BITS, PILANI - DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
III YEAR - EEE, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES

COMPREHENSIVE EXAMINATION (CLOSED BOOK)

Maximum Marks: 80 DATE : 07/06/2004

Time:3 HOURS WEIGHTAGE: 40 %

PART –A (10 X 2 Marks= 20)
Answer All the Questions

1. Find the magnitude of the electric field at the point x = y = z = 0.5m,if the potential as a function of position is given by $V= 2x^2 +3y+4 z^{1/2}$

2. How much current must flow in a loop of radius 0.5 m to produce a magnetic field H= 1 mA/m.

3. Four straight conductors form a square with a magnetic field B perpendicular to the square. If all conductors move outward with the same velocity v while contacting each other at the corners, Find V(rms) induced in the square loop at the instant when its area is 2 m^2,v = 4 m/s and B = cos (2πft), where f = 2 KHz

4. A loss less 100 Ω transmission line is terminated in 200 +j 200 Ω. Find voltage reflection coefficient and VSWR

5. An antenna has a field pattern $E(\theta) = \cos\theta \cos 2\theta$ for $0° \le \theta \le 90°$. Find The half power bandwidth and the beam width between first nulls

6. Calculate the radiation resistance of a center fed λ /5 short dipole antenna with average current is one half the terminal current

7. Find the transmitted and reflected fields when a wave is transmitted from air to Loss less non ferromagnetic dielectric medium with $\varepsilon_r = 10$.

8. Define polarization. What is the difference between perpendicular polarization and parallel polarization

9. Define TE and TM waves

10. Write short notes on cavity resonator

PART –B (6 X 10 Marks= 60)
Answer any 6 Questions

11. Electrostatically, a typical thunder cloud is represented by a capacitor model with horizontal plates 10 Km^2 in area separated by a vertical distance of 1 Km . The upper plate has positive charge of 200 C and lower plate an equal negative charge Find (a) The electro static energy stored in the cloud (b)The potential difference between the top and bottom of the cloud (c) The average electric field in the cloud

12. A high frequency line has the following primary constants L = 1.2 mH/km, C= 0.05 μf/Km. R= G = negligible. Determine (a) the characteristics impedance (b) Propagation constant of the line .For a 400 m section of this line determine (c) The frequency at which the line length one wavelength and (d) wave velocity

13 .A 100 Ωlines is terminated in to a load of 50 –j50 .It is desired to provide matching between the line and the load by means of a short circuited stub. Determine the length of the stub. Assume signal frequency of 10 MHz

14.Justify the following

(a) When the plane wave is incident normally on a boundary between two different media (Medium 1 is air and medium 2 is perfect conductor) the wave is completely reflected and zero field is transmitted in to the conductor

(b) At 1 kHz the rural ground($\varepsilon_r = 14$, $\sigma = 10^{-2}$ mho /m) behave like a conductor, at microwave frequency it act like a dielectric .

15. (a)List out and explain any five antenna parameters

(b) What is the principle of pattern multiplication? Explain with an example.

16. Write short notes

(a) Wave propagation in wave-guides and types of wave guides

(b) RADAR and its application

(c) Linear, Circular and elliptical polarization

17. (a)A parallel polarized wave is incident from a paraffin ($\varepsilon_r = 2$) to flint glass ($\varepsilon_r = 10$) Find the Brewster angle

(b) Find **J** if $\mathbf{H} = \hat{x}\,3 + \hat{y}\,7y + \hat{z}\,12$ x A/m

(c) A wave traveling in the +x direction has two components $\mathbf{E}_1 = \hat{z}\,16\cos(\omega t - \beta x)$ and $\mathbf{E}_2 = \hat{z}\,16\sin(\omega t - \beta x)$ mv (rms)/m . Find the Axial ratio of resultant wave and type of polarization

(d)A solenoid has dimensions L= 1.2 m, N= 750 turns, diameter = 10 cm and current I= 1.75 A, $\mu_r = 5$. Find the field inside the solenoid

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III YEAR - EEE, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES
MAKEUP FOR TEST -2 (OPEN BOOK)

Maximum Marks: 20
Time: 50 minutes

WEIGHTAGE: 20 %

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1. A wave traveling in the +x direction has two components given by $\mathbf{E}_1 = \mathbf{z}\ 16\cos(\omega t-\beta x)$ and $\mathbf{E}_2 = \mathbf{y}\ 16\sin(\omega t-\beta x)$ mV(rms)/m. For the resultant wave Find (a) axial ratio AR,(b) $\mathbf{E}$ (c) $\mathbf{H}$ and (d) average poynting vector S_{av} (e) Is wave is left or right handed [5]

2. Estimate the directivity (in dB) of an antenna with $\theta_{HP} = 2^\circ$,$\phi_{HP} = 1^\circ$(b).Find the gain (in dB) of the antenna if k= 0.5 [2]

3. A 100 Ω line is connected to a load impedance of $Z_L = 300 + j200\ \Omega$ Find (a) line d_1 required to transform this impedance to a pure resistance (b) impedance of $\lambda/4$, line required for a match (c) VSWR on d_1 line and (d) VSWR on the $\lambda/4$ line [5]

4. Two short dipole antennas are oriented such a way that it will act as a broad side array . The distance between them is $\lambda/2$. Find the total array pattern and explain with the help of pattern multiplication [3]

5. What is folded dipole antenna . If the folded has two dipoles of $\lambda/2$ with the same diameter and the distance between them is very small ,what will be the impedance of antenna . [2]

6. What is the condition for an array to be an end fire? If 4 sources of equal amplitude spaced $\lambda/2$, find the $(\theta_{max})_{minor}$,$(\theta_{max})_{major}$ for an end fire antenna. [3]

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III YEAR - EEE, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES
QUIZ- 2 (CLOSED BOOK)

Maximum Marks: 20 **Date: 20.05.2004**

Time: 30 minutes **WEIGHTAGE: 5 %**

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1. The input impedance required to match a load $Z_L = 100\ \Omega$ to a $50\ \Omega$ line is
   (a) $70.7\ \Omega$
   (b) $5000\ \Omega$
   (c) 1.414Ω
   (d) None of the above

2. A dielectric medium has a relative permittivity $\varepsilon_r = 6$ and $\mu_r = 2$. The index of refraction is
   (a) 12
   (b) 3.4
   (c) 0.577
   (d) None of the above

3. In right circularly polarized wave the time phase angle for which Ey leads Ex is
   (a) + 90 °
   (b) - 90 °
   (c) 0 °
   (d) None of the above

4. The average power per unit area for an elliptically polarizes wave traveling in the Z direction in air has x and y components $E_x = 5 \sin(\omega t - \beta x)$ & $E_y = 6 \sin(\omega t - \beta x + 75°)$
   (a) $60\ mW/m^2$
   (b) $10.35\ mW/m^2$
   (c) $82.9\ mW/m^2$
   (d) None of the above

5. Polystyrene has a permittivity of 3. if a wave is incident at an angle of 30 °from polystyrene to air . Calculate the angle of transmission
   (a) 16.77°
   (b) 60 °
   (c) 52.2°
   (d) None of the above

6. What will be the angle at which the incident wave is totally internally reflected back when a wave traveling from a medium with permittivity of 5 to 2
   (a) 34.2°
   (b) 66.42 °
   (c) 39.23°
   (d) None of the above

7. Freshnel reflection coefficient of parallel polarization for a perfect conductor is
   (a) 0
   (b) –1
   (c) +1
   (d) None of the above

8. Which is the false equation
   (a) $D = 4\pi / \iint_{4\pi} Pn\,(\theta,\Phi)\, d\,\Omega$
   (b) $D = P\,(\theta,\Phi)_{max} / P\,(\theta,\Phi)_{av}$
   (c) $D = 4100 / (\theta_{HP} * \Phi_{HP})$
   (d) None of the above

9. The normalized value of the total field of an n linear array of n isotropic in phase point source is
   (a) $E = \sin(n\,\psi/2) / \sin(\psi/2)$
   (b) $E = \sin(n\,\psi/2) / (n * \sin(\psi/2))$
   (c) $E = (n * \sin(n\,\psi/2)) / \sin(\psi/2)$
   (d) None of the above

10. The radiation resistor of a short dipole antenna which is a center fed $\lambda/10$ dipole and has a average current equal to half of the terminal current is
   (a) 2
   (b) 4
   (c) 1.5
   (d) None of the above

11. The terminal impedance of the dipole is 500 Ω. The terminal impedance of the slot is
   (a) 71 Ω
   (b) 17.7 M Ω
   (c) 188.5 M Ω
   (d) None of the above

12. For a horn with $L = 5\,\lambda$, find the largest flare angle for which $\delta = 0.25\lambda$
   (a) 35.5 °
   (b) 17.7°
   (c) 144.49°
   (d) 72.24°

13. The axial ratio of linear polarization is
   (a) 1
   (b) 0

(c) −1
(d) None of the above

14. The maximum aperture of a microwave antenna which has directivity of 900 is
    (a) 6.15 λ
    (b) 7.619 λ^2
    (c) 7.619 λ
    (d) None of the above

15. The gain of the antenna with a circular aperture of diameter 3 m at a frequency of 5 GHz is
    (a) 24.6×10^3
    (b) 82.24×10^3
    (c) 98.4×10^3
    (d) None of the above

16. The radiation resistance of a $\lambda/16$ wire dipole in free space is
    (a) 8.08 Ω
    (b) 49.34 Ω
    (c) 0.981 Ω
    (d) None of the above

17. Which is the false statement
    (a) In perpendicular polarization the electric field is perpendicular to the plane of incidence
    (b) Brewster angle is a angle at which the incident wave is totally transmitted in to medium 2
    (c) Aperture efficiency is directly proportional to the physical aperture
    (d) None of the above

18. A US channel 599 MHz produces a field strength of 2 μV/m at a square corner-receiving antenna with the directivity of 30. The power delivered to the receiving antenna is
    (a) 0.59×10^{-15} w
    (b) 1.06×10^{-15} w
    (c) 6.35×10^{-15} w
    (d) None of the above

19. Which is the false statement. The noise power per unit bandwidth is
    (a) Directly proportional to the boltzman constant
    (b) Directly proportional to the bandwidth
    (c) Directly proportional to the antenna noise temperature
    (d) None of the above

20. Which is the false statement in connection with folded dipole
    (a) High input impedance
    (b) Wide band in frequency
    (c) Act as built in reactance compensation network
    (d) None of the above

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III YEAR - EEE, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES
TEST -2 (OPEN BOOK)

Maximum Marks: 20 **Date: 16.05.2004**

Time: 50 minutes **WEIGHTAGE: 20 %**

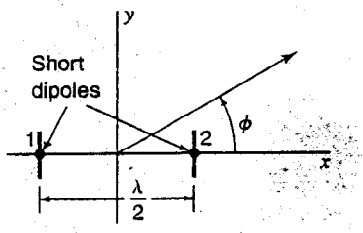
1. Find the reflection coefficient for a plane wave with polarization perpendicular to the plan of incidence from air onto a medium with permittivity $\varepsilon_r = 4$ at an angle of 30 ° [2

2. A plane 2 GHz wave is incident normally on the plane of a half space material having [3 constants $\mu_r = 1, \varepsilon_r = 3$.
   Find (a) The thickness in millimeters
   (b) The relative permittivity required for a matching plate, which will eliminate reflection of the incident wave

3. A uniform 100 Ω line is terminated in a load impedance $Z_L = 150 + j100\Omega$ .Use a shorted stub to match this to the line.
   Find (a) The distance d_1 from the load to stub
   (b) Stub length d_2 for a match [5]

4. An antenna has a uniform field 10 V/m (rms) at a distance of 100m for zenith angle between 30 to 60 ° and azimuth angle between 0 and 80 ° with E = 0 elsewhere. Find the directivity and the effective aperture [4]

5. Two short dipole oriented parallel to the y axis as shown in figure. Find the total array pattern .Explain how the pattern multiplication is used to obtain a total array pattern [3]



6. Explain the construction and working principle of Yagi uda antenna with figure [3]

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III YEAR - EEE, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES
MAKE UP FOR TEST -1 (CLOSED BOOK)

Maximum Marks: 20

Time: 30 minutes **WEIGHTAGE: 20 %**

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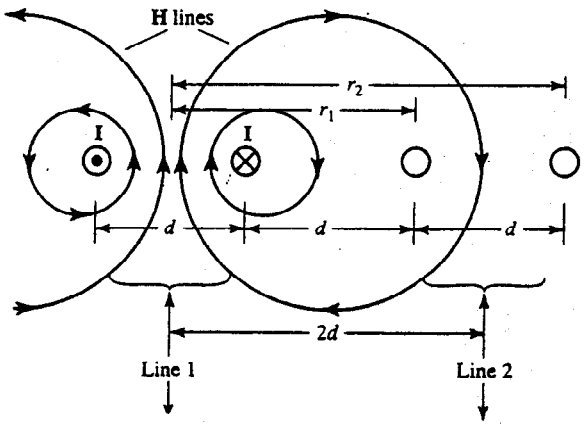
1. Charge is distributed in a spherical region ($r \leq 2$ m) with volume charge density $-200 / r^2$ $\mu C/m^2$. Determine the net electric flux crossing that surface with r = 1 m [2

2. A low frequency transmission line has the following primary constants per km . R= 6 Ω, L= 2.2 mH, C= 0.005μF, G=0.05μmho . Calculate Zo,α and β at a frequency of 1 KHz [3

3. A coaxial line has an impedance of 30Ω. If the inside diameter of the outer conductor is 20 How many field cells in parallel are there? $\varepsilon_r = 1$. [3

4. The plane wave is incident normally on a boudary between two medium with intrinsic impedance Z1 and Z2 , with the incident and reflectted travelling wave field components Ei,Hi,Er,and Hr respectively. Dervive the expression for the reflection coefficient and transmission coefficient . If the wave travel from air to conductor what will be the value of the reflection coefficients [3]

5. Find the mutual inductance of the transmission line that are side by side in the same plane with the spacing equal to the center to center spacing (2d) with $\mu_r = 1$. [3]



6. Write short notes on [6]
   (a) Changing magnetic field and faradays law
   (b) Micro strip transmission lines
   (c) 1/e depth of penetration

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III YEAR - EEE, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES
MAKE UP FOR TEST -1 (CLOSED BOOK)

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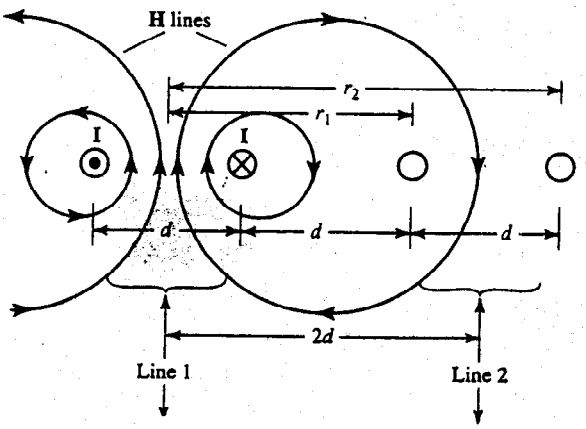

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III YEAR - EEE, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES
TEST -1 (CLOSED BOOK)

Maximum Marks: 20 **Date: 04.04.2004**

Time: 30 minutes **WEIGHTAGE: 20 %**

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1. List out the integral form of Maxwell's equation and identify the equations with the known experimental laws [2

2. Find the magnetic field H for following cases of a plane circular loop of radius R and carrying current of I

   (a) At the center of the loop
   (b) As a function of distance along the axis of the loop and
   (c) At a large distance from the loop [3

3. Three equal positive charges of 4×10^{-9} C are located at three corners of a squares, side 20cm. Determine the magnitude and the direction oh the electric field at the vacant corner point of the square [3

4. The field of 500 KHz uniform plane wave in a loss less dielectric are given by

   $E = (4\mathbf{x} - \mathbf{y} + 2\mathbf{z})$ Kv/m

   $H = (6\mathbf{x} + 18\mathbf{y} - 3\mathbf{z})$ A/m

   Determine (a) the time average power density (b) ε_r if $\mu_r = 1$ [4

5. Derive the expression for the line impedance of coaxial line with the conductor insid diameter of '2a' and outside diameter '2b'. [3

6. With an example explain standing wave and traveling wave [2

7. Find the impedance of the ground at 200M Hz with $\varepsilon_r = 14$, $\mu_r = 1$ and $\sigma = 1$ mho/m [3

BITS, PILANI - DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
III YEAR, SECOND SEMESTER 2003-2004

EEE UC433- ELECTROMAGNETIC FIELDS AND WAVES
QUIZ -1 (CLOSED BOOK)

Maximum Marks: 20

Date: 23.03.2004

Time: 30 minutes

WEIGHTAGE: 5 %

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1. A force field is in 'x' direction and increases linearly with the distance x. Find the work done by the force F in moving an object from x= 2 to a point x= 3

   (a) 1 J
   (b) 1.5 J
   (c) 2.5 J
   (d) None of the above

2. The work per charge is

   (a) Electric field intensity
   (b) Electric field density
   (c) Electrical potential
   (d) None of the above

3. Gradient of V is in the direction of

   (a) The maximum rate of change of potential V
   (b) Is in the direction same as Electric field
   (c) Cannot justify the direction based on electric field
   (d) None of the above

4. Which is the false statement?

   (a) The line integral of field E gives the potential V between two points
   (b) The line integral of E from infinity to a point gives the absolute potential of the point
   (c) The line integral of H around any path enclosing the wire is I
   (d) None of the above

5. Which is the false statement

(a) In a uniform field the E lines are parallel
(b) Non uniform field E lines diverge in going from weaker to stronge
(c) Equipotential surfaces become more widely spaced in weaker fielc region
(d) None of the above

6. Electric flux Ψ through a surface area is

(a) The integral of the normal component of electric field over the area
(b) ε times the integral of the normal component of the electric field o the area
(c) It is the scalar product of Electric field and area for the uniform fie for uniform field over the surface
(d) None of the above

7. Which is the false statement?

(a) The line integral of static electric field E around a close path is Zer
(b) div D is the dot product of the ∇ and D
(c) Divergence of D yields the electric charge at a point
(d) None of the above

8. The capacitance per unit length of the line is

(a) More when the fringing field is ignored
(b) Less when the fringing field is ignored
(c) Not affected by the fringing field
(d) None of the above

9. The current in the conductor is

(a) Directly proportional to the drift velocity
(b)Inversely proportional to the area
(c)Inversely proportional to charge density
(d) None of the above

10. $J = \sigma E$ is

(a) Joule's law
(b) Ohm's law at a point
(c) Kirchhoff 's law
(d) None of the above

11. Faraday's law states that

(a) The line integral of electric field density around a stationary loop Equals the negative surface integral of time rate of change of flux density over a loop
(b) The line integral of electric field around a stationary loop Equals the negative surface integral of time rate of change of flux density over a loop
(c) The line integral of electric field density around a stationary loop Equals the negative surface integral of time rate of change of flux over a loop
(d) None of the above

12. $V = -\int_s (d\mathbf{B}/dt) \cdot ds$ over the surface

(a) Motor equation
(b) Generator equation
(c) Transformer induction equation
(d) None of the above

13. Select the false equation

(a) $\iiint \rho \, dv = Q$
(b) $\mathbf{F} = (\mathbf{I} \times \mathbf{B}) L$
(c) $L = (\mu_o N^2 A) / l$
(d) None of the above

14 . Find the charge density on a long conductor if the flux density $D = 26.6$ pC / m^2 at a distance of 0.1 m

(a) 2.66 pC / m
(b) 16.7 pC / m
(c) 1.67 pC / m
(d) None of the above

15 . At the plane boundary between two conductors, the tangential electric field is 5 V/m in the medium 1 and the tangential current density in medium 2 is 23 A / m^2. Find the conductivity of the medium 2

(a) 4.6 mho / m
(b) 0.2173 mho / m
(c) 519 G mho/m
(d) None of the above

16. A uniform transmission line has inductance L = 150 n H/m . Find the velocity ratio if the shunt capacitance is 10 nf/m

(a) 129.09
(b) 0.086
(c) 129.09
(d) None of the above

17. When the time phase angle between Ey and Hz is 90 ° The average pointing vector magnitude is

(a) Maximum
(b) Half of the maximum
(c) Zero
(d) None of the above

18. For the seawater with $\varepsilon_r = 80$ and $\sigma = 4$ mho/ m. As the frequency increases, it behaves like a

(a) Conductor
(b) Quasi Conductor
(c) Dielectric
(d) None of the above

19. 1/e Depth of penetration is

(a) Increases as frequency increases
(b) Decreases as the frequency increases
(c) Not affected by the frequency
(d)None of the above

20. When a plane wave incident normally on a boundary of two different medium , with medium 1 as air and medium is a perfect conductor , the reflection coefficient is

(a) Zero
(b) 2
(c) 1
(d) -1