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Vellore Institute of Technology
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CHENNAI

23BEC[illegible]76

Final Assessment Test(FAT) - NOV/DEC 2025

Programme	B.Tech. [illegible]L	Semester	Fall Semester 2025-26
Co[illegible]	[illegible] and Microwave Engineering	Faculty Name	Prof. Amit Kumar
		Slot	A2+TA2
		Class Nbr	CH2025260101093
	3 hours	Max. Marks	100

[illegible]ructions To Candidates
Write only your registration number in the designated box on the question paper. Writing anything elsewhere on the question paper will be considered a violation.

Course Outcomes
CO1: [illegible]e the radiation mechanism of electromagnetic fields and identify the various antenna parameters.
[illegible]e design criteria to Linear, HF, UHF, microwave antenna and arrays.
[illegible]end the performance of different microwave sources and ferrite devices.
[illegible] and analyze the passive components at microwave frequencies.
[illegible]gn and analyze the various passive circuits at microwave frequencies.
[illegible]fer the importance of high frequency transistors to design microwave amplifiers.

Section - I
Answer all Questions (4 × 5 Marks)

01. A uniform plane wave is traveling in the positive z-direction. Find the polarization (linear, circular, or elliptical) and sense of rotation (CW or CCW) for the following:
   i. $E_x = E_y, \Delta\varphi = \varphi_y - \varphi_x = 0$
   ii. $E_x \neq E_y, \Delta\varphi = \varphi_y - \varphi_x = 0$
   iii. $E_x = E_y, \Delta\varphi = \varphi_y - \varphi_x = \frac{\pi}{2}$
   iv. $E_x = E_y, \Delta\varphi = \varphi_y - \varphi_x = -\frac{\pi}{2}$
   v. $E_x = E_y, \Delta\varphi = \varphi_y - \varphi_x = \frac{\pi}{4}$

[5] (CO1/K2)

02. A broadside binomial array of six elements is placed along the z-axis separated by a distance d = λ/2.
   (i) Find the amplitude excitation coefficient and write the array factor [4 Marks]
   (ii) What is the progressive phase excitation between the elements? [1 Mark]

[5] (CO2/K2)

03. Explain in detail the different types of feeds used for parabolic reflector antenna and discuss their merits and demerits.

[5] (CO2/K2)

04. Explain five important parameters that characterize the performance of a practical antenna.

[5] (CO1/K2)

Section - II
Answer all Questions (5 × 10 Marks)

05. A small circular parabolic reflector antenna is used for TV direct broadcast. Assuming the diameter of the antenna is 1 m, the frequency of operation is 3 GHz and its aperture efficiency is 68%, determine the following:
   i. Physical area of the reflector (in m^2)
   ii. Maximum effective area of the antenna (in m^2)
   iii. Maximum directivity (dimensionless and in dB)
   iv. Maximum power (in watts) that can be delivered to the TV if the power density of the wave incident upon the antenna is 10 $\mu W/m^2$. Assume no losses between the incident wave and the receiver (TV).
   v. Comment on the power delivered with proper justification (5×2 Marks)

[10] (CO1/K3)

06. Design a four-element ordinary end-fire array with the elements placed along the z-axis at a distance 'd' apart. For a spacing of d =$\lambda/2$ between the elements find:
i. progressive phase excitation between the elements to accomplish this
ii. angles (in degrees) where the nulls of the array factor occur
iii. angles (in degrees) where the maximum of the array factor occur
iv. beamwidth (in degrees) between the first nulls of the array factor
v. Directivity (dimensionless and dB) (5×2 Marks)

07. Design a helical antenna operating at a frequency of f = 475 MHz, given pitch angle of 12.5° and turn radius of 10 cm such that the HPBW=39°. Determine the circumference, number of turns, spacing between the turns, axial length and directivity. [10] (CO2/K3)

08. Describe the operating principle of the following with the help of neat Sketch and label it. Also explain their physical structures and the sequence of physical processes involved in microwave generation.
(i) IMPATT diode and (ii) TRAPATT diode (2×5 Marks) [10] (CO2/K3)

09. For a microwave amplifier, determine G_T, G_A, and G_P if $\Gamma_S = 0.49\angle -150^o, \Gamma_L = 0.56\angle 90^o$. The S parameters of the transistor are: $S_{11} = 0.54\angle 165^o, S_{12} = 0.09\angle 20^o, S_{21} = 2\angle 30^o, S_{22} = 0.5\angle -80^o$ [10] (CO3/K2)

Section - III
Answer all Questions (2 × 15 Marks)

10. (a) A device is tested using Vector Network analyser (VNA) and following S-matrix was found:

$$\begin{bmatrix} 0.15\angle 0^\circ & 0.85\angle 45^\circ \\ 0.85\angle 45^\circ & 0.2\angle 0^\circ \end{bmatrix}$$

(i) Determine if the network is reciprocal, and lossless. [3 Marks]
(ii) If port 2 is terminated with a short circuit. What is the return loss seen at port 1? [5 Marks]
(b) Is it possible to design a three-port network that simultaneously satisfies the conditions of being matched, reciprocal, and lossless? Justify your answer with a proper explanation. [7 Marks] [15] (CO4/K3)

11. Design a lossless T-junction divider with a 30 Ω source impedance to give a 3:1 power split. Determine the magnitude of the scattering parameters for this circuit, using a 30Ω characteristic impedance. Design quarter-wave matching transformers to convert the impedances of the output lines to 30 Ω.
Few Formulae:

$$\theta_n = cos^{-1}\left[1 - \frac{n\lambda}{Nd}\right]$$

$$\theta_m = cos^{-1}\left[1 - \frac{m\lambda}{d}\right]$$

$$\Theta_0 = 2cos^{-1}\left[1 - \frac{\lambda}{Nd}\right]$$

$$D_0 = 2N\left(\frac{d}{\lambda}\right)$$

$$HPBW = \frac{52\lambda_0^{3/2}}{C\sqrt{NS}}$$

$$D = 15\frac{NSC^2}{\lambda_0^3}$$

$$\Gamma_{in} = S_{11} + \frac{S_{12}S_{21}\Gamma_L}{1 - S_{22}\Gamma_L}$$

$$G_T = \frac{|S_{21}|^2(1 - |\Gamma_S|^2)(1 - |\Gamma_L|^2)}{|1 - \Gamma_S\Gamma_{in}|^2\ |1 - S_{22}\Gamma_L|^2}$$

[15] (CO5/K3)

BL-Bloom's Taxonomy Levels - (K1-Remembering,K2-Understanding,K3-Applying,K4-Analysing,K5-Evaluating,K6-Creating)