F/L/TX

Reg. No: 21BEC0328

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BECE305L - Antenna and Microwave Engineering

Class NBR(s): 2938 / 2943 / 2950 / 2959 / 2965 / 2972 / 2978

Slot: E2+TE2

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 Instruction: Use Smith Chart for Q10.

Answer ALL Questions

(10 X 10 = 100 Marks)

1. The power radiated by a lossless antenna is 10 Watts. The directional characteristics of the antenna is represented by the radiation intensity as

$$U = B_0 \cos^4\theta; 0 \le \theta \le \frac{\pi}{2}; 0 \le \varphi \le 2\pi.$$

Find (i) The maximum power density at a distance of 1500 m. (ii) beam area and directivity of the antenna (in dB). (iii) FNBW (iv) HPBW

Use: $\int (\cos^m ax)(\sin ax)dx = -\frac{\cos^{m+1} ax}{(m+1)a}$

2. (a) A lossless dipole antenna, with an input impedance of 73 Ohms, is connected to a transmission line whose characteristic impedance is 50 Ohms. Assuming that maximum radiation intensity of the antenna is B_0 and power radiated is $B_0(0.75\pi^2)$. Calculate (i) maximum gain and (ii) realized gain of the antenna. [5]

(b) A small radar is used to measure the RCS of a small aeroplane as a part of the certification process. The radar transmits 100 W at 6 GHz. The antenna has a gain of 20 and is placed 100 m from the aeroplane, so that the plane is in the direction of maximum antenna directivity. The received power at the radar's antenna is 100 nW. If the propagation is in free space and there are no lossless in the antenna, calculate the radar cross section of the aeroplane. [5]

3.(a) Design a five element Dolph Tschebyscheff distribution broadside array with a spacing of λ/2 between the elements. The pattern is to be optimum with a side lobe level of 30 dB down the main lobe maximum. Determine the normalized amplitude excitation coefficients and the array factor.

OR

3.(b) Design a uniform broadside array of N-elements placed along the z-axis with a uniform spacing d = λ/10 between the elements. Determine the closest integer number of elements so that in the elevation plane the (a) HPBW is 60° (b) FNBW is 60°.

4. (a) Design and draw a pyramidal horn antenna with an E-plane aperture of 9 λ, δ_E=0.2λ and δ_H=0.33λ. Calculate the following: (i) Horn length (ii) H plane aperture and (iii) Flare angle. [5]

(b) Design and draw a rhombic antenna to operate at a frequency of 30 MHz with the angle of elevation 30 degree with respect to ground. [5]

5. Design and draw a log-periodic antenna to obtain a gain of 9 dB (τ = 0.861 and σ = 0.162) to operate for a frequency range of 400 MHz to 1000 MHz. Calculate the first two elements length and position.

6. Write short notes on Gunn diode for the following cases: (i) current-voltage characteristics with two valley theory (ii) various modes of operation

7. A four-port network has S-matrix,

$$[S]=\begin{bmatrix} 0 & -0.707 & -0.707 & 0 \\ -0.707 & 0 & 0 & -0.707 \\ -0.707 & 0 & 0 & -0.707 \\ 0 & -0.707 & -0.707 & 0 \end{bmatrix}$$

(i) Verify the matched, lossless, and reciprocal properties.

(ii) What is the insertion loss between port-1 and port-3 when all ports are properly matched?

(iii) What is the input reflection coefficient seen at port-1 when port-3 has a load reflection coefficient of -0.15 and all other ports are properly matched?

8. (a) Design a 10 dB branch line coupler for a Bluetooth dongle operating at 2.45 GHz. Draw the layout of the coupler with typical scale. [5]

(b) A lossless T-junction has an input impedance of 50 Ω. Find the output characteristc impedance for an input power division ratio of 2:3. Compute the reflection coefficents at the output ports? [5]

9. Design a low pass filter for a cut-off frequency of 8 GHz, with a flat passband response and should have a stop-band attenuation of 30 dB at 11 GHz using stepped impedance method. Draw the layout of the above LPF and expected frequency response. For the design, use the filter coefficient values given below:

Maximally flat low pass – prototype element values										
Order	g1	g2	g3	g4	g5	g6	g7	g8	g9	g10
3	1	2	1							
4	0.763	1.847	1.847	0.765						
5	0.618	1.618	2.000	1.618	0.618					
6	0.517	1.414	1.931	1.931	1.414	0.517				
7	0.445	1.246	1.801	2.000	1.801	1.246	0.445			
8	0.390	1.111	1.662	1.961	1.961	1.662	1.111	0.390		
9	0.347	1.000	1.532	1.879	2.000	1.879	1.532	1.000	0.347	
10	0.312	0.907	1.414	1.782	1.975	1.975	1.782	1.414	0.907	0.312

10.(a) A small-signal amplifier uses a GaAs FET transistor that has the following large signal S-parameters at 3 GHz in a 50 Ω system. Design a maximum gain class A power amplifier using open circuit shunt stubs (for the input side only) using Smith chart.

f (GHz)	S_{11}	S_{12}	S_{21}	S_{22}
3	$0.62 \angle 140°$	$0.06 \angle -10°$	$2.58 \angle 20°$	$0.53 \angle -120°$

OR

10.(b) S-parameters of a Si BJT was measured as follow:

$$[S] = \begin{bmatrix} 0.81\angle -90° & 0.029\angle 55° \\ 2.9\angle 100° & 0.74\angle -40° \end{bmatrix}$$

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

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