BITS PILANI DUBAI CAMPUS
KNOWLEDGE VILLAGE, DUBAI

III Year EEE – II Semester 2005-06
Comprehensive Exam
ELECTROMAGNETIC FIELDS AND WAVES
EEE UC433

Date: 30/05/06 Time: 3 Hrs
Max. Marks: 50 Weightage: 40%

ANSWER ALL QUESTIONS
Attach the Smith chart to the answer book

1. (a) Give the Maxwell's equations in differential form and integral form. Name the laws based on which these equations have been derived. (5M)

   (b) In free space $B = B_m e^{j(\omega t + \beta z)} a_y$

   Show that $E = \frac{\omega B_m}{\beta} e^{j(\omega t + \beta z)} a_x$ (5M)

2. (a) An electromagnetic wave is incident normally on a boundary between two media. Derive the expression for the transmission coefficient and reflection coefficient. Also obtain the relation between transmission and reflection coefficient. (5M)

   (b) The E field of a traveling wave of amplitude 1V/m is incident normally on a sheet of silver of thickness 5μm. Assuming $\sigma = 61.7 \times 10^6$ S/m, f = 200 MHz, find the amplitude of the field emerging from the sheet. (5M)

3. (a) Derive the transmission line wave equation. (4M)

   (b) Find the shortest distance from the load and the length of a shorted stub connected in parallel to a 300 Ω lossless air dielectric line in order to match a load Z_R=600+j300 at 600 MHz. (6M)

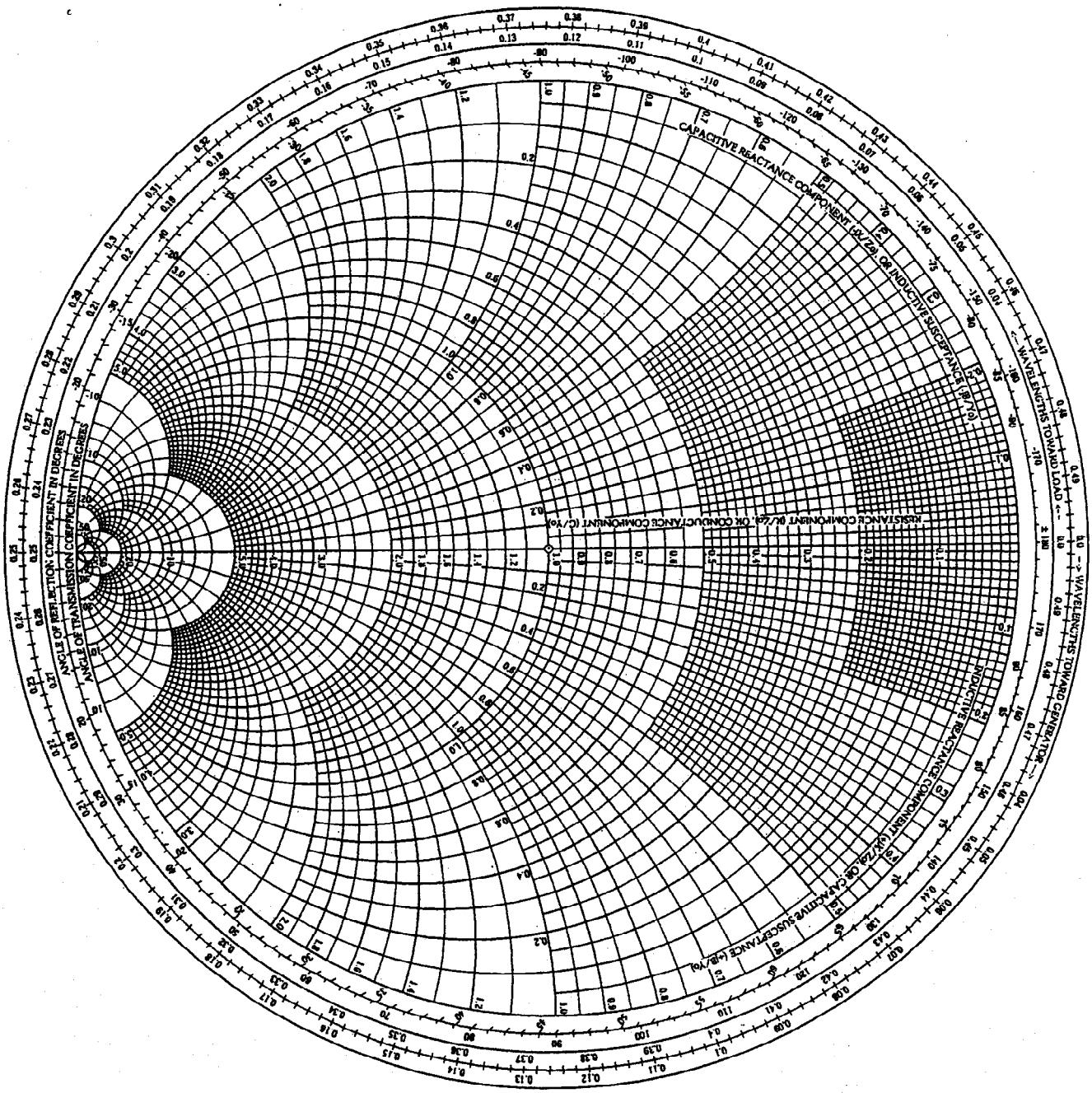
(PTO)

4. (a) Explain the terms:
Beam area, Main beam efficiency, Directivity and Gain. (4M)

(b) Four isotropic sources have equal amplitude and are spaced at $\lambda/2$. Find the phase angle δ required to maximize the field in the direction $\theta = 60^0$. Show the radiation pattern. (6M)

5. (a) Write short note on Broad band antennas. (5M)

(b) A rectangular air filled wave guide has a cross section of 45x90 mm. Find (i) Cutoff wave length for the dominant mode.(ii) Cutoff wavelength if the guide is filled with dielectric of relative permittivity $\varepsilon_r = 1.7$. (iii) Relative phase velocity in the guide at 1.6 times the cut off frequency. (5M)


RESISTANCE COMPONENT (R/Zo) OR CONDUCTANCE COMPONENT (G/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo) OR INDUCTIVE SUSCEPTANCE (+jB/Yo)
INDUCTIVE REACTANCE COMPONENT (+jX/Zo) OR CAPACITIVE SUSCEPTANCE (-jB/Yo)
WAVELENGTHS TOWARD GENERATOR
WAVELENGTHS TOWARD LOAD
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES

BITS PILANI DUBAI CAMPUS
KNOWLEDGE VILLAGE, DUBAI

III Year EEE – II Semester 2005-06
Test2 (Open Book)
ELECTROMAGNETIC FIELDS AND WAVES
EEE UC433

Date: 30/0406 Time: 50mts
Max. Marks: 20 Weightage: 20%

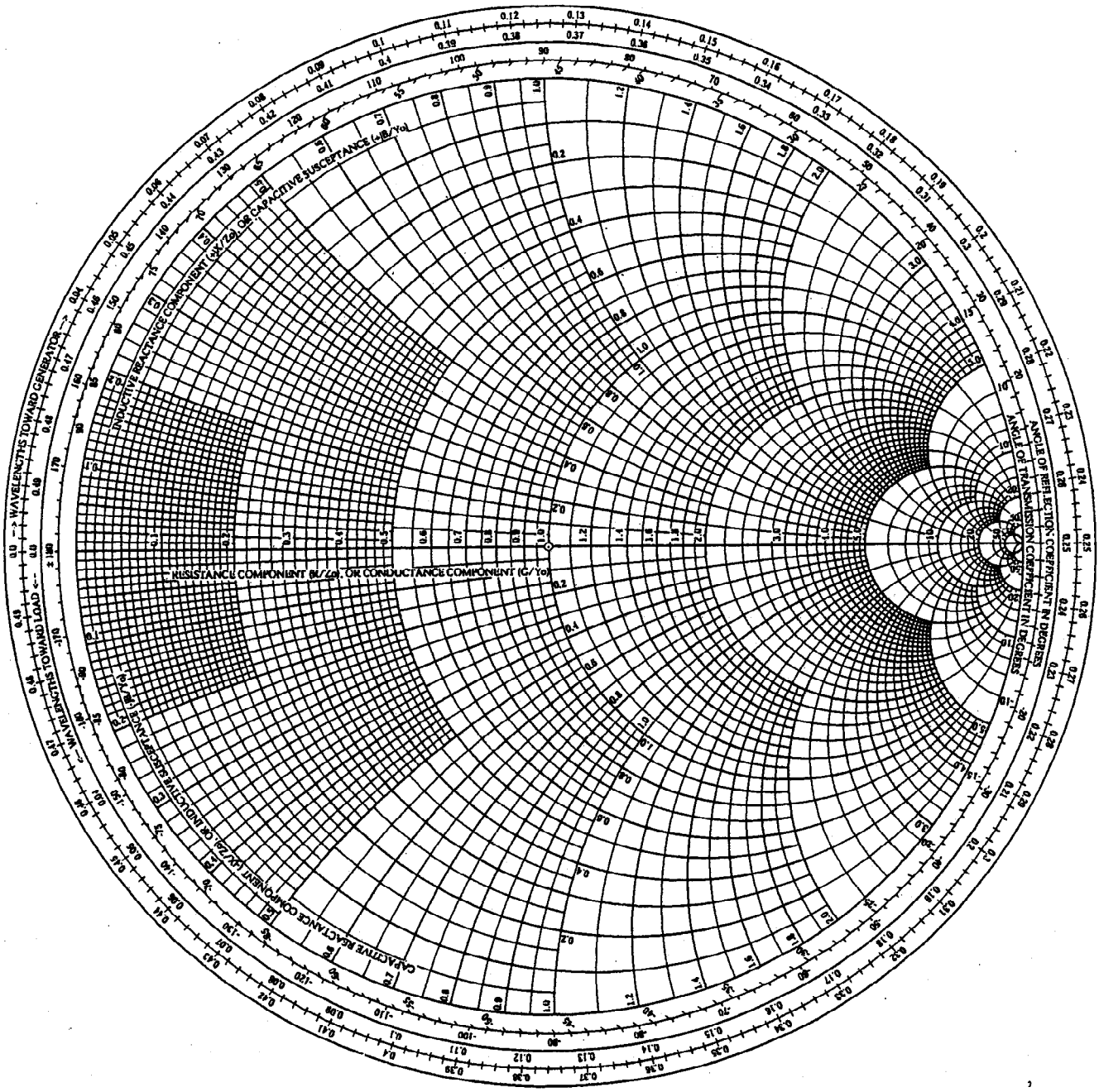
ANSWER ALL QUESTIONS
Attach the Smith chart to the answer book

1. Measurements are made at 5 KHz on a 0.5km long transmission line. The result show that the characteristic impedance is $94\angle -23.2^0\ \Omega$, the total attenuation is 0.06Np and the phase shift between input and output is 8^0. Find R, L, G and C per km. (4M)

2. A 100 ohm line with air as dielectric is terminated by a load impedance of 75+j40 ohm and is excited at 1GHz by a matched generator. Find the position of a single matching stub of 100 ohm impedance on the line and determine the length of the stub. (6M)

3. A parabolic reflector antenna is designed to have a directivity of 30dB at 300 MHz. (a) assuming an aperture efficiency of 50%, find the diameter and estimate the half power beam width. (b) Find the directivity and HPBW if the reflector is used at 150 MHz. (4M)

4. Show the array pattern of a broad side six element array with an inter element spacing $d = \lambda/2$. (6M)


WAVELENGTHS TOWARD GENERATOR →
← WAVELENGTHS TOWARD LOAD
INDUCTIVE REACTANCE COMPONENT (+jX/Zo), OR CAPACITIVE SUSCEPTANCE (-jB/Yo)
RESISTANCE COMPONENT (R/Zo), OR CONDUCTANCE COMPONENT (G/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo), OR INDUCTIVE SUSCEPTANCE (+jB/Yo)
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES

6. Given $E = (-16/r^2)\, a_r$ V/m in spherical coordinates, find the potential of point $(2m, \pi, \pi/2)$ with respect to $(4m, 0, \pi)$

Equipotential surfaces are concentric spherical shells. Let $r = 2m$ at A and $r = 4m$ at B. Then.

$$V_{AB} = \int_{-4}^{2} \left(\frac{-16}{r^2}\right) dr = -4\ V.$$

7. Give the boundary conditions for E and D.

(1) Tangential E is continuous at the boundary.

(2) Normal D is continuous if the boundary is free of charge.

8. The electric field intensity at a point on the surface of a conductor is given by $E = 0.2a_x - 0.3a_y - 0.2a_z$ V/m. Find the surface charge density.

$$D_n = \varepsilon_0 E_n = \rho_s$$

$$E_n = |E| = 0.412\ V/m.$$

$$\rho_s = \frac{0.412}{8.85 \times 10^{-12}} = 3.64\ pC/m^2.$$

9. Give the mathematical expressions for (i) Kirchoff's law (ii) Ohms law for electric fields.

(i) $\nabla \cdot J = 0$

(ii) $J = \sigma E$

10. Give the integral forms of the Maxwell's equations.

Ampere $$\oint H \cdot dl = \int_S \left(J + \frac{\partial D}{\partial t}\right) \cdot ds$$

Faraday $$\oint E \cdot dl = -\int \frac{\partial B}{\partial t} \cdot ds$$

Gauss for Electric fields. $$\int_S D \cdot ds = \int_V \rho\, dv$$

Gauss for Magnetic fields $$\int_S B \cdot ds = 0$$

BITS PILANI DUBAI CAMPUS
KNOWLEDGE VILLAGE, DUBAI

III Year EEE – II Semester 2005-06
Test1
ELECTROMAGNETIC FIELDS AND WAVES

Date: 19/3/06 Time: 50mts
Max. Marks: 20 Weightage: 20%

ANSWER ALL QUESTIONS

1. Given $E = E_m \sin(\omega t - \beta z)\, a_y$ in free space. Find D, B and H. Sketch E and H at t = 0. (4m)

2. In free space, given $E = 30\pi\, e^{j(10^8 t + \beta z)}\, a_x$

$H = H_m\, e^{j(10^8 t + \beta z)}\, a_y$

find H_m and β. (4M)

3. (i) Give the conditions to distinguish between a conductor, dielectric and quasi conductor. (1.5M)
(ii) At what frequency may earth be considered a perfect dielectric given $\sigma = 5 \times 10^{-3}$ S/m, $\mu_r = 1$ and $\varepsilon_r = 8$. (1.5M)

4. A perpendicularly polarized wave propagates from region 1 ($\varepsilon_{r1} = 8.5$, $\mu_{r1} = 1$, $\sigma_1 = 0$) to region 2, free space, with an angle of incidence of 15^0. Given $E_i = 1\mu$V/m, find E_r, E_t, H_r and H_t. (4M)

5. A normally incident E field has amplitude E_i = 1 V/m in free space just outside of seawater in which $\varepsilon_r = 80$, $\mu_r = 1$ and $\sigma = 2.5$ S/m. For a frequency of 30 MHz, at what depth will the amplitude of E be 1.0 mV/m. (5M)