Question 1

(a) Define the following quantities in relation to an antenna. [10]

(i). Near and Far Field
(ii). Half Power Beamwidth (HPBW)
(iii). Directivity
(iv). Gain
(v). Radiation Resistance.

(b) Describe the following using suitable radiation patterns. [06]

(i). Isotropic Antenna
(ii). Directive Antenna
(iii). Omni-directional Antenna

(c) List one example of, [02]

(i). Directive Antenna
(ii). Omni-directional Antenna

(d) A parabolic reflector antenna operating at $3GHz$ has a square aperture of $5m \times 5m$. Calculate the gain of the antenna in dB if the aperture efficiency is 70%. [07]

$D = \frac{4\pi}{\lambda^2} A_{ph}$

43.424 dB

Question 2

(a) Draw the current distribution along a thin wire dipole antenna of length. [04]

(i). $\lambda/50$
(ii). $\lambda/2$
(iii). λ
(iv). $3\lambda/2$

(b) Explain why the radiation pattern of a dipole antenna that is longer than 1.5 times the wavelength is considered useless. [02]

(c) Using suitable diagrams, show how the apparently useless radiation pattern in part (b) can be converted into

(i). The directive radiation pattern of a V-antenna [03]
(ii). The directive radiation pattern of a Rhombic antenna [03]

(d) Briefly describe a Yagi-Uda Array using a suitable diagram and label the active element, directors, and reflector. Explain the effects of the directors, and reflector on the radiation pattern. [05]

(e) A telecommunication base station requires a wideband antenna to handle a frequency range of $2.4 - 4.0GHz$. A log periodic antenna is suggested for this purpose. If the antenna has to be 30 cm long and the minimum spacing between two elements has to be above $5mm$, verify if the design will be feasible for 10, 15 and 20 elements. [08]

Question 3

An antenna array is a set of multiple connected antennas which work together as a single antenna, to transmit or receive radio waves.

(a) Two identical isotropic radiators separated by a distance of $\lambda/2$ are fed by currents of equal magnitude and phase.

(i). Obtain an expression for the far field electric field of the above two-element isotropic array. [06]

(ii). Draw the radiation pattern. [05]

(b) Four identical isotropic radiators separated by a distance of $\lambda/2$ are fed by currents of equal magnitude and phase.

(i). Write an expression for the far field electric field. [02]

(ii). Draw the radiation pattern. [05]

(iii). Estimate the beamwidth between first nulls. [01]

(c) Compare & contrast the radiation patterns obtained in (a) & (b) and explain the effect of increasing the number of radiating elements in an isotropic array. [02]

(d) If a constant phase difference of δ is maintained between the feeding currents of adjacent sources of the 4-element array of part (b) above, briefly describe what is expected of the major lobe of the radiation pattern of the array if δ is gradually changes from 0° to 180°. [04]

Question 4

(a) Briefly explain the importance of Microstrip Patch antennas in telecommunication applications. [05]

(b) Figure Q4.1 indicates a rectangular patch antenna. Draw and explain behaviour of the electric filed lines from the two side views of Length 'L' and Width 'W'. [05]

(c) Explain the advantage of using microstrip arrays and name two types of feeding methods for such an array with diagrams. [03]

(d) Describe the following modes of radio wave propagation in free space.

(i). Ground Waves [04]

(ii). Sky Waves [04]

(iii). Space Waves [04]

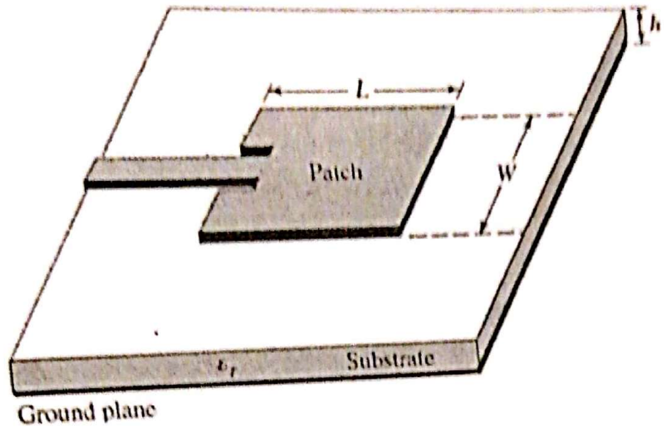

Figure Q4.1: Rectangular Patch Antenna

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