CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	WIRELESS AND MOBILE COMMUNICATION
COURSE CODE	:	BEJ 41203
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY / AUGUST 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

Q1 (a) Explain the concept of hard handoff and soft handoff in cellular communication.

(4 marks)

(b) Explain how cellular concept solves the problem of capacity in the traditional mobile telephone system.

(4 marks)

(c) Explain why a hexagon is chosen to represent the cellular system compared to other shapes.

(3 marks)

(d) A cell pattern is shown in **Figure Q1(d)**. The same number on the cells represents the co-channels.

(i) Find the reuse distance if the radius of each cell is 2 km.

(3 marks)

(ii) Calculate the number of calls that can be simultaneously processed by each cell if each channel is multiplexed among eight users. 10 channels per cell are reserved for control. Assume that a total bandwidth of 30 MHz is available and each simplex channel consists of 25 kHz. Each call requires two simplex channels.

(6 marks)

(iii) Calculate the traffic intensity for each user if each user keeps a traffic channel busy for an average of 5% of an hour and an average of 50 requests per hour are generated.

(3 marks)

Q2 (a) Consider a cellular system with operating frequencies of 900 MHz, cell radius of 100 m, and omnidirectional antennas.

(i) Under the free-space path loss model, determine the required transmit power (in dBm) so that all mobile stations within the cell receive a minimum power of -20 dBm.

(3 marks)

(ii) Determine how much changes of transmit power (in dB) that can be achieved if the system frequency is now 2.6 GHz.

(3 marks)

(iii) Discuss the practicality of using 2.6 GHz for this system. What are the changes would you like to propose to the cellular system provider to improve their system?

(4 marks)

(b) A base station operating at 900 MHz is located 2 km away from a mobile station. A knife-edge obstacle happened to be in the middle of the path between the base station and the mobile station.

(i) Analyse the diffraction loss when the height of the obstacle is 25 m and 0 m.
(7 marks)

(ii) For each case in **Q2(b)(i)**, discuss the position of the obstacle concerning the n^{th} Fresnel zone within which the tip of the obstruction lies.
(6 marks)

Q3 (a) List out the differences between fast fading and slow fading.
(4 marks)

(b) A base station has a 900 MHz transmitter and a vehicle is moving at the speed of 100 km/h.

(i) Compare the received carrier frequency when the vehicle is moving directly toward the BS and when the vehicle is moving in a direction that is 60° to the direction of arrival of the transmitted signal.
(5 marks)

(ii) Illustrate the latest position of the vehicle for both situations.
(4 marks)

(c) The multipath power delay profile is given in **Figure Q3(c)**.

(i) Calculate the mean excess delay.
(3 marks)

(ii) Calculate the RMS delay spread.
(4 marks)

(iii) Calculate the coherence bandwidth if the frequency correlation function is above 5.
(2 marks)

(iv) Determine if this channel is suitable for GSM service without the use of an equalizer.
(3 marks)

Q4 (a) Explain why power control is important for CDMA systems.

(4 marks)

(b) We can gain higher levels of *n*-QAM, such as 64QAM and 256QAM by increasing the amount of amplitude level and phase shift. It seems that the transmission rate can be as high as we want by using this kind of modulation. Is that true? Explain briefly.

(4 marks)

(c) Using suitable diagrams, explain the concept of Frequency Division Duplex (FDD) and Time Division Duplex (TDD) related to uplink and downlink in cellular systems.

(4 marks)

(d) Using the Shannon capacity formula, discuss the changes in channel capacity of the cellular system from 1G to the current technology. The SNR is limited to 10 dB. Let the channel bandwidth for AMPS is 30 kHz, GSM is 200 kHz, UMTS is 5MHz, and LTE is 20 MHz.

(8 marks)

Q5 (a) Explain the current 5G implementation in Malaysia.

(6 marks)

(b) Describe the roles of the Malaysian Communications and Multimedia Commission (MCMC) related to the radio spectrum assignment in Malaysia.

(3 marks)

END OF QUESTIONS

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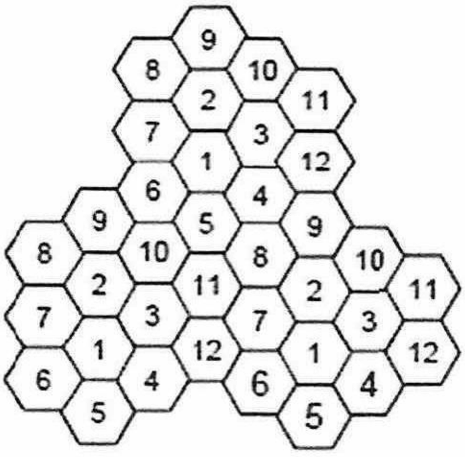

Figure Q1(d)

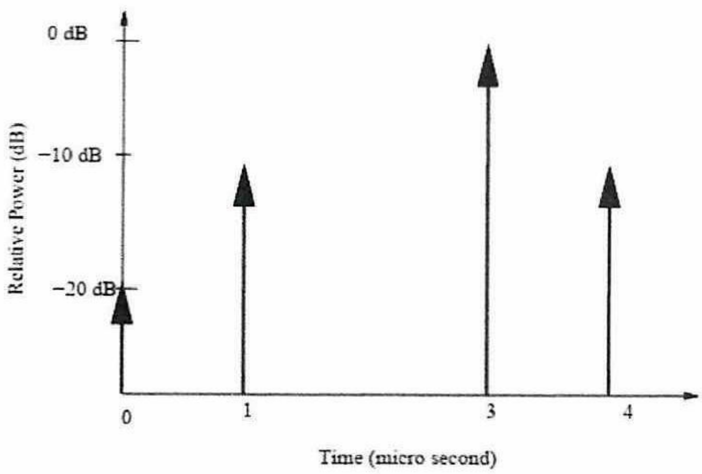

Figure Q3(c)

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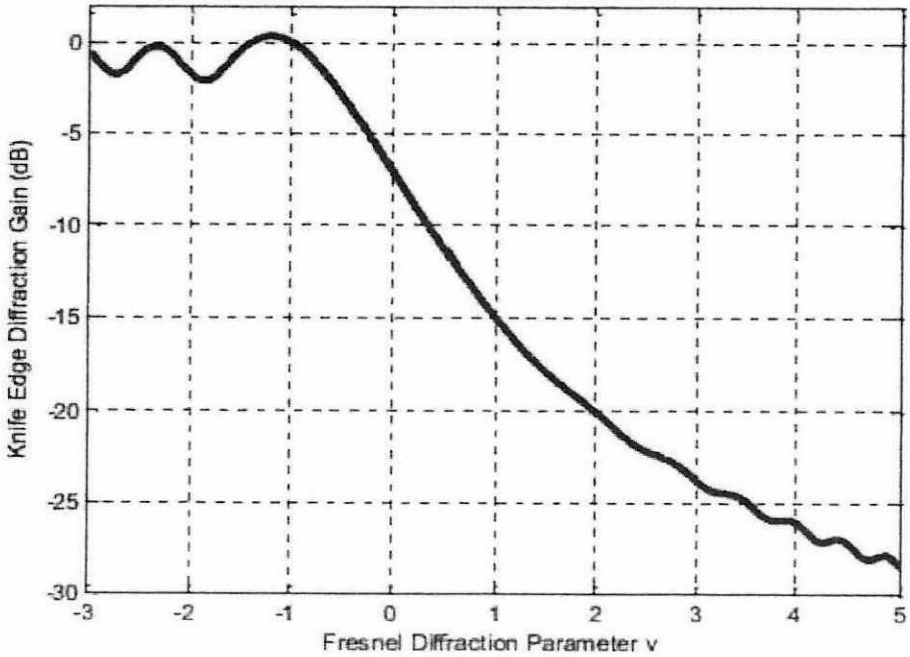

Diffraction gain, G_d as a function of v

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List of equations

$A_u = \lambda H$	$P_{blocked} = \frac{\frac{a^n}{c!}}{\sum_{n=0}^{c} \frac{a^n}{n!}}$
$N = i^2 + ij + j^2$	$q = \frac{D}{R} = \sqrt{3N}$
$\frac{S}{I} = \frac{q^n}{6}$	$\frac{S}{I}_{worst(omni)} = \frac{1}{2(q-1)^{-n} + 2q^{-n} + 2(q+1)^{-n}}$
$\frac{S}{I}_{worst(3-sector)} = \frac{1}{q^{-n} + (q+0.7)^{-n}}$	$\frac{S}{I}_{worst(6-sector)} = \frac{1}{(q+0.7)^{-n}}$
$P_r = P_0 \left(\frac{d}{d_0}\right)^{-n}$	$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2 L}$
$PL(d) = PL(d_o) + 10n\,log\left(\frac{d}{d_o}\right)$	$PL(d) = PL(d_o) + 10n\,log\left(\frac{d}{d_o}\right) + FAF + \sum PAF$
$L_{50}(dB) = L_F + A_{m,u}(f,d) - G(h_{te}) - G(h_{re}) - G_{area}$	$G(h_{te}) = 20\,log\left(\frac{h_{te}}{200}\right)$
$G(h_{re}) = 10\,log\left(\frac{h_{re}}{3}\right) h_{re} \leq 3m$	$G(h_{re}) = 20\,log\left(\frac{h_{te}}{3}\right) 3m \leq h_{re} \leq 10m$
$L_{hata} = 46.3 + 39.00\,log\,f - 13.82\,log\,h_{te} - a(h_{re}) + (44.9 - 6.55\,log(h_{te}))\,log\,d$	$\Delta \approx \frac{h^2}{2}\left(\frac{d_2 + d_1}{d_1 d_2}\right) = \frac{n\lambda}{2}$
$v = h\sqrt{\frac{2(d_1 + d_2)}{\lambda d_1 d_2}} = \alpha\sqrt{\frac{2 d_1 d_2}{\lambda(d_1 + d_2)}}$	$r_n = \sqrt{\frac{n\lambda d_1 d_2}{d_1 + d_2}}$
$f_d = \frac{1}{2\pi}\left(\frac{\Delta\varphi}{\Delta t}\right) = \frac{v\cos\theta}{\lambda}$	$\overline{\tau} = \frac{\sum_k a_k^2 \tau_k}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)(\tau_k)}{\sum_k P(\tau_k)}$
$\overline{\tau^2} = \frac{\sum_k a_k^2 \tau_k^2}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)(\tau_k^2)}{\sum_k P(\tau_k)}$	$\sigma_\tau = \sqrt{\overline{\tau^2} - (\overline{\tau})^2}$
$B_c \approx \frac{1}{5\sigma_\tau}$	$C = B\,log_2\left(1 + \frac{S}{N}\right)$