UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	MOBILE RADIO COMMUNICATION
COURSE CODE	:	BEP 4273 / BEX 43503
PROGRAMME	:	BEE
EXAMINATION DATE	:	JANUARY 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER QUESTION IN **PART A** AND CHOOSE **THREE (3)** QUESTIONS IN **PART B**

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

PART A (COMPULSORY QUESTION)

Q1 The main concept of the GSM cellular radio system is frequency reuse. Due to the growth of demand in the cellular radio, there is a need of increasing the capacity of the system. Consider for case where initially, a cluster size of $N = 7$ hexagonal cells is employed by the network planning engineer in Batu Pahat in 1990 as shown in Figure Q1(a). The network is covered by 7 clusters to support full coverage in Batu Pahat area. The allocated spectrum is 50 MHz and the traffic intensity of each subscriber is 0.1 E.

(a) Calculate the number of user that can communicate simulatenously in Batu Pahat area.

(4 marks)

(b) Consider Grade of Service (GOS) of 2%, investigate the number of user can be supported in the area based on Figure Q1(b).

(6 marks)

(c) Consider only the first layer of interfering cells, and path loss exponent (n) is 4; calculate the signal to interference ratio (S/I) of the co-channel cells in dB.

(4 marks)

(d) However after 5 years, the engineer has revised a new topology of cluster where the 120° sectoring is employed in all cells.

(i) Predict the improvement of S/I of the cellular network

(3 marks)

(ii) Criticise the drawback of sectoring in terms of the number of user can be supported in the area. Support your answer with mathematical calculations.

(8 marks)

PART B

Q2 (a) Discuss the importance of specifying the available channels into control channel, forward channel and reverse channel.

(8 marks)

(b) Explain the architecture of cellular based mobile phone network and the function of all components inside it. Then contrast it with space based (satellite) phone system.

(11 marks)

(c) A basic cellular system consists of mobile stations (MS), base stations (BS) and a mobile switching center (MSC). Illustrate the process involved between MS, BS and MSC before a communication link is established if the call is initiated by a mobile station.

(6 marks)

Q3 (a) Three mechanisms of electromagnetic wave propagation are reflection, diffraction and scattering. Differentiate between reflection and scattering mechanism by explaining their properties when microwave signals hit the flat and rough surfaces.

(6 marks)

(b) Okumura's model is one of the most widely used models for signal prediction in urban area. The model can be expressed as;

$$L_{50}(dB) = L_F + A_{m,u}(f,d) - G(h_{te}) - G(h_{re}) - G_{area}$$

Antenna tower of BS1, BS2 and BS3 are placed in different areas as the following;

BS1 : KLCC, Kuala Lumpur
BS2 : Clearwater Sanctuary Golf Resort, Alor Gajah
BS3 : Kampung Parit Kuda, Semerah, Batu Pahat

Assume these areas are very wide and covered by different cluster and the receive power level at reference distance (1 km) at BS1 is -97 dBm. Assume all base station (BS) (they cover the same size of cell) transmit radio signal at 950 MHz. The height of each BS and MS (each has the same electrical parameters at all area) is 200 m and 3 m respectively. Consider for case where

a MS is located at 5 km away from BS at all three different areas correspondingly.

(i) Evaluate the received power level at the mobile station (P_r) in the THREE (3) locations in the based station network coverage based on Figure Q3(b).

(10 marks)

(ii) Predict the value path loss exponent in the THREE (3) locations (hint: relative to path loss in the free space). Then summarize the answer in Q2(b)(i) loss in different type of environment based on possible occurrence of multipath effect.

(9 marks)

Q4 (a) Demodulation process generally performed by either coherent or noncoherent detector. Differentiate between a coherent and non coherent detector by explaining the working principle of a demodulator with an aid of a diagram.

(10 marks)

(b) Explain about orthogonal modulation technique. Describe ONE (1) application that implements this technique with an aid of constellation diagram.

(7 marks)

(c) Distinguish the working principles between Direct Sequence Spread Spectrum (DS-SS) and Frequency Hopped Spread Spectrum (FH-SS) with an aid of transmitter diagram.

(8 marks)

Q5 (a) The type of fading experience by a signal propagating through a mobile radio channel depends on the nature of the transmitted signal with respect to the characteristics of the channel. Distinguish between Fast Fading and Slow Fading effects due to Doppler Spread.

(7 marks)

(b) Consider for a GSM transmitter which radiates a radio signal with carrier frequency of 1900 MHz. A digital transmission system is used where the symbol rate is 100 Mbps.

(i) calculate the doppler spread for the channel if a mobile station is moving 50 km/hr.

(4 marks)

(ii) calculate the doppler spread for the channel if a mobile station is moving at 72 km/hr.

(2 marks)

(iii) conclude your observation based on answer in (i) and (ii).

(3 marks)

(iv) predict the type of fading undergoes by the signal in (i) and (ii).

(9 marks)

Q6 (a) Discuss the potential combination of Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) with few Multiple Access techniques in order to provide narrowband and wideband communication system.

(6 marks)

(b) If a GSM uses a frame structure where each frame consists of eight time slots, and each time slot contains 150 bit, and data is transmitted at 200kbps in the channel, find;

(i) the duration to send a bit of data.
(ii) the duration to send a slot.
(iii) the duration to send a frame.
(iv) the idle time of a user before the next sucessive transmission.
(v) the frame efficiency if the overhead bits per frame is 350 bits.

(10 marks)

(c) Analyse the concept of Hybrid Spread Spectrum by integrating Time Division and Code Division Multiple Access to produce TDCDMA; and Time Division Frequency Hopping to produce TDFH. Describe TWO (2) advantages of both hybrid Spread Spectrum techniques.

(9 marks)

- END OF QUESTION -

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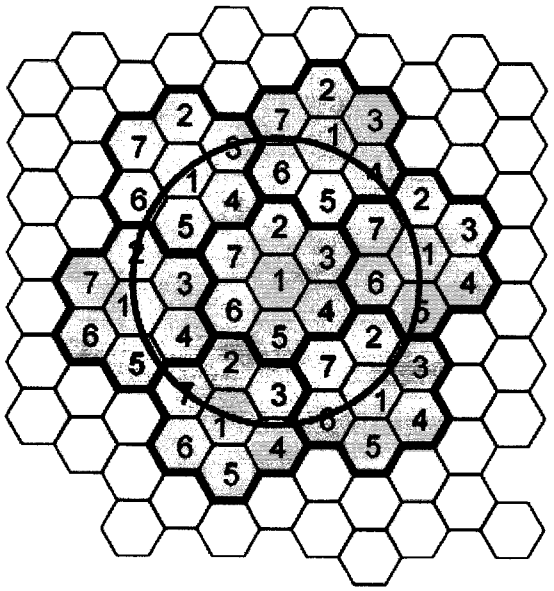

Grey shaded cell refer to Batu Pahat area

FIGURE Q1 (a)

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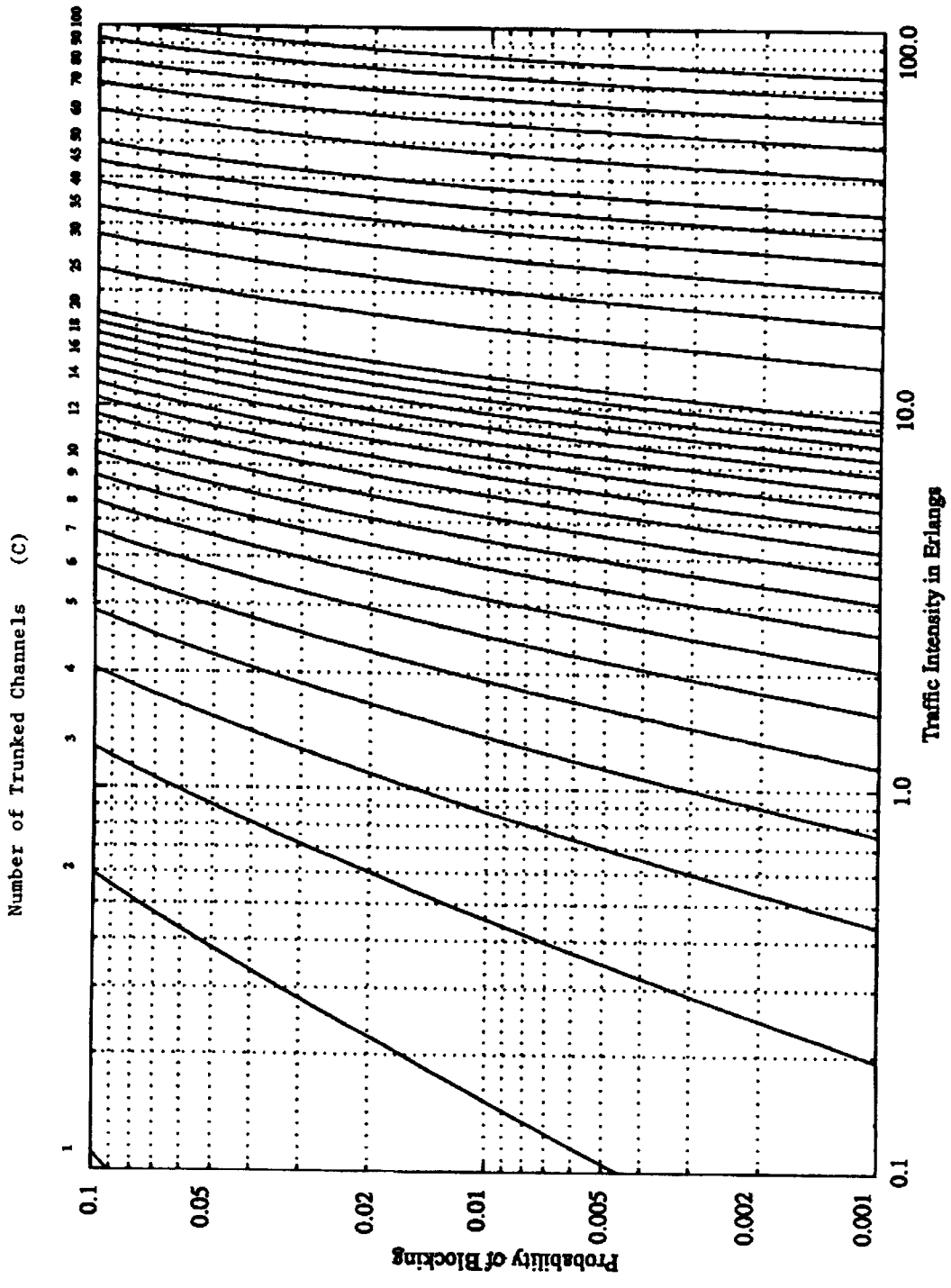

FIGURE Q1 (b)

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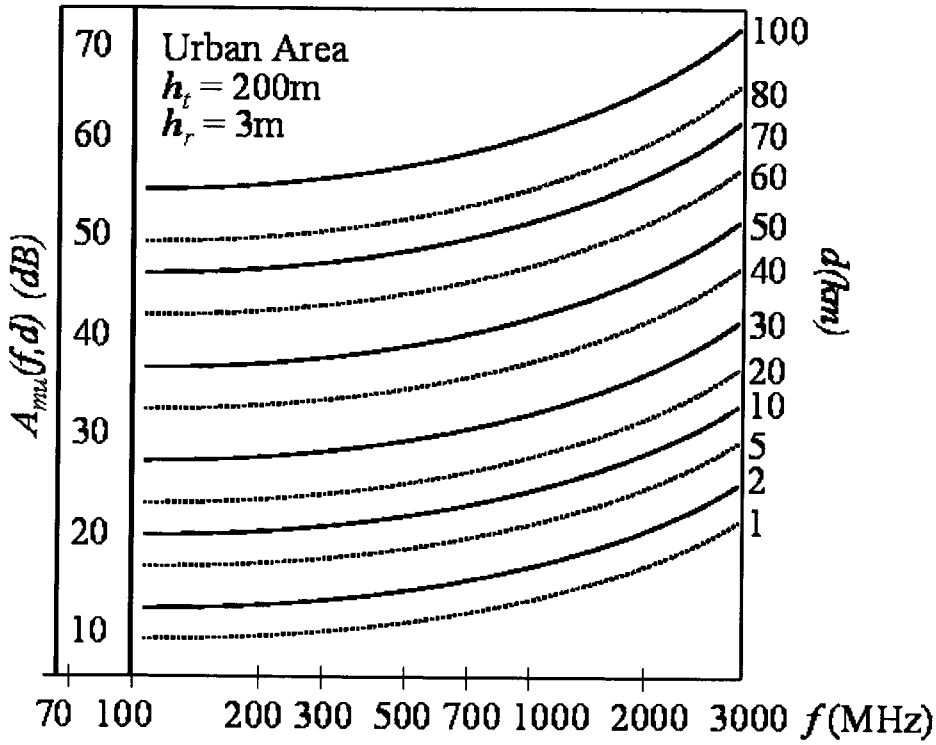
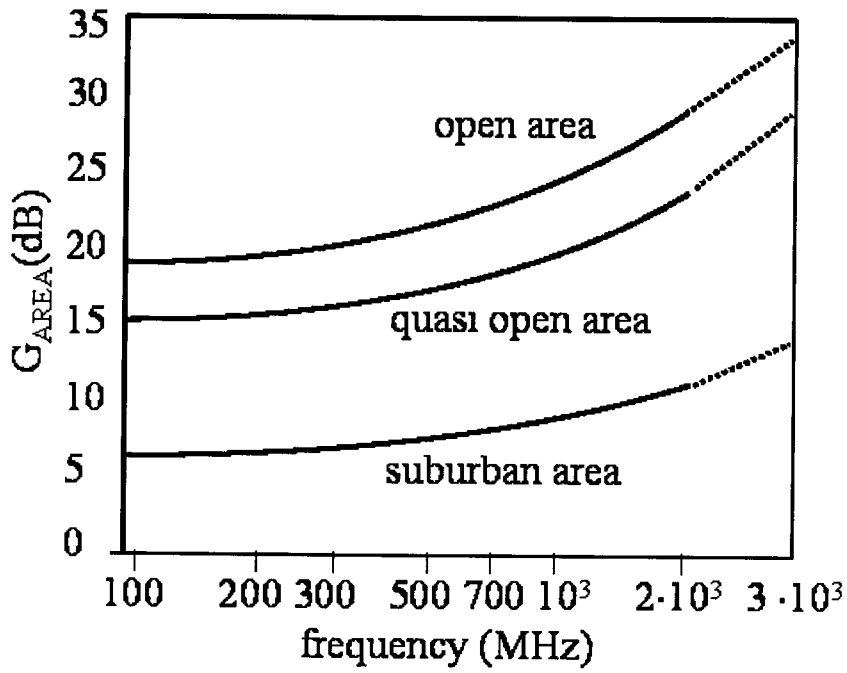


(i)



(ii)

FIGURE Q3 (b)

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Related Equations;

$$\theta = \frac{2\pi d}{\lambda} \qquad r(t) = \sum_{i=0}^{N-1} a_i \exp(j\theta_i(t,\tau))$$

$$S/I = \frac{R^{-n}}{\sum_{i=1}^{i_0} (D_i)^{-n}} \qquad P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$$

$$PL(dB) = PL(d_o) + 10n\log\left(\frac{d}{d_o}\right) + X_\sigma \qquad B_c \approx \frac{1}{5\sigma_\tau}$$

$$B_c \approx \frac{1}{50\sigma_\tau} \qquad \nu = \alpha\sqrt{\frac{2d_1 d_2}{\lambda(d_1 + d_2)}} \qquad \nu = h\sqrt{\frac{2(d_1 + d_2)}{\lambda(d_1 d_2)}}$$

$$T_c \approx \frac{1}{f_m} \qquad T_c \approx \frac{9}{16\pi f_m} \qquad T_c \approx \sqrt{\frac{9}{16\pi f_m{}^2}} = \frac{0.423}{f_m}$$