Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	CELLULAR COMMUNICATION TECHNOLOGY
COURSE CODE	:	BNF 43003
PROGRAMME CODE	:	BNF
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Differentiate between Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA).

(6 marks)

(b) Explain briefly the concept of cellular frequency reuse and sketch the suitable diagram.

(6 marks)

(c) Draw the wireless communication system that includes, Mobile Station (MS), Mobile Switching Center (MSC) and Base Station (BS).

(6 marks)

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

(2 marks)

Q2 (a) 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 $n = 3$. Propose the optimal value of cluster size N

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

(6 marks)

(ii) 120^{o} sectoring

(2 marks)

(iii) 60^{o} sectoring

(2 marks)

(iv) Propose which case should be used (60^{o} or 120^{o})

(2 marks)

(b) If a total of 33 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

(ii) seven-cell reuse

(4 marks)

(c) Determine an equitable distribution of control channels and voice channels, if 1 MHz of the allocated spectrum is dedicated to control channels.

(4 marks)

Q3 (a) If a signal-to-interference ratio **(SIR)** of 15 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

(4 marks)

(ii) n = 3

(4 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 = 8 km
Distance base station to mobile station A = 1 km
Frequency, f = 970 Mhz
P_t1 = 11 dBW
G_t = 9 dB
R for base station and Cell I = 1 km
G_r mobile station A = 1 dB
P_t2 = 24 W

(6 marks)

(c) Explain briefly the following terms in Cellular Concept:

(i) Grade of Services (GOS)

(2 marks)

(ii) Signal to interference ratio (SIR)

(2 marks)

(iii) Handoff

(2 marks)

Q4 (a) 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 3 minutes. The desired performance of the system required not more than 2 calls been blocked out of 100 call. The Erlang B chart are shown in **Figure Q4(a)**.

(i) Calculate the traffic intensity for each user.

(2 marks)

(ii) Compute the number of users that could use the system with 1% blocking if only 2 channels are available.

(2 marks)

(iii) Determine the number of users that could use the system with 1% blocking if 5 trunked channels are available.

(2 marks)

(iv) If the number of users in answer **Q4(a)(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.

(4 marks)

(b) Consider a transmitter which radiates a sinusoidal carrier frequency of 2000 MHz. For a moving vehicle moving 50 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 3 decimal point).

(4 marks)

(c) A general design rule for microwave links is 55 % clearance of the first Fresnel zone. For 1 km link at 2.5 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.

(4 marks)

Q5 (a) 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.

(6 marks)

(b) Briefly explain the concept of Multiple-Input Multiple-Output (MIMO) technology with respect to advanced cellular communication technology.

(3 marks)

(c) Discuss the challenges and limitations in 4G networks from the perspective of mobile station, wireless network and quality of service.

(4 marks)

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

(3 marks)

(e) A geostationary satellite provides service to a region which can be covered by a beam of an antenna on the satellite with a beam width of 1.8°. The satellite carries transponders for Ku-band and Ka-band, with separated antennas for transmitting and receiving. For center frequencies of 14.0/11.5 GHz and 30/20 GHz, determine the diameters of the four antennas on the satellite.

(4 marks)

- END OF QUESTIONS –

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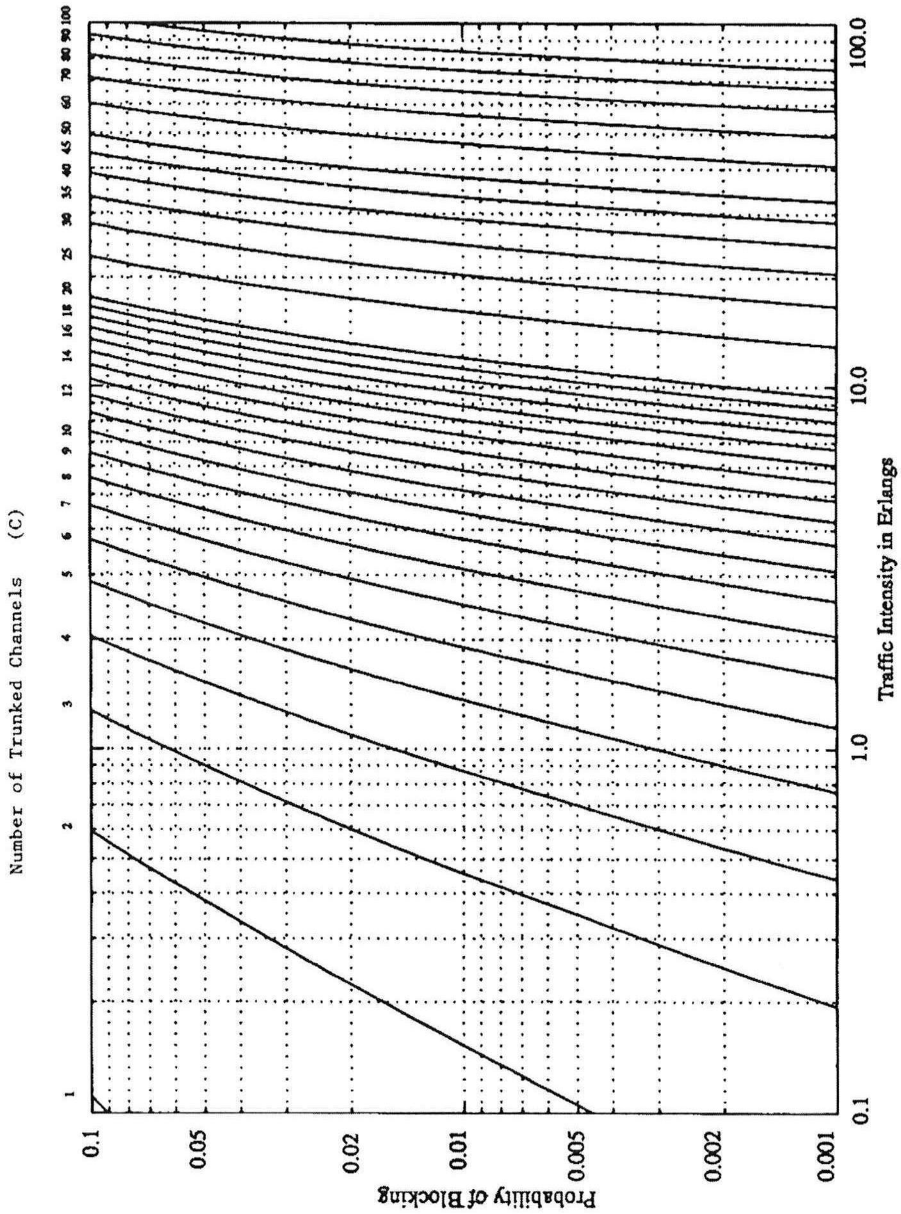

Figure 3.6 The Erlang B chart showing the probability of blocking as functions of the number of channels and traffic intensity in Erlangs.

Figure Q4 (a)

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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 $f_{(MHz)}$
$G=\frac{4\pi A_e}{(\lambda)^2}$	$c=f\lambda$	$P_r(2\ ray\ Model)=P_t G_t G_r\frac{h_t^2 h_r^2}{d^4}$
$T_c=\frac{9}{16\pi f_m}$	$flat\ fading=T_s\geq 10\sigma_\tau$	$M=\frac{\gamma G_u G_p}{(E_b/I_o)H_o}$
$G_p=\frac{Chip\ rate}{Data\ rate}$	$C=BW\log_2(1+SNR)$	$SNR=2^{\left[\frac{C}{W}\right]}-1$
$\theta_{3dB}=\frac{75\lambda}{D}$	$Gain=\frac{33000}{\theta_{3dB}}$	