UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE	: RF & MICROWAVE ENGINEERING
COURSE CODE	: BEP 4263
PROGRAMME	: BEE
EXAMINATION DATE	: APRIL/MEI 2011
DURATION	: 3 HOURS
INSTRUCTION	: ANSWER **FOUR (4)** QUESTIONS ONLY

THIS PAPER CONSISTS OF FIVE (5) PAGES

Q1 The recent Japan's most powerful tsunami disaster occurred in Fukushima results in dramatic changes in molecular composition particularly at atmospheric region.

(a) With the aid of relevant diagrams and equations, briefly describe factors that cause the change in the molecular composition. In your description, compare the propagation of microwave in troposphere and ionosphere regions with defined poles and equators.

(5 marks)

(b) Approximate the troposphere region by considering the refractive index and the angle of incidence of signals in two different mediums for a curvature of space waves.

(10 marks)

(c) Calculate the effective earth radius considering the curvature earth model as obtained in Q1(b)

(10 marks)

Q2 Figure Q2 shows the reflection coefficient magnitude for parallel and perpendicular polarization of a plane wave.

(a) Apply Snell's Law to determine the relationship between microwave energy and oblique incidence angle which propagates between two distinguished mediums with incident at $40^{o} \ll \theta_i \ll 60^{o}$

(5 marks)

(b) If the virtual height of the reflection point is made to be 100 km, estimate the length of skip zone at 5 MHz, 7 MHz and 10 MHz for a spherical earth model.

(10 marks)

(c) Analyze the results obtained in Q2(b) with flat earth configuration.

(10 marks)

Q3 Figure Q3 shows the effect of the variation in dielectric constant and dimensions of resonant microstrip elements printed above grounded dielectric substrates.

(a) With the aid of relevant equations and diagrams, explain sources of loss of microstrip patch elements.

(5 marks)

(b) Design a microstrip patch line considering the width and the length of a microstrip line for a 50Ω characteristic impedance and a 45° phase shift at 2.5 GHz. The substrate thickness is d=0.127cm, with ε_r=2.20.

(8 marks)

(c) As a communications engineer, you have been assigned to design a microstrip line for multi-band systems which can be mounted onto a mobile station in Batu Pahat. It composes of zero thickness copper conductors on a substrate having εr = 8.4 tan δ =0.0005 and thickness 2.4 mm. If the line width is 1 mm, and operated at 10 GHz, develop a multi-band microstrip antenna with these specifications which takes into account the characteristics impedance and the attenuation due to the conductor loss and dielectric loss.

(12 marks)

Q4 Propagation of microwave energy in both passive and active microwave devices depends on reflection and transmission properties of propagation mediums.

(a) Propose a full design of a two-cavity klystron to operate at 10 GHz by evaluating maximum voltage and power gain. Given I_0 = 3.6 mA, V_0 = 10 kV. The drift space length is 2 cm and the output cavity total shunt conductance is G_{sh} = 20 μ mho and beam coupling coefficient β_2 = 0.92. In your design consideration, briefly describe the operation of a klystron amplifier.

(10 marks)

(b) Derive the modes of wave propagation of TE and TM fields that may exist in a rectangular waveguide.

(5 marks)

(c) A rectangular air-filled copper waveguide with dimension 0.9 inch x 0.4 inch cross section and 12 inch length is operated at 9.2 GHz with a dominant mode. Design a rectangular waveguide in a dominant mode of microwave operation considering the following parameters:

(i) cut-off frequency

(ii) guide wavelength

(iii) phase velocity

(iv) characteristic impedance and loss factor

(10 marks)

Q5 Impedance transforming properties of transmission lines can be used in designing matching networks.

(a) Based on an equivalent lumped component circuit of a transmission line, state the condition for maximum power transfer.

(5 marks)

(b) For a load impedance $Z_L = 60 - j80\Omega$, design two single-stub (short circuit) shunt tuning networks to match this load to a 50 Ω line. Assuming that the load is matched at 2 GHz, and that the load consists of a resistor and capacitor in series, plot the reflection coefficient magnitude from 1 GHz to 3 GHz for each solution.

(20 marks)

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SEMESTER/SESSION : SEMESTER I /2010/2011 PROGRAM: 4 BEE

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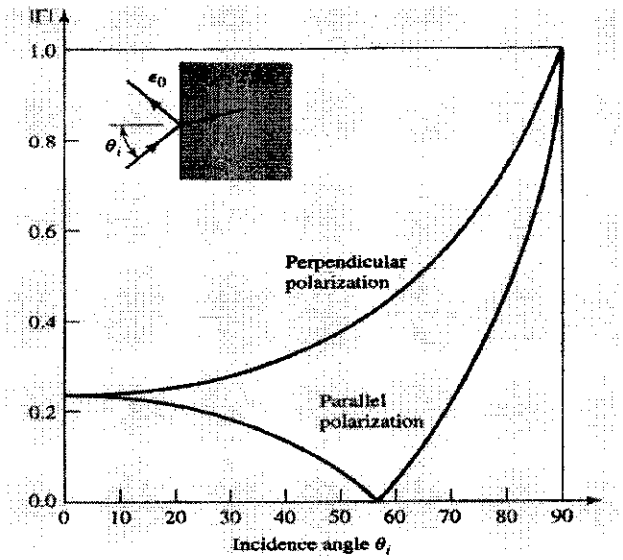

FIGURE Q2

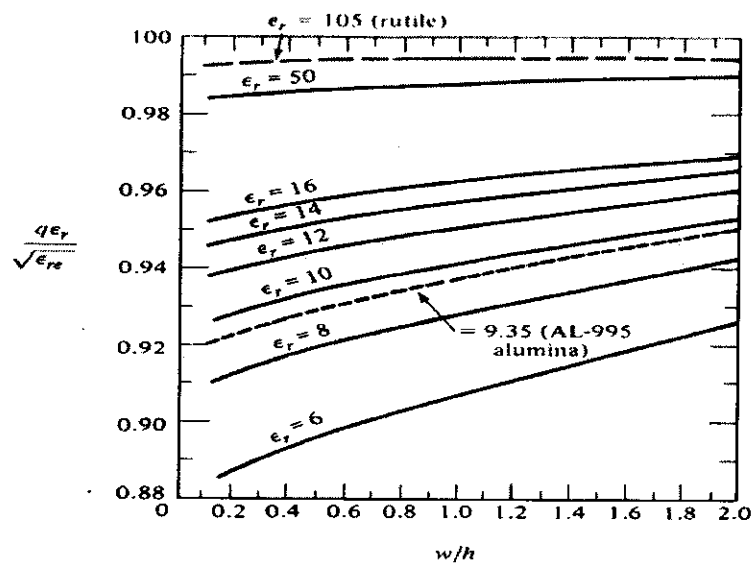

FIGURE Q3

The Complete Smith Chart

Black Magic Design