CONFIDENTIAL

Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	ANTENNA THEORY AND DESIGN
COURSE CODE	:	BEB 41003
PROGRAMME	:	BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

CONFIDENTIAL

Q1 (a) Distinguish between the terms of omnidirectional and isotropic.

(4 marks)

(b) For waves travelling on a real coaxial cable connected to a linear antenna, define the following terms:

(i) Complex reflection coefficient, and
(ii) Characteristic impedance

(5 marks)

(c) Design a rectangular microstrip patch antenna based on a dominant mode. The designed antenna can be mounted on the roof of a car. The center frequency is 1.6 GHz, the dielctric constant of the substrate is 10.2, and the thickness is 0.127 cm.

(i) Determine the dimensions of the rectangular patch in centimeter (cm).

(4 marks)

(ii) Calculate the resonant input impedance, assume no coupling between the two radiating slots.

(8 marks)

(iii) Determine the position of the feed to match the antenna to the 75 Ω line.

(4 marks)

Q2 (a) Explain briefly the meaning of broadband antenna.

(3 marks)

(b) Give **FOUR (4)** example of broadband antenna.

(4 marks)

(c) With the aid of relevant diagram, explain the function of elements in Yagi-Uda antenna.

(6 marks)

(d) A Yagi-Uda antenna is used as a TV antenna receiving whose center frequency is 183 MHz. With a regular resonant $\lambda/2$ dipole as the feed element in the array, the input impedance is approximately 68 Ω. The antenna is connected to the TV using twin lead line with characteristic impedance of 300 Ω.

(i) Calculate the smallest input impedance of the array if it has to maintain a VSWR equal or less than 1.1.

(8 marks)

(ii) Suggest the best way to modify the present feed to meet the desired VSWR.

(4 marks)

Q3 (a) An electric field strength of 10 μV/m is to be measured at an observation point $\theta=\pi/2$, 500 km from a half-wave dipole antenna operating at 50 MHz.

(i) Determine the length of the dipole.

(3 marks)

(ii) Calculate the current that must be fed to the antenna and the average power radiated by the antenna.

(5 marks)

(iii) If a transmission line with $Z_o = 75\ \Omega$ is connected to the antenna, find the standing wave ratio.

(4 marks)

(b) You are required to design array of 4 x 4 dipole antenna to be placed in an anechoic chamber for radiation pattern measurements.

(i) 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 pattern multiplication.

(4 marks)

(ii) The square array consists of $\lambda/2$ dipoles. Each having a maximum gain of 3 dB is fed by 16 signals of adjustable relative phase and equal amplitudes. Assuming 90 % efficiency, calculate the boresight gain when the signals are all in phase.

(5 marks)

(iii) Predict the gain performance of the array of the dipole antenna compared to a single dipole antenna.

(4 marks)

Q4 (a) Discuss **TWO (2)** advantages of using circular arrays.

(4 marks)

(b) Explain the operation of a traveling wave antenna.

(5 marks)

(c) Design a uniform linear phased scanning array which has a maximum radiation direction is 30°. The desired half power beamwidth is 2° while the element separation is $\lambda/4$. Refer to **Figure Q4(c).**

(8 marks)

(d) Determine the array pattern on the horizontal plane of a two-monopole array with mutual coupling taken into account by refering to **Figure Q4(d).**

(8 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2014/2015 PROGRAMME : BEJ
COURSE NAME : ANTENNA THEORY AND DESIGN COURSE CODE : BEB 41003

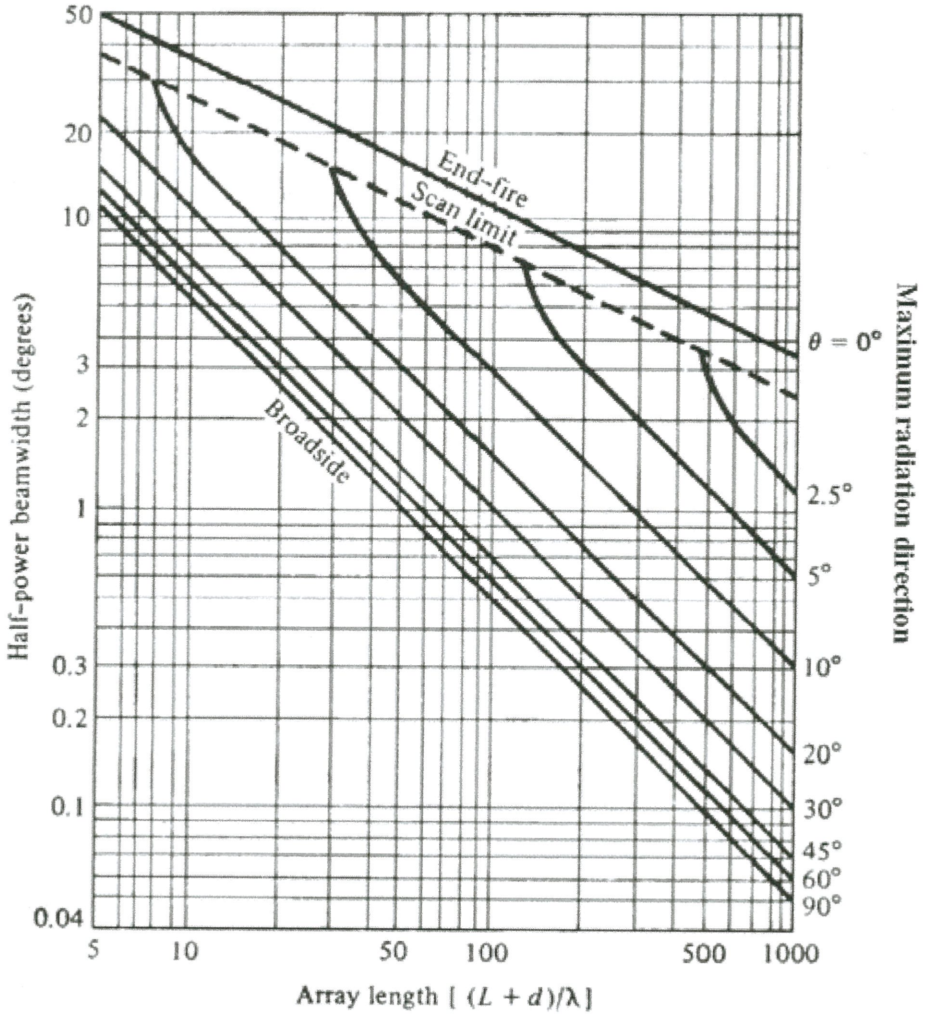
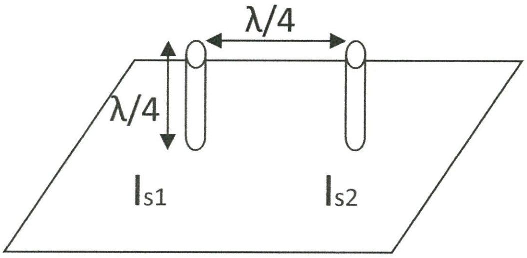


FIGURE Q4 (c)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM II/2014/2015	PROGRAMME	: BEJ
COURSE NAME	: ANTENNA THEORY AND DESIGN	COURSE CODE	: BEB 41003



$I_{s1}=1$

$I_{s2}=e^{j\beta}$

B=150°

$Z_{12}=Z_{21}=21.8-j21.9\ \Omega$

$Z_{11}=Z_{22}=47.3+j22.3\ \Omega$

$Z_{g1}=Z_{g2}=50\ \Omega$

FIGURE Q4(d)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2014/2015 PROGRAMME : BEJ
COURSE NAME : ANTENNA THEORY AND DESIGN COURSE CODE : BEB 41003

Microstrip Patch Antenna

$$W = \frac{v_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

$$L = \frac{v_0}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$$

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

Array antenna

$$|\mathrm{AF_n}(\psi)| = \frac{1}{\Gamma}\left|\frac{\sin\left(N\frac{\psi}{2}\right)}{\sin\left(\frac{\psi}{2}\right)}\right|$$

$$\psi = kd\cos\phi + \beta\big|_{\phi=\phi_0} = 0, \qquad \Rightarrow \qquad \beta = -kd\cos\phi_0$$

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2014/2015 PROGRAMME : BEJ
COURSE NAME : ANTENNA THEORY AND DESIGN COURSE CODE : BEB 41003

$$I_1 = \frac{I_{s1} - \frac{Z_{12}}{Z_{11}+Z_{g1}} I_{s2}}{\left[1 - \frac{Z_{12}Z_{21}}{(Z_{11}+Z_{g1})(Z_{22}+Z_{g2})}\right]}, \quad I_2 = \frac{I_{s2} - \frac{Z_{21}}{Z_{22}+Z_{g2}} I_{s1}}{\left[1 - \frac{Z_{12}Z_{21}}{(Z_{11}+Z_{g1})(Z_{22}+Z_{g2})}\right]}$$

$$I_1 = \frac{1}{D}\left(I_{s1} - Z'_{12} I_{s2}\right) \qquad I_2 = \frac{1}{D}\left(I_{s2} - Z'_{21} I_{s1}\right)$$

$$D = 1 - \frac{Z_{12}Z_{21}}{(Z_{11}+Z_{g1})(Z_{22}+Z_{g2})}$$

$$Z'_{12} = \frac{Z_{12}}{Z_{11}+Z_{g1}}$$

$$Z'_{21} = \frac{Z_{21}}{Z_{22}+Z_{g2}}$$

$$|E| = |AF| = \left|\frac{I_{s1}}{I_1 D}\left\{\left[1 + e^{j(kd\cos\emptyset+\beta)}\right] - Z'_{12} e^{j\beta}\left[1 + e^{j(kd\cos\emptyset-\beta)}\right]\right\}\right|$$