B. TECH. (WINTER SEMESTER) EXAMINATION
ELECTRONICS ENGINEERING
ELECTROMAGNETICS
AP-204

Maximum Marks: 60  
Credits: 04  
Duration: Three Hours

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

1(a) Sketch a spherical coordinate system with reference to a Cartesian coordinate system. Show that a point in spherical coordinate system is at the intersection of three mutually perpendicular planes. Identify these planes. [3.0]

(b) Express the vector field \( \vec{D} = (x^2 + y^2)^{-1}(\hat{x}_x + \hat{y}_y) \) in cylindrical coordinates. Evaluate \( \vec{D} \) at \((2, 0.2\pi, 5)\). [3.0]

(c) Define Curl of a vector field. What is the physical significance of curl? Obtain an expression for the curl in spherical coordinates. [6.0]

(d) State and prove Uniqueness Theorem. [3.0]

2(a) State Biot-Savart's Law? Express this law in terms of current element \( IdL \), surface current density \( K \) and current density \( J \). [2.0]

(b) Derive an expression for the magnetic field intensity due to an infinite sheet of current. The sheet has a surface current density along \( y \)-axis. Give necessary explanation in identifying the various components of the field. [6.0]

OR

(b) Discuss the origin of magnetism in magnetic materials. How many types of magnetic materials are there? Give at least one example of each of these magnetic materials. Describe their magnetic properties. [6.0]

(c) Define \( H \), \( B \) and \( M \). How these vectors are related for magnetic materials? Calculate the magnetic flux between the conductors of coaxial transmission line by considering a definite length. Discuss magnetic boundary conditions at the interface of two linear, homogeneous and isotropic media. [7.0]

3(a) Show that Ampere's law is incompatible with the equation of continuity. How did Maxwell resolve this inconsistency? [2.5]

OR

Contd. 2...
(a') Deduce the expressions for time varying magnetic and electric fields in terms of
time varying vector and scalar potentials.

(b) Obtain the expression for induced emf in a moving loop in time varying field in
differential and integral forms.

(c) Check whether the following fields satisfy Maxwell's equations or not. Assume that
the fields exist in charge free regions.
(i) \[ A = 40 \sin (\alpha t + 10) \mu_x. \]
(ii) \[ C^+ (3p^+ \cot (\varphi) a_0 + \frac{\cos (p)}{p} a_0 \sin (\varphi)) \]

(d) If \( P = 2 \sin (10t + x - \pi/4) \bar{a}_y \) and \( \bar{Q}_S = e^{i\varphi} (\bar{a}_x - \bar{a}_z) \sin (\pi y) \), determine the
Phasor form of \( P \) and the instantaneous form of \( Q_S \).

(e) What is a time harmonic field? Write the time harmonic Maxwell's equations in
point and integral forms. Comment on the physical significance of Maxwell's
equations.

4(a) Write the expressions for \( E, B, \alpha, \beta, \gamma, \mu, \eta \) for the case of electromagnetic waves in
lossy dielectrics, lossless dielectrics, free space and good conductors.

(b) Show that for a conductor wire of radius \( a \), \[ \frac{R_{dc}}{R_{ac}} = \frac{a}{2\delta} \]

(c) State and derive Poynting's theorem.

OR

4(a') Consider an electromagnetic wave incident at oblique angle at the interface of a
lossless dielectric media and whose electric field vectors \( E \) are polarized
perpendicular to the incident plane. (i) Obtain the Fresnel's equations. (ii) Show that
Brewster's angle in case of non magnetic lossless media does not exist. (iii) Also
show that the reflection and transmission coefficients for non magnetic dielectric media become,
\[ \Gamma_\perp = \frac{\sin (\theta_t - \theta_i)}{\sin (\theta_t + \theta_i)}, \quad T_\perp = \frac{2 \cos \theta_i \sin \theta_t}{\sin (\theta_t + \theta_i)} \]

(b') Show that for a uniform plane wave, the Maxwell's equations reduce to;
\[ k \times E = \omega \mu H, \quad k \times H = -\omega e E, \quad k.H = 0, \quad k.E = 0. \]

(c') Discuss radio wave propagation in ionosphere through reflection and refraction.
2013-14
B.TECH. EXAMINATION
ELECTRONICS ENGINEERING
ANALOG ELECTRONICS
EL-213

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Answer parts of a question together.

Q.No. Question M.M.
1(a) Compare the Wilson mirror and the simple mirror by evaluating the (i) current transfer ratio error due to finite $\beta$ and (ii) the output resistance, if transistors used have $\beta=100$ and $r_e=100k\Omega$. [04]
1(b) For the active loaded BJT differential amplifier biased by $I=0.8mA$, find the transconductance gain, output resistance, differential voltage gain and input resistance, if transistors used have $\beta=160$ and $V_A=100V$. [04]
1(c) A differential amplifier operates from an emitter current source with output resistance of $1M\Omega$. What resistance is associated with each common-mode half circuit? For collector resistors of $20k\Omega$, what is the resulting common-mode gain for single ended output? [04]

OR
1(c') A differential amplifier using a $0.6mA$ emitter bias source uses two well matched transistors but collector load resistors are mismatched by 10%. What input offset voltage is required to reduce the differential output voltage to zero? [04]

2(a) Which current source provides biasing to the 741 opamp. circuit? [02]
2(b) Name the transistors' composite pair used in the input differential stage of 741 opamp. [02]
2(c) What is the load circuit for input stage of 741 opamp.? [02]
2(d) Name and justify the choice of composite pair transistors for second stage of 741 circuit.
2(e) What are the requirements for output stage and how are they fulfilled in 741 opamp.?
2(f) What is the role of \( C \) used in the feedback loop of second stage of 741 circuit?
3(a) Explain the operation of the circuit shown in Figure 1.

![Figure 1](image1)

OR

3(a') Figure 2 shows a buffered precision peak detector circuit. Explain its operation.

![Figure 2](image2)

3(b) Design a rectangular wave generator for 50kHz with 75% duty cycle using 555 Timer IC, assuming a 100pF capacitor to be available?

OR

3(b') Realize a voltage controlled square/triangular wave generator using inverting Schmitt trigger and obtain the expression for frequency of the outputs.

3(c) What are the applications of (i) voltage to current converter and (ii) current to voltage converter circuits?
4(a) For the circuit as shown in Figure 3, explain the operation along with necessary derivations.

4(b) Realize an analog multiplier circuit based on log and antilog amplifiers using three opamps.

4(c) What are the desirable features of an Instrumentation amplifier?

5(a) Derive the expression for the bandwidth of a BJT differential amplifier using high frequency transistor model.

5(b) Explain with justifications the advantages of employing emitter followers at the input and the output of a Cascode amplifier circuit.

5(c) "Push pull amplifiers are good in eliminating even harmonic distortions". Justify the statement.

OR

5'(a) A Cascode amplifier exhibits three poles at 0.5MHz, 2MHz and 10MHz. Calculate the bandwidth of the circuit.

5'(b) Design a 555 Timer based circuit for generating 15kHz output if trigger input of 45kHz and capacitor of 1nF is available.

5'(c) It is required to obtain 1MHz signal using PLL based circuitry assuming a crystal oscillator with 2.5MHz output. Show the realization along with the hardware requirements.
2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRONICS ENGINEERING
CONTROL SYSTEMS
EL-223

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. Write notes on any THREE of the following: 12
   (a) Synchros
   (b) Tachometers
   (c) Gyroscope
   (d) Servomotors
   (e) Position Control systems

2. State the Nyquist stability criterion.
A unity feedback control system has its open-loop transfer function as:

   \[ G(s) = \frac{60}{(s + 4)(s^2 + 2s + 5)} \]

   Draw the complete Nyquist plot and hence, determine the stability of the system.

OR

2'. Draw the complete root-locus diagram for the following open-loop transfer function,
indicating all the steps clearly: 12

   \[ G(s)H(s) = \frac{K(s + 2)}{s(s + 3)(s^2 + 2s + 2)} \]

   contd... 2
3. The open-loop transfer function of a unity feedback system is $G(s) = \frac{K}{s(s+2)}$. Design a suitable compensator so that the velocity steady state error constant should be 20 and phase and gain margins should be more than $50^\circ$ and 10 dBs respectively.

OR

3'. What are PID controllers? Indicate their effects on the system's performance.

Find the error-rate factor, $K_e$, to make the damping ratio equal to 0.5 for the system shown.

$$R(s) \rightarrow + \rightarrow \frac{1 + sK_e}{s+2} \rightarrow \frac{10}{s} \rightarrow C(s)$$

4. Define controllability and observability of a control system.

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

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

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

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 $N = \frac{4}{\pi X} \angle 90^\circ$, is operating in cascade with the linear system having $G(s) = \frac{10}{s(G+1)(s+2)}$, in the forward path. Determine the amplitude and frequency of the limit cycle, if it exists.
2013-14
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.

Q.No. 
Question

1(a) What is the dual of a logic function? Show that the dual of the exclusive-OR is equal to its complement. [05]

1(b) Express the following function as a sum of minterms and as a product of maxterms:

\[ F(A, B, C, D) = B'D + A'D + BD \]

1(c) What is an Equivalence gate? How can you use it to make a controlled NOT gate? [05]

2(a) Give the gate level diagram of a 3x8 decoder with enable input. Implement a full adder using a decoder. [05]

2(b) What is the dual of a logic function? Show that the dual of the exclusive-OR is equal to its complement. [05]

2(c) An 8x1 multiplexer has inputs A, B and C connected to the selection inputs S2, S1 and S0 respectively. The data inputs I0 through I7 are as follows: I0 = I3 = 0; I1 = I5 = I7 = 1; \(-I_2 = I_4 = I_6 = D; I_2 = D'.\) Determine the Boolean function that the multiplexer implements. [05]

2'(a) Simplify the complement of the following function and implement it using NAND gates: \[ F(A, B, C, D) = \Sigma(1, 2, 3, 4, 8, 9, 10, 11, 12) \] [07]

2'(b) Implement the following Boolean function with a multiplexer: \[ F(A, B, C, D) = \Sigma(0, 2, 5, 7, 11, 14). \] Apply A, C, D, in that order, to the select lines. [08]
3(a) Explain the operation of an SR latch constructed with NOR gates. Use the SR latch to obtain an SR flip-flop. When and why do indeterminate states occur? [06]

3(b) A sequential circuit with two D flip-flops A and B, two inputs x and y, and one output z is specified by the following next-state and output equations:

\[ A(t+1) = x' y + x B \]
\[ B(t+1) = x' A + x B \]
\[ z = A \]

(a) Draw the logic diagram of the circuit.
(b) List the state table for the sequential circuit.
(c) Draw the corresponding state diagram.

OR

3(b') Design a Counter with the repeated binary sequence: 0, 1, 2, 4, 6. Use JK flip-flops. [09]
Assume that if an unused state is encountered the state machine jumps to 000.

4(a) Design a Decimal adder using two 4-bit binary adders. [05]

4(b) Design a four-bit combinational circuit 2's complementor (the output generates the 2's complement of the input binary number.) Show that the circuit can be constructed with exclusive-OR gates. [10]

OR

4(b') Explain the operation of a Carry Look Ahead Adder. [10]
Q. No. 1(a) A continuous time signal $x(t)$ is shown in figure. Sketch and label each of the following signals:
   i. $x(t) u(1-1)$
   ii. $x(t) [u(t) - u(1-1)]$

OR

Q. No. 1(a') Determine whether or not each of the following signals is periodic.
   i. $x(t) = \text{Even} \{ \sin(4\pi t) u(t) \}$
   ii. $x(t) = [\cos(2\pi t/3)]^2$

Q. No. 1(b) The Fourier series coefficients of a continuous time signal that is periodic with period 4 is given by $a_k = \frac{jk}{\pi}, \quad -3 < k < 3$

Find the signal $x(t)$. 

Q. No. 1(c) The system shown in figure is formed by the cascading of two systems. The impulse responses of individual systems are also given in the figure. Find the impulse response of overall system. Also find if the overall system is BIBO stable.
2(a) Prove the convolution property of Fourier transform.

2(b) Consider a signal $y(t)$ which is related to two signals $x_1(t)$ and $x_2(t)$ by

$$y(t) = x_1(t-1) * x_2(t+1)$$

where $x_1(t) = e^{-2t}u(t)$ and $x_2(t) = e^{-3t}u(t)$; $*$ stands for convolution.

Find $Y(s)$.

2(c) Find the inverse $z$-transform of $X(z) = \frac{1-2z^{-1}}{1-e^{-2t}+z^{-2}}$

It is given that $x[n]$ is absolutely summable.

OR

2'(a) Consider a causal LTI system with frequency response $H(j\omega) = \frac{2}{j\omega+3}$

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

$$y(t) = e^{-2t}u(t) - e^{-4t}u(t)$$

Determine $x(t)$.

2'(b) For a non-causal and stable LTI system find the inverse Laplace transform of the system function

$$H(s) = \frac{s+2}{s^2+8s+2}$$

2'(c) Finds the $z$-transform of the discrete time signal

$$x[n] = 3[n-1] + 2[n+1] - u[n] - u[n-1]; \text{ where } |a|>1$$

Also show the ROC.

3(a) Suppose a causal LTI system with frequency response $H(\omega)$ is described by the following difference equation relating input $x[n]$ and output $y[n]$:


Here $a$, $b$, and $c$ are constants.

Determine the values of $a$, $b$, and $c$ so that the frequency response of the system is

$$H(\omega) = 1 - 0.5e^{-2i\omega}cos(3\omega)$$

3(b) Determine the Nyquist rate for the signal $x(t) = \text{sinc}(100\pi t) + \text{sinc}(50\pi t)$.

3(c) Reduce the following block diagram by block diagram reduction method to get the overall gain (C/R)
3(c') Solve the signal flow graph to get the overall gain (C/R).

4(a) A random variable $Y$ is related to the random variable $X$ by the equation $Y = 3X - 4$. The probability density function of $X$ is given by $f(x) = \exp(-2|x|)$ for $-\infty < x < \infty$.

   i. Find the probability density function of the random variable $Y$.
   ii. Find the probability that $Y$ is negative.
   iii. Find the probability that $Y$ is greater than $X$.

4(b) Two random variables, $X$ and $Y$, have a joint probability density function given by

$$f(x,y) = kxy \quad 0 \leq x \leq 1, 0 \leq y \leq 1$$

   - $0$ elsewhere

   i. Determine the value of $k$ that makes this a valid probability density function.
   ii. Determine the joint probability distribution function $F(x,y)$.
   iii. Find the joint probability of the event $X \leq 0.5$ and $Y > 0.5$.

4(c) Write the properties of joint probability distribution function for two random variables.

OR

4(c') Define the following with respect to random process:

   i. Ergodic and Non-Ergodic random process
   ii. Stationary and Non-Stationary
2013 – 2014
B Tech (Winter Semester) Examination
( Electronics Engineering)
Principles of Communication Engineering
EL – 242/ EL – 341
Credits: 4
Maximum Marks: 60
Duration: Three Hours

Notes:
1. Answer all questions.
2. Any missing information can suitably be assumed.

1. (a) Write an expression for the frequency response of an ideal linear phase low pass filter. Is it physically realizable? 2
(b) What is the relationship between pre-envelope and complex envelope of a bandpass signal? 2
(c) Plot roughly the variation of carrier power and total sideband power with percentage modulation of an AM signal. 2
(d) What is the image frequency in a SSB? Why is it suppressed? 2
(e) Consider an FM signal

\[ s(t) = A \cos \left[ 2\pi f_c t + 2\pi k_f \int_0^t m(\xi) d\xi \right] . \]

Let \( t_1 \) and \( t_2 \) (\( t_2 > t_1 \)) denote the times associated with two adjacent zero crossings of \( s(t) \). If

\[ \int_t^{t_2} m(\xi) d\xi = (t_2 - t_1)m(t) \quad t_1 < t < t_2, \]

show that

\[ k_f m(t) \approx (0.5\pi / \Delta t) - f_1, \]

where \( \Delta t = t_2 - t_1 \). 7

1’ (a) How should you select the charging and discharging time constants of an envelope detector for its satisfactory operation? 2
(b) Why do you need more than one stages of modulation in SSB schemes? 2
(c) With the help of phasor diagrams explain the difference between narrowband FM and an AM signal. 3

Contd... 2
(d) A VSB system is shown in Fig. 1. The bandwidth of the message signal \( m(t) \) is \( W \) and the transfer function of the bandpass filter is \( H(f) \).

(i) Determine the complex envelope of the impulse response, \( h(t) \), of the BPF.

(ii) Derive an expression for the modulated signal \( m(t) \).

\[
\begin{array}{c}
\text{A cos } \omega_c t \\
\text{VSB signal}
\end{array}
\]

\[
\begin{array}{c}
m(t) \\
BPF \\
h(t)
\end{array}
\]

\[
\text{Fig. 1}
\]

2 (a) A signal \( x_1(t) \) is bandlimited to 2 kHz while \( x_2(t) \) is bandlimited to 3 kHz. Find the Nyquist sampling rates for

(i) \( x_1(2t) \)

(ii) \( x_1(t) + x_2(t) \)

(iii) \( x_1(t)x_2(t) \)

(iv) \( x_1(t) + x_2(t) \)

(b) A signal \( x(t) \) undergoes a zero-order hold operation with an effective sampling period \( T \) to produce a signal \( x_0(t) \). Let \( x_1(t) \) denote the result of a first-order hold operation on the samples of \( x(t) \); i.e.,

\[
x_1(t) = \sum_{n=-\infty}^{\infty} x(nT) h_1(t - nT),
\]

where \( h_1(t) \) is shown in Fig. 2. Specify the frequency response of a filter that produces \( x_1(t) \) as its output when \( x_0(t) \) is the input.

\[
\text{Fig. 2}
\]

(c) Consider a sine-wave of frequency \( f_m \) and \( A_m \) applied to a delta modulator of step size \( \delta \). Show that slope-overload distortion will occur if \( A_m > \frac{\delta}{2A_m T_s} \), where \( T_s \) is the sampling period. What is the maximum power that may be transmitted without slope-overload distortion?

contd...
(c') Plot the spectrum of a PAM wave produced by the modulating wave
\[ m(t) = A_0 \cos 2\pi f_t t \]
Assuming a modulation index \( \mu < 1 \), modulation frequency \( f_t = 0.25 \) Hz, sampling period \( T_s = 1 \) second and pulse duration \( \tau = 0.45 \) second. Using an ideal reconstruction filter, plot the spectrum of the filter output.

3 (a) Discuss the effects of pre-emphasis and de-emphasis filtering on the overall SNR in FM system.
(b) A signal can be modeled as a lowpass stationary process \( X(t) \) whose probability density function at any time \( t \) is given in Fig. 3. 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?
(ii) If the available bandwidth of the channel is 40 kHz, what is the highest achievable SQNR?

![Fig. 3](image)

(b') List the properties of narrowband noise.
If a narrow band noise \( n(t) \) is Gaussian with zero mean, and its power spectral density \( S_n(f) \) is locally symmetric about the mid-band frequency \( f_c \), show that inphase and quadrature noise components, \( n_I(t) \) and \( n_Q(t) \), are statistically independent.

4 (a) Determine the output of the matched filter of the pulse \( p(t) \) when the input waveform is
\[ s(t) = A_s p(t - p(t - T_b)) \]
where \( p(t) \) is the square pulse of unit amplitude and duration \( T_b \).
(b) State and explain the Nyquist criterion for obtaining zero inter-symbol interference (ISI). Show that \( X(f) \), Fourier transform of the received pulse, shown in Fig. 4 satisfies the Nyquist criterion of ISI free communication. (\( T \) is the symbol duration and \( a \), a constant, lies between 0 and 1)

![Fig. 4](image)
2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
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.
Use of Smith Chart is permitted.

Q.No. Question M.M.
1(a) Find the electric field intensity at a point P(0,0,z) due to a circular ring of radius 'a', carrying a total charge Q, distributed uniformly along the ring. Neglect the thickness of the ring and consider point P along the axis of the ring at a distance z from its center. [04]

1(b) 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 \( \nabla \cdot \mathbf{D} = \rho_v \). [03]

1(c) A spherical charge distribution exists in free space in region \( 0 < r < a \) given by

\[ \rho_c(r) = \rho_o \left(1 - \frac{r^2}{a^2}\right) \]

Find the total charge, electric field intensity E and electric potential V everywhere. [05]

(OK)

1'(a) Consider a positive point charge Q placed at the center of spherical metallic shell of an inner radius 'a' and outer radius 'b' as shown in Fig. 1. Find and plot (a) Electrical field and (b) electric potential everywhere as a function of radial distance 'r'. [05]

Contd... 2
1'(b) Show that a vector field $\vec{A}$ is conservative if $\vec{A}$ possesses one of these two properties:

(i) The line integral of tangential component of $\vec{A}$ along a path extending from a point P to a point Q is independent of the path.

(ii) The line integral of the tangential component of $\vec{A}$ around any closed path is zero.

1'(c) A parallel-plate capacitor is made using two circular plates of radius $a$, with bottom plate on the xy-plane, centred at the origin. The top plate is located at $z=d$, with its centre on the z-axis. The top plate has potential of $V_0$, whereas the bottom plate is grounded. The region between the plates is filled with dielectric having radially dependent permittivity given as $\varepsilon(\rho) = \varepsilon_0 (1 + \rho / a)$. Find the capacitance between the plates by solving Laplace's equation.

2(a) Two perfect dielectrics have relative permittivity $\varepsilon_1=2$ and $\varepsilon_2=8$. The planar interface between them is a surface $x+y+2z=5$. The origin lies in region 1. If $\vec{E}_1 = 100 \, \hat{a}_x - 10 \, \hat{a}_y + 50 \hat{a}_z \, V/m$, find $\vec{D}_2$. Also find energy density in both regions.

2(b) A conducting current strip carrying $\vec{I} = 12 \, \hat{a}_z \, A/m$ lies in the x=0 plane between $y=0.5$ and $y=1.5$ m. There is also a current filament of $I=5A$ in the $a_x$ direction along the z-axis. Find the force exerted on the filament by the current strip.

2(c) Show that the line integral of the vector potential $\vec{A}$ about any closed path is equal to the magnetic flux enclosed by the path, or,

\[ \oint \vec{A} \cdot d\vec{l} = \int \vec{B} \cdot d\vec{S} \]
2'(a) Derive the point form of continuity equation. Explain its physical interpretation.

2'(b) Two co-axial conducting cylinders of radius 2 cm and 4 cm have a length of 1 m. The region between the cylinders contains a layer of dielectric from \( \rho=2 \text{ cm} \) to \( \rho=3 \text{ cm} \) with \( \varepsilon_r=4 \) and rest of the region between cylinders is filled with free space. Find the capacitance between two cylinders.

2'(c) A filament is formed into a circle of radius \( a \), centered at the origin in the plane \( z=0 \). It carries a current \( I \) amp in the \( \hat{z} \) direction. Find \( \vec{H} \) at the origin.

3 (a) Write Maxwell's equations for time varying fields in both differential and integral forms. Give physical interpretations of each Maxwell's equations. Also write point form of Maxwell's equations for sinusoidal time varying fields.

3(b) In a medium characterized by \( \varepsilon=0, \mu=\mu_0, \varepsilon_w=\varepsilon_0, \) and \( \vec{E} = 20 \sin(10^6 t - 0.66z) \hat{y}, \text{ V/m} \), find \( \vec{H} \).

3(c) State and explain Poynting theorem and terms involved in the expression of Poynting vector. Also write the expression of average power density carried by the travelling electromagnetic field.

4(a) In a non-magnetic medium \( \vec{E} = 4 \sin(2\pi 10^7 t - 0.8x) \hat{z}, \text{ V/m} \), find relative permittivity, intrinsic impedance and time averaged power per unit area carried by the wave.

4(a') A uniform plane wave propagating in a medium has \( \vec{E} = 2e^{-\alpha t} \sin(10^6 t - \beta z) \hat{y}, \text{ V/m} \). If the medium is characterized by \( \varepsilon_r=1, \mu=20 \) and \( \varepsilon_w=3 \text{ mhos/m} \). Find attenuation constant, phase constant, intrinsic impedance, dissipation factor and \( \vec{H} \).

4(b) The electric field strength of a uniform plane electromagnetic wave in free space is 1 V/m and frequency is 300 MHz. If a large thick copper plate of \( \sigma=5.8 \times 10^7 \text{ S/m} \), \( \varepsilon=\varepsilon_0 \) and \( \mu=\mu_0 \) is placed normal to the direction of wave propagation. Determine

(i) \( \vec{E} \) and \( \vec{H} \) at the surface of plate.

Cont'd... 4
(ii) Depth of penetration,
(iii) Conduction current density at the surface

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.

5(b) Derive the expression for reflection coefficient of a lossless transmission line in terms of load and characteristic impedances. Also give relationship between the reflection coefficient and standing wave ratio.

5(c) Two λ/4 transformers in tandem are to connect a 50Ω line to a 75 Ω load, as shown in Fig. 2. Determine the characteristic impedance $Z_{01}$ if $Z_{02}$ is 30 Ω and there is no reflection wave left of A.

![Diagram of transmission line with $Z_{01} = 50\text{Ω}$, $Z_{02} = 2\text{Ω}$, and a 75 Ω load.](image)