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Question Paper Code : 10543

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 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 — ($10 \times 2 = 20$ marks)

1. Determine the total power radiated by a $B_0 \cos \theta$ source.
2. An antenna pointing in a certain direction has a noise temperature of 50 K. The ambient temperature is 290 K. The antenna is connected to a pre-amplifier that has a noise figure of 2dB and an available gain of 42 dB over an effective bandwidth of 15 MHz. Calculate the effective input noise temperature T_e for the amplifier and the noise power P_{ao} at the output of the preamplifier.
3. The radius of the loop is $\lambda/25$ and the medium is free-space. Calculate the radiation resistance of a twelve-turn small circular loop?
4. Calculate the angular aperture for a paraboloid reflector antenna for which aperture 0.2.
5. Write a brief note on Pattern multiplication concept.
6. In a broadside array of 20 isotropic radiators, equally spaced at distance of one half of wavelength. Calculate the beam width between the first nulls.
7. For an equal split Wilkinson power divider of 75 ohms system impedance, Calculate characteristic impedance and resistance value.
8. List any two properties of Magic Tee.
9. Express the various power gains of a two-port network.
10. What do you mean by unilateral figure of merit?

PART B — (5 × 13 = 65 marks)

11. (a) In an equivalent electrical network, the Total loss resistance is 1 ohms, Generator impedance as $50 + j25$ ohms, Generator peak voltage is given as 2V and loss resistance is $73 + j42.5$ ohms (excluding dipole), Characteristic impedance is 50 ohms. Find the power supplied by the source (real), radiated by the antenna and dissipated by the antenna. (6+4+3)

Or

- (b) The normalized radiation intensity radiated by an lossless antenna is given by

$$U(\theta, \varphi) = \begin{cases} \sin^2 \varphi \cos^4 \theta & 0 \leq \theta \leq 90^\circ \\ & 90^\circ \leq \theta \leq 180^\circ \\ 0 & \text{Elsewhere} \end{cases}$$

(i.e., in the upper half-space). It is zero in the lower half-space.

Find the :

- (i) Exact directivity (dimensionless and in dB). (4)
 - (ii) Half-power beam width (in degrees) Elevation plane. (3)
 - (iii) Gain (dB) (3)
 - (iv) Maximum effective area when operating at 10 GHz. (3)
12. (a) Discuss the construction, working and derive the necessary equations for an antenna whose output is periodic as a function of logarithm of frequency.

Or

- (b) Discuss on the principle of a microwave dish antenna. Explain in detail and comment on their feed systems.
13. (a) For an 'n' element uniform linear array obtain the pattern maxima, minima when the elements are fed with currents of equal in amplitude and progressive phase shift and consider complementary angle.

Or

- (b) Design a Dolph T- chebysheff broadside array of 8 elements, one half wavelength spacing between the elements. Calculate the excitation coefficients.

14. (a) Discuss the odd mode and even mode analysis of a quadrature 90 degree hybrid coupler.

Or

- (b) Discuss the odd mode and even node analysis of a Wilkison power divider.

15. (a) RF amplifiers have to be designed for maximum gain, improved bandwidth for a specific value to the amplifier gain. Design using constant gain circles to obtain its centre and radius for input and output sections.

Or

- (b) Design a low-pass, fourth-order, maximally flat filter using only shunt stubs. The cutoff frequency is 8 GHz and the impedance is 50 ohms. Assume $g_1 = g_4 = 0.7654$, $g_2 = g_3 = 1.8478$, $g_5 = 1$, first element series inductor)

PART C — (1 × 15 = 15 marks)

16. (a) The far-zone power density radiated by a helical antenna can be approximated by

$$\overline{W}_{rad} = \overline{W}_{average} \approx a_r C_0 \frac{1}{r^2} \cos^4 \theta$$

The radiated power density is symmetrical with respect to ϕ , and it exists only in the upper hemisphere ($0 \leq \theta \leq \pi/2$, $0 \leq \phi \leq 2\pi$); C_0 is a constant. Determine the following :

- (i) Power radiated by the antenna (in watts). (3)
- (ii) Maximum directivity of the antenna (dimensionless and in dB) (3)
- (iii) Direction(in degrees) along which the maximum directivity occurs. (3)
- (iv) Maximum effective area (in m^2) at 1 GHz. (3)
- (v) Maximum power (in watts) received by the antenna, assuming no losses, at 1 GHz when the antenna is used as a receiver and the incident power density is 10 mwatts/ m^2 . (3)

Or

- (b) A GaAs FET has the following scattering and noise parameters at 8GHz
 $Z_0 = 50$ ohms, $S_{11} = 0.7 \angle -110^\circ$, $S_{12} = 0.02 \angle 60^\circ$, $S_{21} = 3.5 \angle 60^\circ$,
 $S_{22} = 0.8 \angle -70^\circ$, $F_{min} = 2.5dB$, $\Gamma_{opt} = 0.70 \angle 120^\circ$, $R_N = 15ohms$.

Design an amplifier with minimum noise figure and maximum possible gain. Use open-circuited shunt stubs in the matching sections.

