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Question Paper Code : 40540

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Seventh Semester

Electronics and Communication Engineering

EC 8701 — ANTENNAS AND MICROWAVE ENGINEERING

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. The effective antenna temperature of an antenna looking toward zenith is approximately 5 K. Assuming that the temperature of the transmission line (waveguide) is 72°F, find the effective temperature at the receiver terminals when the attenuation of the transmission line is 5 dB/100 ft and its length is 3 ft.
2. A hypothetical isotropic antenna is radiating in free-space. At a distance of 200 m from the antenna, the total electric field is measured to be 4 V/m. Find the power density.
3. Find the radiation resistance of a single-turn and an six-turn small circular loop antenna. The radius of the loop is $\lambda/27$ and the medium is free space.
4. State a few advantages of microstrip antennas.
5. Brief on pattern multiplication concept with example.
6. Mention a few drawbacks of Smart antennas.
7. Why isolators are preferred in microwave circuits?
8. List a few applications of magnetron.
9. Define unilateral gain.
10. A transmission line has an characteristic impedance of 50Ω , which is to be matched to a load of 101Ω , a $\lambda/4$ transmission line to be used to match the impedance. Calculate the characteristic impedance of the line (ohms)

PART B — (5 × 13 = 65 marks)

11. (a) A series of microwave repeater links (to improve the signal strength) operating at 10 GHz are used to relay television signals into a valley that is surrounded by steep mountain ranges. Each repeater consists of a receiver, transmitter, antennas and associated equipment. The transmitting and receiving antennas are identical horns, each having gain over isotropic of 15 dB. The repeaters are separated in distance by 10 km. For acceptance signal-to-noise ratio, the power received at each repeater must be greater than 10 nW. Loss due to polarization mismatch is not expected to exceed 3 dB. Assume matched loads and free-space propagation conditions. Determine the minimum transmitter power that should be used.

Or

- (b) The far-zone power density radiated by an antenna is approximated as: $\overline{W}_{rad} = \overline{W}_{avg} \approx a_r C_0 \frac{1}{r^2} \sin \phi \cos^4 \theta$. The radiated power density is symmetrical with respect to ϕ and exists only in the upper hemisphere: $0 \leq \theta \leq \pi$, $0 \leq \phi \leq \pi$; C_0 is a constant. Calculate the power radiated by the antenna (in watts), directivity and gain (assume the antenna as lossless). Also find the value of C_0 , if power radiated is 10 watts.

12. (a) How expansion and contraction of dipole elements are observed in frequency independent antennas? Discuss on the construction and working of a log periodic dipole array in detail and derive the design equations.

Or

- (b) (i) Brief the concept of loop antenna. In detail explain the construction and working of a helical antenna in different modes and obtain the necessary design equations. (5)
- (ii) Design a five-turn helical antenna which at 500 MHz operates in the normal mode. The spacing between turns is $\frac{\lambda_0}{50}$. It is desired that the antenna possesses circular polarization. Determine the
- (1) Circumference of the helix (in λ_0 and in meters) (2)
 - (2) Length of a single turn (in λ_0 and in meters) (2)
 - (3) Overall length of the entire helix (in λ_0 and in meters) (2)
 - (4) Pitch angle (in degrees). (2)

13. (a) Design a six-element binomial array of isotropic elements positioned along the z-axis a distance d apart. Find the (i) Normalized excitation coefficients (ii) array factor, (iii) nulls of the array factor for $d = \lambda$ (iv) maxima of the array factor for $d = \lambda$. (3+3+3+4)

Or

- (b) Two point sources are fed with currents of equal in magnitude and opposite phase, the spacing between the elements in one-half of the wavelength. Obtain the electric field, array factor, maxima, minima and half power point direction and sketch the radiation pattern of the array.
14. (a) Analyze and explain a directional coupler in odd and even modes.

Or

- (b) Explain the construction and working of PIN diode in detail.
15. (a) The S parameter for the HP HFET at 2.5 GHz with a bias voltage $V_{gs} = 0$ are given as follows ($Z_0 = 50$ ohms): $S_{11} = 0.9 \angle -61^\circ$, $S_{21} = 3 \angle 124^\circ$, $S_{12} = 0.01 \angle 63^\circ$, $S_{22} = 0.8 \angle -28^\circ$. Determine the stability of the transistor by using the $k - \Delta$ test and the μ test and plot the stability circles on a smith chart.

Or

- (b) Design a LPF for fabrication using microstrip lines. The specification are cutoff frequency at 3.5 GHz, fifth order, impedance of 50 ohms and a 3dB equal-ripple characteristic. The normalized LPF prototype values for 3dB is $g_1 = 3.4817$, $g_2 = 0.7618$, $g_3 = 4.5381$, $g_4 = 0.7618$, $g_5 = 3.4817$, $R_L = 1.000$. Assume the first element as inductor.

PART C — (1 × 15 = 15 marks)

16. (a) A GaAs FET has the following scattering and noise parameters at 5.8 GHz ($Z_0 = 50$ ohms): $S_{11} = 0.59 \angle -60^\circ$, $S_{21} = 2 \angle 81^\circ$, $S_{12} = 0^\circ$, $S_{22} = 0.7 \angle -60^\circ$, $F_{min} = 2.5 \text{ dB}$, $\Gamma_{opt} = 0.70 \angle 120^\circ$, $R_N = 15$ ohms. Design an amplifier with minimum noise figure and maximum possible gain. Implement using Smith Chart.

Or

- (b) Design an 8 element Dolp-Chebyshev array of isotropic sources of one half of wavelength spacing the elements. The side lobe level is 26 dB down the main lobe maximum. Obtain the relatives of the elements.

