Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.TECH (ECE)/SEM-2/MC-205C/2011

2011

ELECTROMAGNETIC INTERFERENCE/ ELECTROMAGNETIC COMPATIBILITY AND SIGNAL INTEGRITY

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

Answer the following to the point. $5 \times 2 = 10$

1. Define using simple diagram, common ground impedance coupling and explain its existence/non-existence in differential mode in interconnect lines between two equipment.
2. Explain the advantages and disadvantages of single and multi-point grounding.
3. Explain how strong EM radiation is harmful to personnel.
4. Explain how MOVs minimize transient EMI.
5. A thick metal sheet of thickness $t = \lambda / 50$ has a circular hole having diameter $d = \lambda/10$. Find the shielding effectiveness of the sheet in dB.

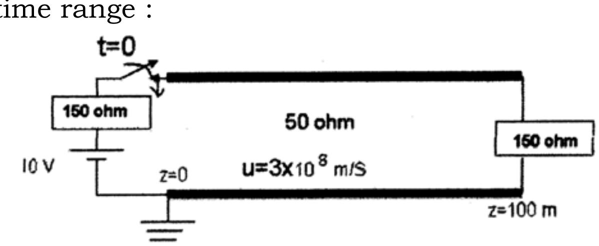
GROUP – B

(Long Answer Type Questions)

Answer any *four* questions of the following.

$4 \times 15 = 60$

6. a) The following transmission line is switched on at time t = 0. Sketch the current *vs.* time wave shape at the output terminal showing appropriate current levels and time range :

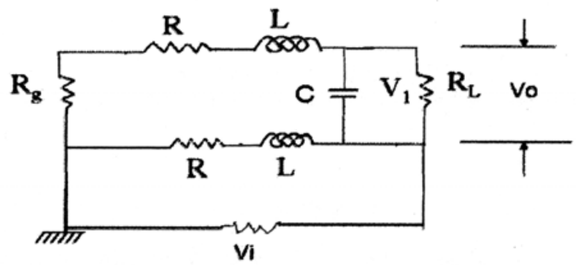


b) A 100 MHz plane wave is incident normally on a plane isolated double shield made of copper ($\sigma = 5 \cdot 96 \times 10^7$ S/m) having same thickness with an air gap between the two shields. Calculate the difference between the reflection losses and absorption losses for this double shield and single shield formed when two shields are sandwiched together without air gap.

7. a) Define SAR and the rate of temperature rise due to microwave heating giving their mathematical expressions and units.

b) A biological substance has conductivity 140 S/m, mass density 1200 kg/cubic m and the specific heat 1·2 kcal deg C/kg. Find the rate of temperature rise in deg C/S when exposed to plane wave electric field 1V/m at 10 GHz.

8. a) The electrical equivalent circuit of an 1 meter ground loop coupling (GLC) model is shown below, where Rg=50 ohm and per meter line parameters are R = 1 ohm/m, L=1 nh/m, C = 1pF/m and load R_L = 100 ohm. Find the GLC in dB at frequency 100/2 π MHz.



b) A lossless filter is terminated at source and load ends by mismatched resistances R_1, R_2, respectively.

(i) Show that mismatch loss is given by

$$mL = 10\log_{10}\left(\frac{1+\rho}{2\sqrt{\rho}}\right)$$

where $\rho = \frac{R_1}{R_i}$, R_i is the input resistance of the filter at the frequency of minimum attenuation.

(ii) Under what condition filter output will be more than input voltage ?

9. a) A plane wave incidents normally on a plane metallic shielding barrier (σ, μ_0, ε_0) of thickness = t. Show that the reflection and absorption losses are expressed, respectively, by

$$R = 10\log_{10}\left(\frac{\sigma}{8\omega\varepsilon_0}\right); \text{ dB}$$

$$A = 8.686t\sqrt{\pi f \mu_0 \sigma}; \text{ dB}$$

b) Explain with neat diagrams the construction and operation of LISN and Feed-through capacitor.

10. a) A 50 ohm TEM cell used for radiated susceptibility measurements has input VSWR = 1.5. Find the E-field at the centre between the septum and bottom ground conductor separated by a distance of 30 cm for an input power of 20 dBm from a 50 ohm rf source.

b) Define cross-talk interference. Under what conditions the cross-talk between two lines become capacitive or inductive ? Show with the help of a simple analytical model that near end and far end cross-talks between two lossless traces become rectangular pulses for an excitation of unipolar trapezoidal pulse.

11. a) Explain how reflection free area is selected in an Open Area Test Site of 3m range indicating shape and size of such site as per FCC requirements for RE tests.

b) A 100 MHz uniform plane wave is incident on an 50 ohm antenna having antenna factor 10 dB. The antenna is connected to a 50 ohm receiver with a 10m long 50 ohm coaxial cable of loss 0·5 dB per metre. If the voltage received at the receiver is 30 dBuV, determine the electric field received by the antenna in dBuV.