Question Paper

Exam Date & Time: 08-Dec-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

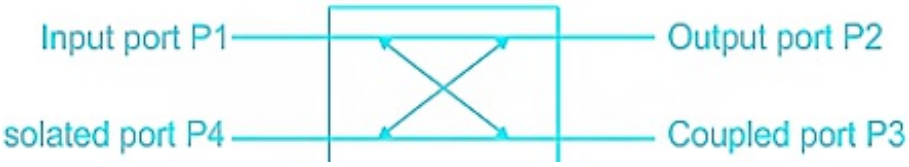
FIFTH SEMESTER B.TECH. DEGREE EXAMINATIONS - NOVEMBER / DECEMBER 2023
SUBJECT: ECE 3154- MICROWAVE ENGINEERING

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Missing data may be suitably assumed.

1A) A four-port directional coupler has a 4:1 power splitting ratio and a dissipation loss of 3dB. The coupler directivity is 40 dB. What fraction of input power P1 will go to ports P2 and P3? (4)



1B) In a magic tee, the collinear ports 1, 2 and the difference ports are terminated, respectively. The loads give reflection coefficients of $\Gamma_1 = \frac{1}{2}, \Gamma_2 = \frac{3}{5}, \Gamma_4 = \frac{4}{5}$. If 500 mW power is fed at (4)

port 3, Find.
i) Power is transmitted through ports 1,2 and 4.
ii) Power reflected at port 3.
iii) Total power loss by the magic tee.

1C) In an isolator, the isolation is 30dB, and the insertion loss is 0.4 dB. Find its scattering parameter. (2)

2A) Explain the operation of an Isolator using a suitable diagram. (4)

2B) With a detailed diagram, demonstrate the construction and working principle of TWT. (4)

2C) What is a bunching cavity and catcher cavity? (2)

3A) The normalized radiation intensity of an antenna is rotationally symmetric in $\emptyset$, and it is (4)

represented by

$$U = \begin{cases} 1; & 0^0 \leq \theta < 30^0 \\ 0.5; & 30^0 \leq \theta < 60^0 \\ 0.1; & 60^0 \leq \theta < 90^0 \\ 0; & 90^0 \leq \theta \leq 180^0 \end{cases}$$

a) What is the directivity (above isotropic) of the antenna (in dB)?
b) What is the directivity (above an infinitesimal dipole) of the antenna (in dB)?

3B) A linear polarized wave traveling in the negative Z-direction has a tilt angle (τ) 45°. It is incident (4)

upon an antenna whose polarization characteristic is given by

$$\widehat{\rho_a} = \frac{4\widehat{a_x} + j\widehat{a_y}}{\sqrt{17}}$$

Find the polarization loss factor (dimensionless and dB)

3C) Find the half-power beamwidth in azimuth and elevation plane (in degrees) for the normalized radiation intensity $U = \sin\theta + \sin\varphi$ (2)

4A) Explain the necessity of vector potential **A** and **F**. Derive vector wave equation in terms of electric vector potential and obtain its solution (4)

4B) Derive the equation for calculating the radiation resistance of a small dipole antenna. (4)

4C) What are fringing effects in rectangular patch antenna? Explain the impact of the physical dimensions of the rectangular patch on the resonating frequency. (2)

5A) Derive normalized array factor expression for two elements infinitesimal dipole antenna array and find the conditions for broadside array and end-fire array. (4)

5B) Design a circular microstrip patch antenna using an RT/5880 substrate with dielectric constant ε_r of 2.2, thickness of 2 mm, and resonance frequency of 5 GHz. (4)

5C) Briefly explain the significance of millimeter wave and their impact on future wireless communication. (2)

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