Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	ANTENNA THEORY AND DESIGN
COURSE CODE	:	BEB 41003
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JUNE/JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF TWELVE **(12)** PAGES

Q1 (a) Describe the ground effects on a half wave dipole with the help of relevant diagrams and supporting formulas.

(4 marks)

(b) Important design considerations are required to design a half-wave dipole. With the aid of relevant diagrams and mathematical equations:

(i) Derive the fields, E and H radiated from a half-wave dipole in the fraunhofer region.

(3 marks)

(ii) If the length of a half wave dipole is increased from $\lambda/2$ to $3\lambda/2$, predict the radiations patterns and performance of the gain of the dipole. (2 marks)

(iii) Sketch the current distributios on a half-wave dipole and a quarter wave monopole. (1 mark)

(c) As a communications engineer, you are required to design a rectangular patch which has a dielectric substrate of relative permittivity $\varepsilon_r = 2.2$ and thickness, $h \approx \lambda_o/100$.

(i) Determine the impedance and bandwidth of the patch. (4 marks)

(ii) Calculate the length and impedance of $\lambda/4$ section of microstrip transmission line to match the patch to a 50 Ω line.

(8 marks)

(iii) Determine the position of the feed to match the antenna to the 50 Ω line.

(3 marks)

Q2 (a) Explain briefly the comparison between spiral and parabolic reflector antennas.

(4 marks)

(b) Give **THREE (3)** examples of broadband antenna with specific applications.

(6 marks)

(c) For a 2m diameter parabolic reflector with 10W of power radiated by the fed mechanism operating at 5 GHz, the transmit antenna efficiency is given by 85%, determine:

(i) beamwidth, (4 marks)

(ii) transmit power gain (dB), (4 marks)

(iii) receive power gain (dB), and (4 marks)

(iv) Effective Isotropic Radiated Power (EIRP). (3 marks)

Q3 (a) Distinguish Method of Moment and Finite Difference Time Domain for an antenna design.

(4 marks)

(b) A length of 4 cm Hertzian dipole antenna operating at 2 GHz is required to be designed with the efficiency factor of 0.7. Determine:

(i) the radiation resistance,

(3 marks)

(ii) the power gain, and

(3 marks)

(iii) the effective aperture.

(3 marks)

(c) For a transmit antenna with a radiation resistance $R_{rad} = 65\ \Omega$ and an effective antenna resistance, $R_e = 12\ \Omega$, a directive gain, $G_d = 25$ and an input power $P_{in} = 175$ W, determine:

(i) radiation/Antenna efficiency,

(3 marks)

(ii) antenna gain, G_p (Absolute and dB),

(3 marks)

(iii) radiated power in Watts, and

(3 marks)

(iv) EIRP in Watts.

(3 marks)

Q4 As a researcher at a consulting agency, you are required to design an array of 4 x 4 square patch antenna to be placed at an anechoic chamber for radiation pattern measurements.

(a) Briefly explain the principle of pattern multiplication and end-fire array.
(4 marks)

(b) Predict possible effects on the array performance if the element spacing between adjacent elements is greater than $\lambda/2$.
(4 marks)

(c) With the aid of relevant diagrams and mathematical equations, briefly describe constraints imposed on the individual elements in order for the properties of the array antenna to be calculated by using a fixed pattern multiplication. (4 marks)

(d) The square array is now replaced with $\lambda/2$ dipoles. Each having a maximum gain of 3 dB is fed by 14 signals of adjustable relative phase and equal amplitudes. Assuming 90% efficiency:

(i) Analyze the radiation pattern between a single dipole antenna and the 4 x 4 array antenna. (3 marks)

(ii) Calculate the boresight gain when the signals are all in phase.
(5 marks)

(iii) Predict the gain performance of the dipole array antenna given in **Q4(d)** compared to a single dipole antenna.
(5 marks)

- END OF QUESTIONS -