UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	WIRELESS AND MOBILE COMMUNICATION
COURSE CODE	:	BEJ 41203
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 **(a)** Define the concept of cell splitting.

(2 marks)

(b) Batu Pahat district has an area of 1872.56 km^2 with current population 495,338 residents. The signal to interference ratio S/I is 18 dB, path loss exponent, n is 4 and there are 6 co-channels cells in the first tier. Assume the whole district area is covered with constant cellular cell size of 2.6 km^2, calculate;

(i) The cluster size, N.

(3 marks)

(ii) The number of clusters available to cover the whole Batu Pahat district.

(3 marks)

(iii) The number of user that able to communicate simultaneously in a cell if the telecom provider has allocated 25 MHz duplex spectrum bandwidth, 200 kHz duplex channel bandwidth and one channel share with eight users.

(3 marks)

(iv) The number of users that can be supported in a cell based on the answer obtain **in Q1(b)(iii).** Given Grade of Service (GOS) is 2% and traffic intensity per user is 0.1 Erlang.

(3 marks)

(v) The number of subcriber can be served in a Batu Pahat district.

(3 marks)

(vi) The market penetration of the designed network.

(3 marks)

Q2 **(a)** Suggest the suitable propagation model used in the following environments. Justify your answer;

(i) Satellite communication.

(2 marks)

(ii) Indoor building.

(2 marks)

(iii) Outdoor suburban area.

(2 marks)

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(b) Given that the Two-Ray Ground Reflection Model is;

$$P_r = \frac{P_t G_t G_r {h_t}^2 {h_r}^2}{d^4}$$

Where the P_t is the transmitted power, G_t is the gain of the transmitter, G_r is the gain of the receiver, h_t is the height of the transmitter, h_r is the height of the receiver and d is the distance between the transmitter and receiver.

(i) Derive the propagation loss in the Two-Ray model so that it can be formulated as PL= 120+40 log d (km) + 20log h_t (m) +20log h_r (m).

(3 marks)

(ii) Calculate the propagation loss at a distance, d = 1 km from the Base Station (BS), given that the $h_t = 40m$, $h_r = 1\ m$.

(2 marks)

(iii) Calculate the power received signal at mobile station (MS) for answer obtained in **Q2(b)(ii),** if the P_t= 26.5 dBm, $G_t = 10dB$, $G_r = 5dB$.

(2 marks)

(iv) If the minimum signal strength (RSS) at the edge of the cell is -85 dBm if P_t= 26.5 dBm, $h_t = 40m$, and $h_r = 1\ m$, calculate the optimum radius, R of the cell.

(4 marks)

(v) Justify why the 2- Ray model is independent of an operating frequency.

(3 marks)

Q3 **(a)** **Table Q3** shows the path loss exponent in a different environment.

(i) Given that the mean path loss at 1 m is 30 dB and wall attenuation factor is 13 dB, calculate the minimum path loss at distance 30 m from the transmitter through two concrete walls rooms in an obstructed building.

(3 marks)

(ii) Repeat question **Q3(a)(i)** for the same building environment but with line of sight.

(3 marks)

(iii) From your answer in **Q3(a)(i)** and **Q3(b)(ii)**, discuss the influence of propagation mechanism to the path loss exponent in the different environments.

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(4 marks)

(b) The Shannon–Hartley theorem states the channel capacity, C of cellular communications systems as the following;

$$C = Blog_2\left(1 + \frac{S}{N}\right)$$

where, B is the bandwidth of the channel in hertz, S/N is the signal-to-noise ratio (SNR). Based on this theorem, discuss the evolution of the cellular system technology from the 2nd Generation (2G) to the 5th Generation (5G) to achieve demand for higher data rates.

(10 marks)

Q4 **(a)** In general, the cellular network is not available in the sea area. In order to improve the network coverage for the maritime users, you are required to investigate the possibility of extending the terrestrial network from the coast area to the sea area.

(i) Choose ONE measurement system for determining small scale fading for this situation and justify your answer.

(5 marks)

(ii) Highlight the possible nature factors that influence the small scale fading in the maritime environments.

(4 marks)

(b) Consider for a GSM transmitter which radiates a radio signal with carrier frequency of 2600 MHz. A digital transmission system is used where the symbol rate is 30 Mbps.

(i) Calculate the doppler spread for the channel if a mobile station is moving 90 km/hr.

(4 marks)

(ii) Calculate the doppler spread for the channel if a mobile station increases the speed to 140 km/hr.

(3 marks)

(ii) Predict the type of fading undergoes by the signal in **Q3(a)(i)** and **(ii)**

(4 marks)

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Q5 (a) Highlight the versatility of one multiple-access technique suitable for internet applications.

(7 marks)

(b) With the aid of a spectrum diagram, highlight the advantages and disadvantages of Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) for downlink and uplink in cellular systems.

(7 marks)

(c) Explain why near-far problem occurs in CDMA and how to combat it.

(6 marks)

-END OF QUESTIONS-

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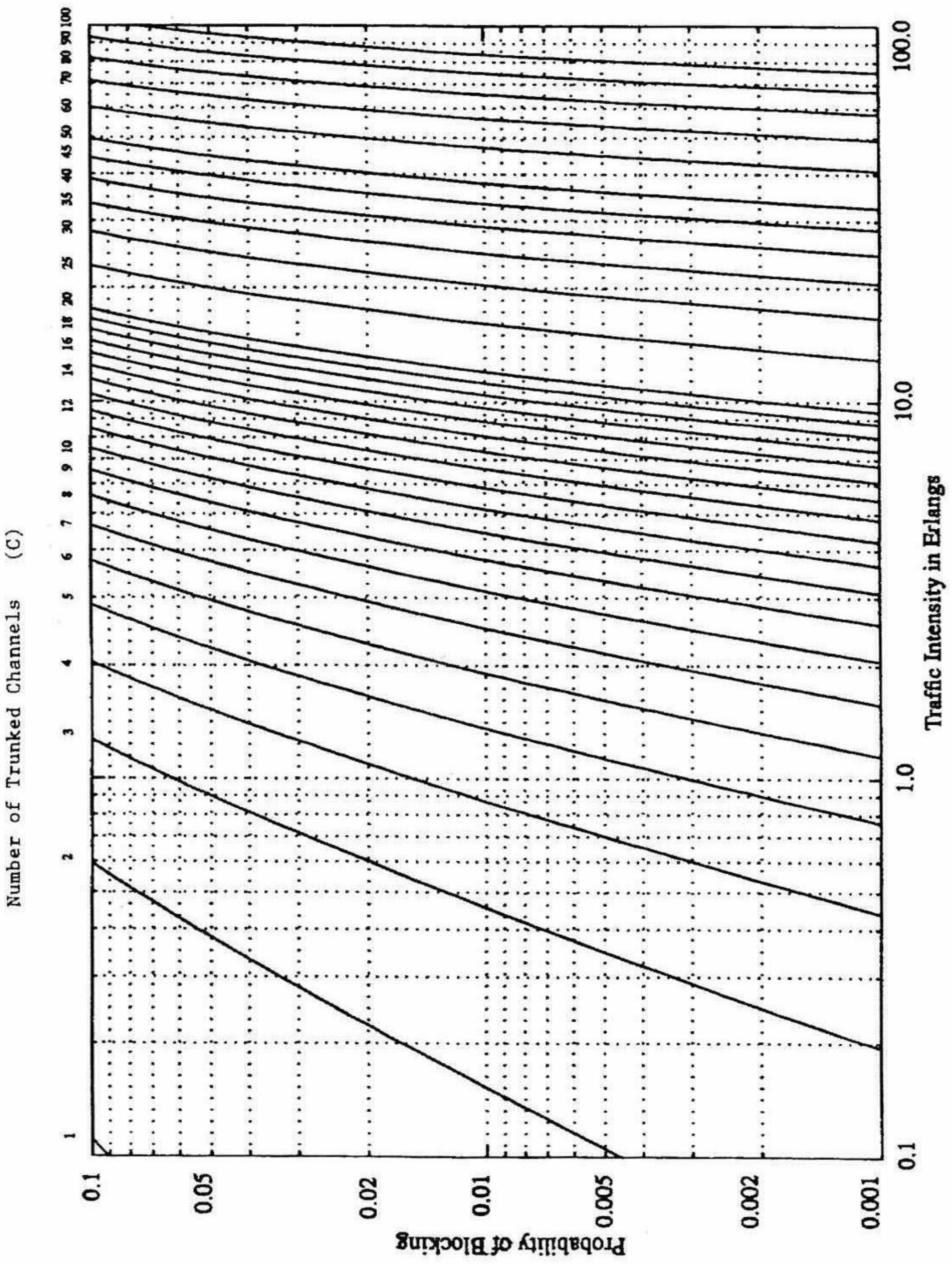

Figure Q1(b) : Erlang B Chart

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Table Q3(a)

Environment	Path loss Exponent
Free space	2
Urban cellular radio	2.7 to 3.5
Shadowed Urban cellular radio	3 to 5
In building line of sight	1.6 to 1.8
Obstructed building	4 to 6
Obstructed in factories	2 to 3

Miscellaneous Equations

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2 L}$$

$$PL(d) = PL(d_o) + 10n\log\left(\frac{d}{d_o}\right)$$

$$PL(d) = PL(d_o) + 10n\log\left(\frac{d}{d_o}\right) + FAF + \sum PAF$$

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

$$G(h_{te}) = 20\log\left(\frac{h_{te}}{200}\right)$$

$$G(h_{re}) = 10\log\left(\frac{h_{re}}{3}\right) \quad h_{re} \le 3m$$

$$G(h_{re}) = 20\log\left(\frac{h_{te}}{3}\right) \quad 3m \le h_{re} \le 10m$$

$$L_{hata} = 46.3 + 39.00\log f - 13.82\log h_{te} - a(h_{re}) + (44.9 - 6.55\log(h_{te}))\log d$$

$$f_d = \frac{1}{2\pi}\left(\frac{\Delta\phi}{\Delta t}\right) = \frac{v\cos\theta}{\lambda}$$

$$\frac{W/R}{(N-1)\alpha} = \frac{E_b}{N_0}$$

$$T_c \approx \sqrt{\frac{9}{16\pi f_m}} = \sqrt{\frac{9c}{16\pi v f_c}}$$

$$\Delta T = \gamma L T_c$$

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