Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech (ECE)/SEM-2/MEC-204/2010

2010

ADVANCED EM THEORY & MICROWAVE INTEGRATED CIRCUITS

Time Allotted : 3 Hours | Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Very Short Answer Type Questions)

1. Answer any *five* of the following : 5 × 2 = 10

   i) State and explain the singularities of the vector field.

   ii) Given $H = \hat{u}_y\, x \cos \omega t$, determine the current density J^t and hence total current flow i^t through a disk defined by $z = 0$, $x^2 + y^2 = 1$.

   iii) How to get right-handed circular polarized wave ?

   iv) Explain induction theorem and its importance.

   v) Define skin depth and explain its importance in shielding of electromagnetic waves.

   vi) Using neat diagram distinguish between Scattering and Diffraction.

   vii) Define Specific Absorption Rate (SAR) used in biological hazards of electromagnetic energies. Express it mathematically in terms of material parameters and electromagnetic field.

GROUP – B

(Short Answer Type Questions)

Answer any *four* of the following. 4 × 5 = 20

2. From Maxwell's equations show that the power supplied by the sources within a region must equal that leaving the region plus that dissipated within the region plus the rate of increase in electric and magnetic energies stored within the region.

3. A micro strip line is composed of negligible Cu thickness on a substrate having ε_r = 8·4 tanδ = 0·0005 and thickness 1 mm. If line width is 5 mm and operated at 10 GHz, calculate (a) the characteristic impedance, (b) the attenuation due to conductor and dielectric loss.

4. Describe the phenomenon of Rayleigh fading and Rician fading in wireless communication. Explain the methods of combating fading.

5. Find the impedances of two section quarter wave transformers to match a 50 ohm source and a 25 ohm load. Determine the VSWR at the input end of the first transformer and at the output end of the second transformer.

6. In a wireless communication link, fading margin = 30 dB, path loss = 100 dB, loss in the branching circuits of TX and RX = 10 dB, loss in the TX and RX antenna systems = 5 dB, TX antenna gain = 30 dB, and RX antenna gain = 40 dB. Calculate the overall system gain required.

7. Describe the construction and operation of reciprocal MIC phase shifter.

GROUP – C

(Long Answer Type Questions)

Answer any *two* of the following. $2 \times 20 = 40$

8. a) State and prove the reciprocity theorem $< a, b > = < b, a >$ 10

   b) Show that a current sheet $J = \hat{u}_x J_o$ over the plane $z = 0$, produces the outward travelling plane waves expressed by

   $E_x = -(\eta J_o e^{-jkz})/2 \qquad z > 0$

   $= -(\eta J_o e^{jkz})/2 \qquad z < 0$

   in an infinite homogeneous medium. 10

9. a) Construct the possible solutions to Helmholtz equation in cylindrical coordinates and give the physical interpretation of each function. State where such functions are used. 10

   b) (i) Prove that it is impossible to construct a perfectly matched, lossless, reciprocal three port passive device. 5

   (ii) A matched micro strip isolator has insertion loss of 1 dB and isolation of 30 dB. Find the scattering parameters. 5

10. A GaAs – MESFET amplifier is to be designed at 10 GHz with 500 MHz bandwidth for maximum power gain. The measured parameters at 10 GHz with a 50 ohm reference are

    $S_{11} = 0{\cdot}52 \angle -145^\circ$, $S_{12} = 0{\cdot}03 \angle 20^\circ$, $S_{21} = 2{\cdot}56 \angle 17^\circ$, $S_{22} = 0{\cdot}48 \angle -20^\circ$, $\Gamma_{\sin} = 0{\cdot}75 \angle 170^\circ$, $\Gamma_{Lout} = 0{\cdot}72 \angle 105^\circ$

    Determine $G_{A\max}$ and design input and output matching networks with a 50 ohm reference for maximum power gain.

11. a) A shunt mounted PIN diode in a lossless 50 ohm strip line is represented by a shunt impedance $Z = R + jX$. The forward resistance of the diode is 0·1 ohm and the junction capacitance is 0·02 pF. Calculate the insertion loss and isolation at a frequency 2 GHz. 10

b) Design a Butterworth low-pass 50 ohm micro strip filter having cut-off frequency 2 GHz, and insertion loss of 30 dB at 4 GHz. Use lossless dielectric substrate of $\varepsilon_r = 9{\cdot}6$ and thickness = 0·635 mm. 10