose slew rate is 10V/μs? For a sine wave of the same frequency, what is the maximum amplitude of undistorted output signal?

Q.No. 1(b) Explain the operation of active loaded BJT differential amplifier. If the circuit is biased by I=1mA, find the transconductance gain, output resistance, differential voltage gain and input resistance, assuming transistors with β=100 and $V_A=80V$.

OR

Q.No. 2' Analyze the circuit shown below to find all the node voltages and branch currents, assuming $|V_{DS}|=0.7V$ and infinite $\beta$. 

![Circuit Diagram](image)
2(a) Which transistor composite pair is used as the second stage of opamp 741? Analyze the same to find small signal voltage gain, input and output resistances.

2(b) Analyze the circuit given below to find $V_o/V_i$, assuming ideal opamps.

![Circuit Diagram](image)

3(a) Explain the operation of the circuit shown in figure 3, and also plot the transfer characteristic.

![Circuit Diagram](image)

OR

3(a') For the circuit as shown in figure 4, plot the output waveform, if input is a sine wave of 5V peak amplitude and frequency of 2KHz.

3(b) Derive the expression of bandwidth for a Cascade amplifier.

4(a) Design a voltage controlled oscillator using two opamps and prove that the frequency can be varied linearly with control voltage. OR

contd... 3
4(a) Design a square wave generator using two CMOS NOR gates, and obtain the expression for frequency of the output.

4(b) Design a single opamp based circuit for generating rectangular wave of 4KHz, with duty cycle 75%, assuming 10nF capacitor(s).

5. Pick the correct answer (for parts I to VI with justification(s)).

I. The crossover distortion is characteristic of which of the following class of amplifiers? (a) A; (b) B; (c) AB; (d) C.

II. An opamp has input bias currents of 12nA and 14.5nA. The input offset current is: (a) 26.5nA; (b) 13.25nA; (c) 2.5nA; (d) 1.208nA.

III. For an opamp based voltage follower circuit: (a) it is based on inverting configuration; (b) it has low input impedance; (c) it has high output impedance; (d) none of these.

IV. If the differential voltage gain and the common mode voltage gain of a differential amplifier are 48 dB and 2 dB respectively, then its common mode rejection ratio is: (a) 24dB; (b) 50dB; (c) 46dB; (d) 96dB.

V. The 741 opamp has a unity gain frequency of: (a) 10Hz; (b) 1MHz; (c) 10MHz; (d) none of these.

VI. The circuit as given below (Fig. 5) is: (a) integrator; (b) precision rectifier; (c) log amplifier; (d) zero-crossing detector.

Fig. 5

VII. In a PLL, when the input signal frequency is increased, the PLL acquires lock at 20KHz, and tracks the input up to 110KHz, beyond which lock is no more maintained. When the input frequency is decreased from higher values, the signal is acquired at 100KHz, and the lock is maintained up to 10KHz, below which the PLL is unlocked. Find the capture range, lock range and free running frequency.
1(a) Differentiate among the following types of control systems:

(i) Time varying and time invariant
(ii) Causal and non-causal
(iii) Autonomous and non-autonomous

1(b) What is a synchro? Explain its application in a servo system using a block diagram.

2(a) What are PID controllers? Explain their effects on the performance of the system.

2(b) Figure shows a control system using output rate feedback. Determine the tachometer constant $K_t$ so as to obtain damping ratio of 0.4.

\[ R(s) \rightarrow \frac{15}{s(s+1)(s+5)} \rightarrow C(s) \]

3. What are the limitations of Routh-Hurwitz criterion for testing the stability of control systems?

Using the Routh-Hurwitz criterion, determine the stability of the system if its open loop transfer function is of type one with velocity error constant of 10 sec$^{-1}$ and having poles at -3 and -6.

OR

---

[Contd. - 2]
3. A feedback control system has its characteristic equation:

\[ F(s) = s(s + 4)(s + 8) + K(s + 1) - \delta \]

Draw the complete root-locus, indicating all the steps clearly and hence, determine the following:
(i) \( K \) for marginal stability  
(ii) \( K \) for damping ratio = 0.5

4. Define controllability and observability of a control system.

Test the controllability and observability of the system described by the following state equations:

\[
\begin{bmatrix}
\dot{x}_1 \\
\dot{x}_2 \\
\dot{x}_3
\end{bmatrix} = 
\begin{bmatrix}
3 & -2 & -1 \\
1 & 0 & 1 \\
0 & 0 & -1
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2 \\
x_3
\end{bmatrix} + 
\begin{bmatrix}
0 \\
1 \\
0
\end{bmatrix} u(t)
\]

\[
\begin{bmatrix}
y_1 \\
y_2
\end{bmatrix} = 
\begin{bmatrix}
0 & 1 & 0 \\
1 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2 \\
x_3
\end{bmatrix}
\]

OR

4'. What are the different forms of state space equations?

Obtain the state model in observable phase-variable canonical form for the given transfer function:

\[ G(s) = \frac{Y(s)}{U(s)} = \frac{K(c_2s + c_1)}{s^3 + a_3s^2 + a_2s + a_1} \]

5. What are the methods of analysis for nonlinear control systems?

For a unity feedback control system, if an ideal relay with an output equal to unity has its describing function as \( N = \frac{4}{Rx} \), is operating in cascade with the linear system having \( G(s) = \frac{10}{s(s+1)(s+2)} \), in the forward path. Determine the amplitude and frequency of the limit cycle, if it exists.
2014-15
B.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRONICS ENGINEERING
LOGIC CIRCUITS
EL 231

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>State and prove the Consensus theorem of Boolean algebra.</td>
<td>[05]</td>
</tr>
<tr>
<td>1(b)</td>
<td>Why are Gray codes called Reflected codes? Construct the set of 5-bit Gray codes.</td>
<td>[05]</td>
</tr>
<tr>
<td>1(c)</td>
<td>Define Boolean algebra in terms of Huntington's postulates.</td>
<td>[05]</td>
</tr>
<tr>
<td>2(a)</td>
<td>Minimise and implement the logic function ( F(A,B,C,D,E) = \sum(0,2,8,9,10,11,13,16,18,24,25,26,29) ) using only NAND gates.</td>
<td>[10]</td>
</tr>
<tr>
<td>2(b)</td>
<td>An 8x1 multiplexer has inputs A, B and C connected to the selection inputs ( S_2 ), ( S_1 ) and ( S_0 ) respectively. The data inputs ( I_0 ) through ( I_7 ) are as follows: ( I_1 = I_2 = 0 ); ( I_3 = I_7 = 1 ); ( I_4 = I_5 = D ); ( I_6 = D' ). Determine the Boolean function that the multiplexer implements.</td>
<td>[05]</td>
</tr>
</tbody>
</table>

OR

2'(a) Implement the following function \( F(A,B,C,D) = \Pi(1,4,8,10) \) using:
(i) only NOR gates (ii) minimum number of gates  
[10]

2'(b) Implement a 4-variable function \( Y(A,B,C,D) = A'B'(C+D) + A'B + AB'C + ABD \) using a 4-to-1 line MUX.  
[05]

3(a) Design a synchronous Modulo-6 counter using JK flip-flops. Assume that the machine is automatically initialized if it enters into an unwanted state.  
[10]

3(b) Giving their block diagrams, distinguish between Mealy and Moore machines.  
[05]

OR

3(b') Why is edge triggering needed in Synchronous Sequential circuits? Give the block diagram of a Master-Slave D Flip-flop. How will its output be affected if an input changes after the positive edge when the clock is still at high level?  
[05]
4(a) Design a four-bit combinational circuit 2's complementor (the output generates the 2’s complement of the input binary number). Also, if possible, show that the circuit can be constructed with exclusive-OR gates.

4(b) Use FA blocks to construct an 8-bit Ripple Binary adder. What is its main limitation? OR

4(b') Give the logic diagram of a 4-bit Parity generator.
2014 - 2015
WINTER SEMESTER B.TECH. EXAMINATION 2014-15
ELECTRONICS ENGINEERING
PRINCIPLES OF COMMUNICATION ENGINEERING
EL-242

Max. Marks: 60 Credits: 04 Time: Three Hours

Attempt ALL Questions
Symbols used carry their standard meaning.
Make suitable assumptions where necessary.

1a A SSB AM signal is generated by modulating on 800-kHz carrier by the signal \( m(t) = \cos(2000\pi t) + 2\sin(2000\pi t) \). The amplitude of the carrier is \( A_c = 100 \).
   i. Determine the signal \( \tilde{m}(t) \).
   ii. Determine the (time domain) expression for the lower sideband of the SSB AM signal.
   iii. Determine the magnitude spectrum of the lower sideband SSB signal.

1b Draw the block diagram of an AM Superheterodyne Radio Receiver and discuss the constraints imposed on the choice of Intermediate Frequency.

OR

1'a A sinusoidal signal of 1 ms time period is to be amplitude modulated using a square wave carrier of time period 1 \( \mu \)s. Is it possible to generate a DSB-SC signal centred around the frequency of 9 MHz, if so, how? Draw the block diagram and the spectrum at the output of each block.

1'b The carrier \( c(t) = A \cos(2\pi \times 10^6 t) \) is angle modulated (PM or FM) by the sinusoidal signal \( m(t) = 2 \cos(2000\pi t) \). The deviation constants are \( k_p = 1.5 \) rad/V and \( k_f = 3000 \) Hz/V.
   i. Determine the modulation index for PM and FM signals.
   ii. Determine the bandwidth in each case using Carson's rule.

2a Draw a block diagram of a DPCM system and explain its working.

2b Draw a frame format of T1 system and calculate the bit rate and channel bandwidth required. Explain the use of elastic store with reference to the T1 system.

2c In a CD player, the sampling rate is 44.1 KHz and the samples are quantized using a 16-bit/sample quantizer. Determine the resulting number of bits for a piece of music with a duration of 50 minutes.

contd...
3 a  Explain a method by which the threshold effect in FM can be reduced.

3 b  The message signal \( m(t) \) has a bandwidth of 10 KHz, a power of 16 W and a maximum amplitude of 6. It is desirable to transmit this message to a destination via a channel with 80-dB attenuation and additive white noise with power-spectral density \( S_n(f) = N_0/2 = 10^{-12} \text{ W/Hz} \), and achieve a SNR at the modulator output of at least 50 dB. What is the required transmitter power and channel bandwidth if the SSB-SC modulation scheme is employed?

OR

3 b' A signal can be modelled as a lowpass stationary process \( X(t) \) whose PDF at any time \( t \) is given in Figure 1. The bandwidth of this process is 5 KHz, and it is desired to transmit it using a PCM system.

i. 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?

ii. If the available bandwidth of the channel is 40 kHz, what is the highest achievable SQNR?

![Figure 1](image)

4 a  Calculate the probability of bit error in a communication system with PCM using ON-OFF NRZ signalling and having AWG noise with zero mean. If the probability of bit error is \( 10^{-6} \), find the time of transmission required to have 100 bits in error. Assume that the transmission rate equal to E1 system.

4 b  List three properties of a Matched filter receiver and prove any one.

OR

4 b' Give the reasons of having inter symbol interference if binary data is transmitted over a bandlimited channel. Explain why and how precoding of binary data is carried out in a Duobinary signalling?
2014-15
B.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRONICS ENGINEERING
THEORY OF ELECTROMAGNETIC WAVES
EL-252

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q.No. Question M.M.
1(a) Charges $-Q$ and $+3Q$ are separated by a distance 2m. A third charge is located such that the electrostatic system is in equilibrium. Find the location and value of the third charge in terms of $Q$. [06]

1(b) A sphere of radius 'a' and dielectric constant $\varepsilon_r$ having a uniform charge density of $\rho_0$ is placed in air. Find the potentials at the centre and surface of the sphere. [06]

OR

1'(a) State and explain the Gauss's law. Deduce the Coulomb's law from the Gauss's law thereby affirming that Gauss's law is an alternative statement of Coulomb's law and that Coulomb's law is implicit in Maxwell's equation $\nabla \cdot D = \rho_0$. [06]

1'(b) Find work done in moving a $3C$ charge in a field $E = \hat{y}a_y + \hat{x}a_x + 2\hat{z}a_z$ from point B $(1, 0, 1)$ to A $(0, 1, 1)$ along the shorter arc of the circle $x^2+y^2=1, z=1$ & along a straight line. What inference do you get from the two answers? [06]

2(a) State and explain Ampere's circuit law. A hollow conducting cylinder has inner radius 'a' and outer radius 'b' carries current $I$ along the positive z-axis. Find $H$ everywhere. [06]

2(b) Derive the point form of continuity equation. Explain its physical interpretation. [03]

2(c) Show that the line integral of the vector potential $A$ about any closed path is equal...
to the magnetic flux enclosed by the path, or \[ \oint \mathbf{A} \cdot d\mathbf{s} = \int \frac{\mathbf{B} \cdot d\mathbf{s}}{\varepsilon}. \]

3(a) Show that \( \mathbf{E} = -\nabla V \) is inadequate for defining time varying fields. Derive the modified form of this equation for time varying fields.

3(b) A 30-cm by 40-cm rectangular loop rotates at 130 rad/s in a magnetic field 0.06 \( \text{Wb/m}^2 \) normal to the axis of rotation. If the loop has 50 turns, determine the induced voltage in the loop.

OR

3(h') Let \( \mu = 3 \times 10^{-5} \text{ H/m} \), \( \varepsilon = 1.2 \times 10^{-10} \text{ F/m} \) and \( \sigma = 0 \) everywhere. If \( \mathbf{H} = 2 \cos(10^5 t - \beta x) \hat{a}_x \) \( \text{A/m} \), use Maxwell's equations to obtain expressions for \( \mathbf{B}, \mathbf{D}, \mathbf{E} \) and \( \beta \).

4(a) Calculate the skin depth and velocity of propagation for a uniform plane wave at frequency 6 MHz traveling in polyvinylchloride (I_{\mu} = 1, \sigma_{\epsilon} = 4, \text{dissipation factor}=7 \times 10^{-2}).

OR

4(a') Explain the term "Polarization". What do you mean by linearly, elliptically and circularly polarized waves?

4(b) Derive the wave equations for \( \mathbf{E} \) and \( \mathbf{H} \) for a sinusoidal wave in a lossy conducting medium.

5(a) Explain how transmission lines can be used as reactive circuit elements at high frequencies. Give the equivalent reactive components represented by transmission lines of various lengths under open and short circuit conditions.

OR

5(a') What are the advantages of stub matching over quarter-wave transformer matching? Write the steps used to design single-stub impedance matching of a transmission line.

5(b) Find the input impedance of a 75 cm long transmission line where \( Z_0 = 70 \Omega \), terminated with a \( Z_1 = 140 \Omega \) load at 150 MHz. Assume the phase velocity to be equal to the speed of light in free space.