Name: ID No.:

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2023-24
EEE G581 RF AND MICROWAVE ENGINEERING
MID SEMESTER TEST (CLOSED BOOK)

Date: 11-10-2023 **Duration: 90 Minutes** **Max marks: 40**

Instruction: *Answer all questions*

Q1) A 4-port network is described by the S-matrix given below. Port 2 is matched. A matched lossless transmission line of length **λ/3** is connected between ports 3 and 4. Find port1 to port2 transmission coefficient (T_{21}) [10]

$$[S] = \begin{bmatrix} 0.4\angle -45^\circ & 0 & 0 & 0.5\angle 45^\circ \\ 0 & 0.7\angle -45^\circ & 0.6\angle 45^\circ & 0 \\ 0 & 0.6\angle 45^\circ & 0.7\angle -45^\circ & 0 \\ 0.2\angle 50^\circ & 0 & 0 & 0.4\angle -45^\circ \end{bmatrix}$$

Q2) An RF source with 75 Ω output impedance is connected to a planar device having 33 Ω input impedance. Propose an *appropriate* impedance matching section between the two at 2.4 GHz. Find the design parameters of the matching section that can be realised using microstrip technology with $W/d > 2$. Use a substrate of dielectric constant 3 and thickness 1.58 mm. [10]

Q3) A 1-port device is represented by an input impedance of 80 Ω resistance in series with 10 nH inductance. A 50 Ω lossless transmission line excites the device at 800 MHz. Use *only* the Smith chart to solve the following.

(i) Find the VSWR and reflection coefficient for the load [6]

(ii) Design a short-circuited series stub to match the load to the line if VSWR =1 is required at the junction. The stub should be as close to the load as possible [6]

(iii) Repeat (ii) if VSWR=2 is required at the junction. [8]

Attach separate Smith charts for (ii) and (iii)

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$$\epsilon_e = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \frac{1}{\sqrt{1 + 12d/W}}$$

$$\frac{W}{d} = \begin{cases} \dfrac{8e^A}{e^{2A} - 2} & \text{for } W/d \le 2 \\ \dfrac{2}{\pi}\left[B - 1 - \ln(2B-1) + \dfrac{\epsilon_r - 1}{2\epsilon_r}\left\{\ln(B-1) + 0.39 - \dfrac{0.61}{\epsilon_r}\right\}\right] & \text{for } W/d > 2 \end{cases}$$

$$A = \frac{Z_0}{60}\sqrt{\frac{\epsilon_r + 1}{2}} + \frac{\epsilon_r - 1}{\epsilon_r + 1}\left(0.23 + \frac{0.11}{\epsilon_r}\right)$$

$$B = \frac{377\pi}{2Z_0\sqrt{\epsilon_r}}.$$