Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	CELLULAR COMMUNICATION TECHNOLOGY
COURSE CODE	:	BNF 43002
PROGRAMME CODE	:	BNF
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	2 HOURS AND 30 MINUTES
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 EXAMINATION CONDUCTED VIA CLOSED BOOK

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

Q1 (a) There are several wireless standards and systems that qualify as 3G systems which include UMTS and CDMA2000. Differentiate both of the systems.

(4 marks)

(b) Cellular concept and frequency reuse was a major breakthrough in solving spectrum congestion and user capacity.

(i) Explain briefly the concept of cellular frequency reuse.

(3 marks)

(ii) State advantages of the frequency reuse concept.

(3 marks)

(iii) Sketch the frequency reuse diagram.

(2 marks)

(c) Differentiate between forward channel, reverse channel and control channel.

(6 marks)

(d) Calculate maximum data transmission rate for 8 channels if the data rate is 43.2 kbps.

(2 marks)

Q2 (a) If 120W is applied to a unity gain antenna with a 950 MHz carrier frequency,

(i) Determine the received power in dBm at a free space distance of 1500 meter from the antenna.

(5 marks)

(ii) Determine P_r at 15 km distance from transmitter. Assume unity gain for the receiver antenna.

(3 marks)

(b) If a total of 132 MHz of bandwidth is allocated to a particular cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses

(i) four-cell reuse.

(2 marks)

(ii) seven-cell reuse.

(2 marks)

(iii) Determine an equitable distribution of control channels and voice channels for question **Q2(b)(i)** and **Q2(b)(ii)**, if 1 MHz of the allocated spectrum is dedicated to control channels.

(4 marks)

(c) There are two major kind of interferences produced within a cellular telephone system that are co-channel interference and adjacent-channel interference. Differentiate both interferences and draw suitable diagram.

(4 marks)

Q3 (a) If a signal-to-interference ratio (SIR) of 17 dB is required for satisfactory for a cellular system, determine the frequency reuse factor, Q and cluster size, N that should be used for maximum capacity if the path loss exponent is the following, n. Assume that there are six co-channel cell in the first tier, and all of them are at the same distance from the mobile. Use suitable approximations.

(i) n = 4

(3 marks)

(ii) n = 3

(3 marks)

(b) Determine whether mobile station A receives any interference from co-channel cell I with the following related parameters.

Distance base station to Cell I = 7 km
Distance base station to mobile station A = 1.5 km
Frequency, f = 950 Mhz
P_t1 = 15 dBW
G_t = 7 dB
R for base station and Cell I = 1 km
G_r mobile station A = 1 dB
P_t2 = 24 W
System requirements: Analog system, C/I > 13 dB – 18 dB
Digital system, C/I > 11 dB – 15 dB

(5 marks)

(c) A cellular service provider decided to use a digital Frequency Division Multiple Access (FDMA) scheme which can tolerate a signal-to-interference ratio of 18 dB in the worst case. The mobile radio channel provided a propagation path loss exponent of $n = 4$. Calculate the optimal value of cluster size N for

(i) omnidirectional antennas, assuming there are 6 co-channel interference

(4 marks)

(ii) 120° sectoring

(2 marks)

(iii) 60° sectoring

(2 marks)

(iv) propose which case should be used (60° or 120°)

(1 marks)

Q4 (a) Explain briefly the following terms in Cellular Concept:

(i) Grade of Services (GOS)

(2 marks)

(ii) Signal to interference ratio (SIR)

(2 marks)

(b) In cellular radio systems, assume each user of a single base station mobile radio system averages 5 calls per hour, each call lasting an average of 2 minutes. The desired performance of the system required not more than 2 calls been blocked out of 100 call. The Erlang B chart is shown in **Figure Q4(b)**.

(i) Calculate the traffic intensity for each user.

(2 marks)

(ii) Compute the number of users that could use the system with 2 % blocking if only 3 channels are available.

(2 marks)

(iii) Determine the number of users that could use the system with 0.5 % blocking if 5 trunked channels are available.

(2 marks)

(iv) If the number of users in answer for **Q4(b)(iii)** is suddenly doubled, examine the new blocking probability of the 10 channel trunked mobile radio system. Assume that the requirement is GOS ≤ 0.02, determine whether the system is acceptable or not.

(3 marks)

(c) Consider a transmitter which radiates a sinusoidal carrier frequency of 2000 MHz. For a vehicle moving at 80 km/h, compute the received carrier frequency if the mobile is moving directly towards the transmitter, and directly away from the transmitter (give your answer up to 7 decimal point).

(3 marks)

(d) A general design rule for microwave links is 55 % clearance of the first Fresnel zone. For 3 km link at 1.5 GHz, determine

(i) The maximum first Fresnel zone radius.

(2 marks)

(ii) The clearance height above the obstruction to the Line of Sight (LOS) path.

(2 marks)

Q5 (a) Given carrier frequency of 1700 MHz, a mobile station is moving with the speed of 65 km/h.

(i) Determine whether the channel is fast or slow fading.

(3 marks)

(ii) Calculate how many bits are sent while the channel appears static.

(2 marks)

(b) Compare 3G and 4G mobile cellular technology standards in a table which consist of the following parameters; frequency band, RF channel bandwidth, data rate, access technique, responsible standard body and modulation type.

(4 marks)

(c) Consider a mobile system, which is a TDMA system that uses a 6 Mbps data rate to support 30 users per frame.

(i) Calculate the raw data rate provided for each user?

(1 marks)

(ii) If guard time, ramp-up time, and synchronization bits occupy 30 kbps, determine the traffic efficiency for each user.

(2 marks)

(d) Explain the terms centrifugal and centripetal with regard to a satellite in orbit around the earth with the aid of a diagram.

(2 marks)

(e) A Q band earth station consist of the transmit antenna with gain of 50 dB. The transmitter power is 70 W at a frequency of 60 GHz. A geostationary satellite consist of receiving antenna with a gain of 30 dB. The signal then route to the transponder. The noise temperature of the transponder is 350 Kelvin with a bandwidth of 150 MHz and a gain of 110 dB. Calculate

(i) free-space path loss of the earth-satellite link

(2 marks)

(ii) received power at the satellite antenna

(2 marks)

(iii) noise power at the transponder input

(2 marks)

- END OF QUESTIONS –

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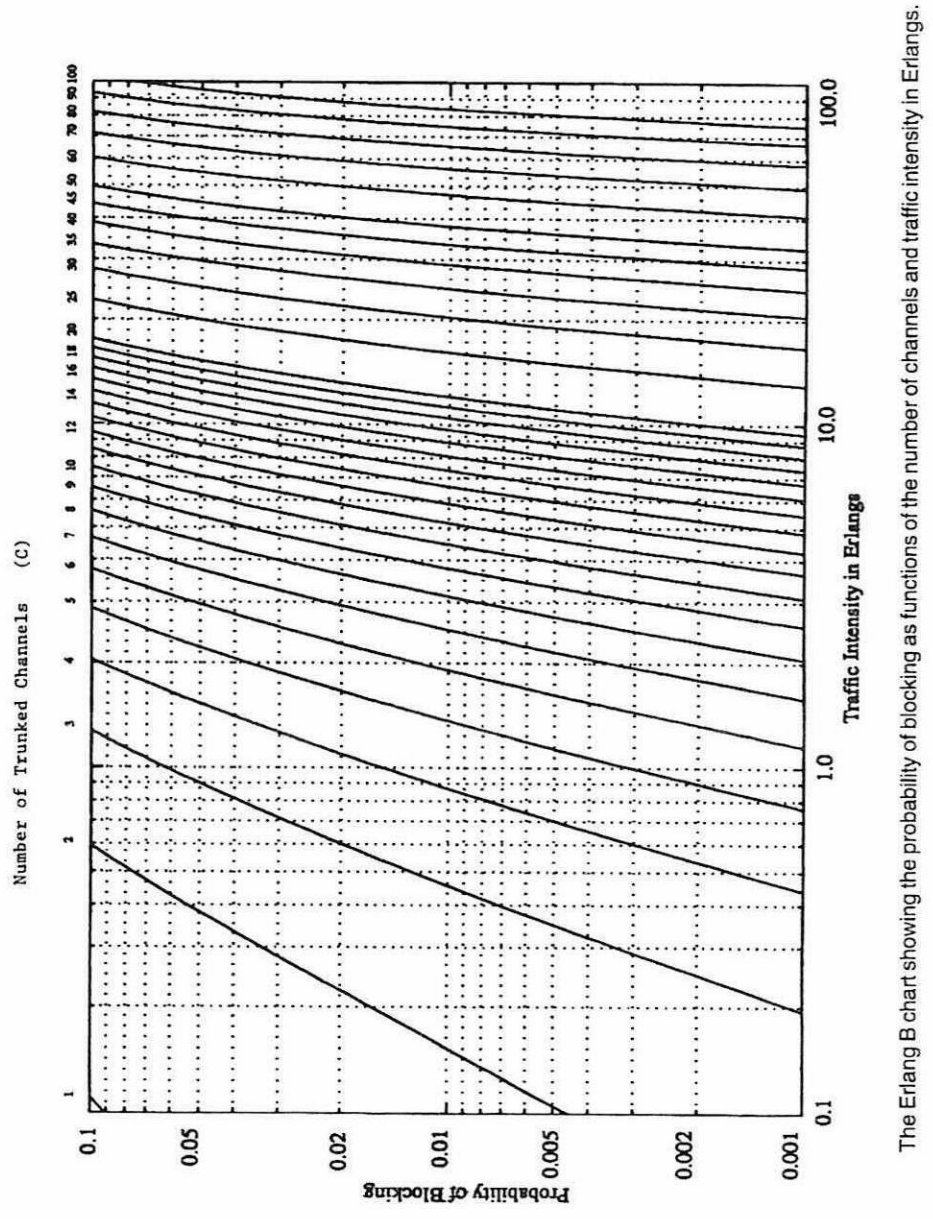

Figure Q4 (b)

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Formula Sheet

$Q = \frac{D}{R} = \sqrt{3N}$	$\frac{S}{I} = \frac{\left(\sqrt{3N}\right)^n}{i_o}$	$r_n(Fresnel\ Zone) = \sqrt{\frac{n\lambda d_1 d_2}{d_1 + d_2}}$
$A_u = \lambda H$	$A = UA_u$	$A_c = \frac{UA_u}{C}$
$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$	$P_r(d) = \frac{\lvert E\rvert^2}{120\pi} A_e$	$P_r(d) = \frac{V_{ant}^{\ 2}}{4R_{ant}}$
P_r(dBw)-P_t+G_t+G_r-Losses	$EIRP(dBW) = P_t + G_t$	FSL= 32.45+20 log $d_{(km)}$+20 log $f_{(MHz)}$
$G = \frac{4\pi A_e}{(\lambda)^2}$	$c = f\lambda$	$P_r(2\ ray\ Model) = P_t G_t G_r \frac{h_t^2 h_r^{\ 2}}{d^4}$
$T_c = \frac{9}{16\pi f_m}$	$flat\ fading = T_s \geq 10\sigma_\tau$	$M = \frac{\gamma G_u G_p}{(E_b / I_o) H_o}$
$G_p = \frac{Chip\ rate}{Data\ rate}$	$C = BW \log_2(1 + SNR)$	$SNR = 2^{\left[\frac{C}{W}\right]} - 1$
$\theta_{3dB} = \frac{75\lambda}{D}$	$Gain = \frac{33000}{\theta_{3dB}}$	$T_s = 1/R_b$