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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017**

COURSE NAME : ANTENNA THEORY AND DESIGN
COURSE CODE : BEB 41003
PROGRAMME : BEJ
EXAMINATION DATE : JUNE 2017
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

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THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

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- Q1**
- (a) Propose a relationship between the bandwidth and beamwidth for a Hertzian dipole antenna 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) Differentiate between a Hertzian dipole and a half-wave dipole. (3 marks)
- (ii) Predict possible changes if a feedline is connected to one of the edges of a half-wave dipole antenna. (3 marks)
- (c) As a communications engineer, you are required to design a rectangular patch as shown in Figure **Q1(c)** which has a dielectric substrate of relative permittivity $\epsilon_r = 2.2$ and thickness, $h \approx \lambda_0/100$.
- (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 50Ω line. (8 marks)
- (iii) Determine the position of the feed to match the antenna to the 50Ω line. (3 marks)

- Q2**
- (a) Explain briefly the meaning of broadband antenna. (4 marks)
 - (b) Give **FOUR (4)** examples of broadband antenna with specific applications which require broadband performance. (6 marks)
 - (c) For a 2m diameter parabolic reflector with 10W of power radiated by the feed mechanism operating at 5 GHz, the transmit antenna efficiency is given by 75%, 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) Describe important steps to perform scattering parameter measurements for a dipole antenna operating at 8 GHz. (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 $P_m = 175 \text{ W}$, 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 4×4 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 4×4 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 QUESTION -

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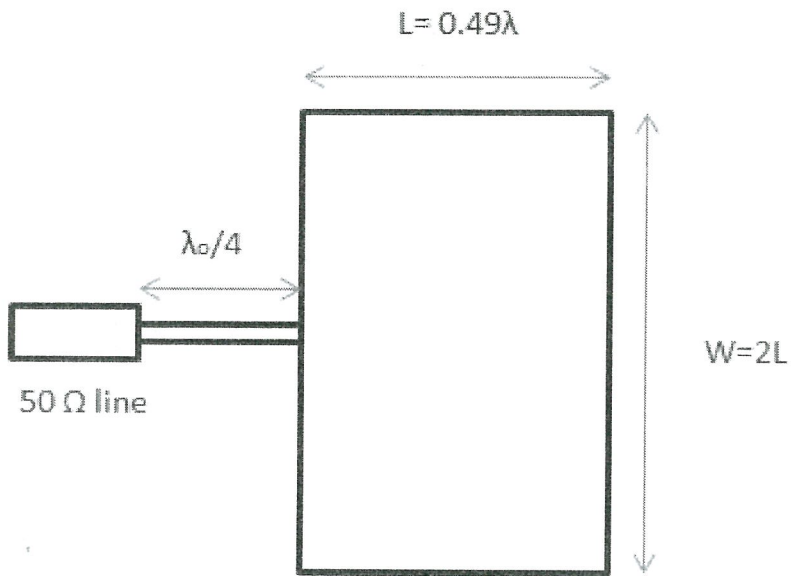


FIGURE Q1(c)

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