

INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR
Department of Electronics and Electrical Communication Engineering

Mid Autumn Semester Examination 2010
RF & Microwave Engineering (EC 31005)

RA

Full Marks: 50
Time: 2 Hrs

Answer all questions. The marks for each question is indicated to the right.

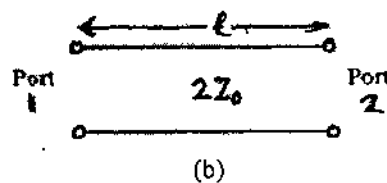
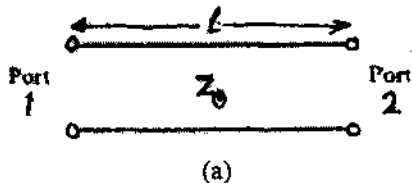
1. A certain transmission line operating at $\omega = 10^6$ rad/s has an attenuation constant $\alpha = 8$ dB/m, a propagation constant $\beta = 1$ rad/m, a characteristic impedance $Z_0 = 60 + j40 \Omega$ and is 2 m long. If the line is connected to a voltage source of $10\angle 0^\circ$ V with an internal resistance of $Z_g = 40 \Omega$ and terminated by a load of $20 + j50 \Omega$, determine
- The input impedance
 - The sending-end current
 - The current at the middle of the line
- (3+2+5=10)

2. A four-port network has the scattering matrix shown below :

$$[S] = \begin{bmatrix} 0.1 \angle 90^\circ & 0.8 \angle -45^\circ & 0.3 \angle -45^\circ & 0 \\ 0.8 \angle -45^\circ & 0 & 0 & 0.4 \angle 45^\circ \\ 0.3 \angle -45^\circ & 0 & 0 & 0.6 \angle -45^\circ \\ 0 & 0.4 \angle 45^\circ & 0.6 \angle -45^\circ & 0 \end{bmatrix}$$

- Is this network lossless?
 - Is this network reciprocal?
 - What is the return loss at port 1 when all other ports are terminated with matched loads?
 - What is the insertion loss between ports 2 and 4, when all other ports are terminated with matched loads?
 - What is the reflection coefficient seen at port 1 if a short circuit is placed at port 3 with all other ports terminated by matched loads?
- (2+2+3+3+5=15)
3. A certain three-port network is lossless and reciprocal and has $S_{13} = S_{23}$ and $S_{11} = S_{22}$. Show that if port 2 is terminated with a matched load, port 1 can be matched by placing an appropriate reactance at port 3.
- (12)

4. Derive the scattering matrices for the lossless transmission line structures in (a) and (b) shown below, relative to a system impedance of Z_0 .



(5+8=13)