E/L/TX

Reg. No: 21BEC0637

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BECE305L - Antenna and Microwave Engineering

Class NBR(s): 2934 / 2939 / 2946 / 2956 / 2961 / 2970 / 2974

Slot: E1+TE1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instructions: Use Smith Chart for Q10.

Answer ALL Questions

(10 X 10 = 100 Marks)

1. (i) A geosynchronous satellite is transmitting a TV signal to an earth-based station at a distance of 40,000 km. Assume that the dish antennas of the satellite and the earth station have diameters of 0.5 m and 5 m, and aperture efficiencies of 60%. If the satellite's transmitter power is 6 W and the downlink frequency is 4 GHz, calculate the antenna gains in dB. [6]

   (ii) The radiated power density of an antenna is given by $A_o \sin\theta/r^2$. Find the maximum directivity of the antenna. Assume maximum radiation is along 90°. [4]

2. An antenna has a field pattern given by $E(\theta) = \cos^2\theta \text{ for } 0° \leq \theta \leq 90°$. Find the half power beamwidth, beamwidth between first nulls and beam area.

3.(a) Design a four element broadside array of with a spacing of $\lambda/2$ between the elements using Tchebyshev array polynomial. The pattern is to be optimum with a side lobe level of 19.1 dB down the main lobe maximum. Find the excitation coefficients.

OR

3.(b) The array factor of a two element antenna array is given by

$E(t) = |\cos\theta|.\cos[\frac{1}{2}(kd\cos\theta+\beta)]$. Plot its radiation pattern for following element spacing d and phase difference β:

i) $d = \lambda/4 \; ; \; \beta = 0$

ii) $d = \lambda/2 \; ; \; \beta = \pi/4$

4. (i) A seven element Yagi-Uda array of linear dipoles is used as a TV antenna for receiving the channels 6 to 10 from 50 MHz-75 MHz. Find [5]
   a) the length of each element,
   b) their spacing,
   c) The total length of the array.

   (ii) If a helical antenna has a spacing between turns 0.05 m, diameter 0.1 m, number of turns equal to 20 and operates at 1000 MHz. Find the null to null beam width of the main beam and half power beam width and directivity. [5]

5. Design a rectangular microstrip antenna using a substrate with ε_r=2.2, h = 1.6 mm, to resonate at 1.8 GHz. Draw the schematic of the antenna

6. Explain the microwave generation in a Klystron amplifier with detailed diagrams.

7. A three-port network has following S matrix,

$$[S]=\begin{bmatrix} 0.009 & 0.01 & 0.99 \\ 0.99 & 0.008 & 0.01 \\ 0.01 & 0.989 & 0.009 \end{bmatrix}$$

i) Verify the matched, lossless and reciprocal properties.

ii) If all the ports are matched properly, calculate the insertion loss from port 2 to 3.

iii) Calculate the return loss at port-2 when other ports are strictly matched.

8. (i) Design a Wilkinson's power divider for 3 GHz application with 1:3 power division ratio for a 60 Ω system impedance and draw its layout. **[6]**

(ii) Design and draw a 180-degree 60 Ω hybrid coupler for a 9 GHz mixer in a radar. Draw a scaled layout of it. **[4]**

9. Design a planar maximally flat low pass filter using open-circuited shunt stubs for the cutoff frequency 4.0 GHz, order 4, and impedance 50 Ω. The normalized filter coefficients are: g_1=0.7654, g_2=1.8478, g_3=1.8478, g_4=0.7654. Draw the typical layout of the final filter circuit.

10.(a) Design an amplifier for maximum gain at 5.0 GHz with a GaAs FET that has the following S parameters ($Z_o = 50\,\Omega$) : S_{11} = 0.65 ∠ -140°, S_{12} = 0.04 ∠ 60°, S_{21} = 2.4 ∠ 50°, S_{22} = 0.70 ∠- 65°. Design the output matching sections using open-circuited shunt stubs using Smith chart.

OR

10.(b) A GaN HEMT has the following S-parameters at 6 GHz:

$$[S] = \begin{bmatrix} 0.64\angle -93^0 & 0.034\angle 39^0 \\ 5.03\angle 114^0 & 0.81\angle -34^0 \end{bmatrix}$$

(i) Perform the K-Δ test (ii) draw the load stability circle in the Smith chart and shade the unstable region.

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