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Question Paper Code : 80536

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

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. A linearly polarized wave traveling in the negative z-direction has a tilt angle of 45°. It is incident upon an antenna whose polarization characteristics are given by $\hat{\rho}_a = \frac{3\hat{a}_x + j\hat{a}_y}{\sqrt{17}}$. Find the polarization loss factor in dB.

2. Maximum current carried by an $\lambda/40$ antenna is 120 A, calculate the power radiated by antenna, radiation resistance and efficiency, if loss resistance is 2 ohms.

3. Find the field strength for a vertical loop antenna of 20 turns, operating at 3 MHz frequency and voltage induced in the loop is 36 mV. The area of the loop antenna is 1.5 m^2.

4. A parabolic reflector operates at 3GHz, its BWFN is 12°. Calculate the diameter and the capture area of the antenna.

5. Mention the five controls that are used shape the overall pattern of the array antenna.

6. Calculate the directivity (dB) for broad side and end fire array consisting of 7 isotropic elements equally spaced at one-half of the wavelength.

7. A linear magnetron has the following specifications anode voltage 12kv, cathode current 2A, flux density 0.02 Wb/m^2. The cathode and anode distance is 5 cm. Find the Hull cut off voltage and cut off magnetic flux density for fixed voltage.

8. How a power divider can be operated as a power combiner? Justify with suitable example.

9. A single-section quarter wave matching transformer is to match a load of 12 ohms load to a 50 ohm line at frequency 3 GHz. Determine the characteristic impedance of the matching section and reflection coefficient for SWR 1.5.

10. List the significant considerations for oscillators used in RF and microwave systems.

PART B — (5 × 13 = 65 marks)

11. (a) The radiation intensity of an lossless hypothetical antenna is by

$$U(0,\phi)=\begin{Bmatrix}\sin\theta\cos^2\varphi & 0^\circ<0<180 \\ & 90^\circ<\varphi<270 \\ 0 & \text{elsewhere}\end{Bmatrix}$$

The maximum of the radiation intensity occurs towards $\theta=90^\circ$ and $\varphi=180^\circ$. Find the

(i) Exact maximum directivity (dimensionless and in dB). (3)

(ii) Half-power beam width (in degrees) in the principal azimuth (horizontal) plane. (3)

(iii) Half-power beam width (in degrees) in the principal elevation (vertical) plane (3)

(iv) Maximum directivity (dimensionless and in dB) using an appropriate approximate method. (4)

Or

(b) A series of microwave repeater links operating at 11 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 aperture antennas, each having gain 15 dBi. The repeaters are separated in distance by 10 km. For acceptable 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.

12. (a) Explain and obtain the electric field, magnetic field, radiation resistance, power radiated and directivity of loop antenna.

Or

(b) State the necessity of microstrip antennas. Analyze microstrip antenna with in detail.

13. (a) Two dipoles of equal length are equidistant from the origin with their centers lying on the y-axis,. The magnitude excitation of elements is the same and opposite phase. For a separation 'd' between the elements, deduce an expression for the radiation pattern and the angles of observation where the nulls of the array occur.

Or

(b) Design a five element binomial array of $\lambda/2$ dipoles, placed symmetrically along the x-axis a distance d apart. The length of each dipole is parallel to the z-axis.

(i) Find the normalized excitation coefficients. (2)

(ii) Write the array factor for all space. (2)

(iii) Angles (in degrees) where the nulls (if any) occur (2)

(iv) Determine all the angles (in degrees) where the array factor possesses main maxima. (4)

(v) Mention the merits of binomial array. (3)

14. (a) State the necessity of a coupler? Analyze the various modes of a 90 degree coupler.

Or

(b) Discuss the construction and working of a IMPATT diode in detail.

15. (a) Why RF amplifiers need to be checked for stability conditions. Derive the unconditional stability conditions, equations for source circle, load circle and radius for source and the load.

Or

(b) A active device need to be designed for 3.5 GHz wireless application. The characteristic impedance of the device is 50 ohms. $S_{11}=0.59\angle -60^\circ$, $S_{21}=2\angle 81^\circ$, $S_{12}=0.059\angle 26^\circ$ and $S_{22}=0.499\angle -60^\circ$ minimum noise figure of the FET=1.59 dB, $\Gamma_{opt}=0.599\angle 100^\circ, R_N=20\ ohms$. Assume the device is unilateral, and calculate the maximum error in GT. Design an amplifier having a 2.0 dB noise figure with the maximum gain that is well-suited with this noise figure subsequently. Implement using Smith chart.

PART C — (1 × 15 = 15 marks)

16. (a) Why a power divider is required in RF systems? Analyze a power divider in odd and even modes.

Or

(b) Determine Dolph-T chebycheff current distribution for the minimum beam width of a linear in phase broadside array of eight isotropic sources. The spacing between the elements is $3\lambda/4$ and the side lobe level is to be 40 dB down. What is the half power beam width?