SRM Institute of Science and Technology
College of Engineering and Technology
DEPARTMENT OF ECE
SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamil Nadu

QP SET A

Academic Year: 2023-24 (ODD)

Test: CLAT-1 **Date: 8/8/2023**
Course Code & Title: 18ECC301T, WIRELESS COMMUNICATION **Duration:** 1Hr
Year & Sem: IV & VII **Max. Marks:** 25

Course Articulation Matrix:

	18ECC301T - Wireless Communication	**Program Outcomes (POs)**														
		Graduate Attributes												**PSO**		
COs	**Course Outcomes (COs)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	Interpret the concepts of Wireless communication and basic cellular networks	3	-	-	3	-	-	-	-	-	-	-	2	-	-	-
CO-2	Analyze different Radio wave propagation models for cellular communication	-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

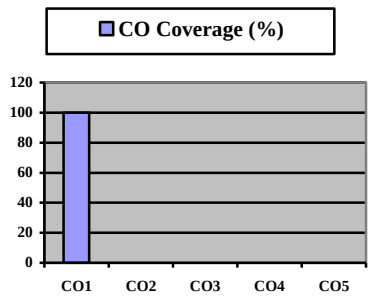
Part - A **(5 x 1 = 5 Marks)** **Instructions: Answer all Questions**					
Q. No	**Questions**	**Marks**	**BL**	**CO**	**PO**
1	While locating a co-channel cell, a RF site engineer will do the following mapping after moving 'i' cells along any particular direction a. Turn 90 deg counter clockwise & move j cells b. Turn 60 deg clockwise & move j cells c. Turn 60 deg counter clockwise & Move j cells d. Move j cells and Turn 60 deg counter clockwise	**1**	**1**	**1**	**1**
2	Identify the channel to be used for a transmission of device power level from mobile station to base station a. Forward Control Channel b. Reverse Control Channel c. Forward Voice Channel d. Reverse Voice Channel	**1**	**1**	**1**	**1**
3	What is the distance between two co channel base stations? a. 3N b. $R\sqrt{3N}$ c. 3RN d. 3 N	**1**	**2**	**1**	**4**
4	What is the Co-Channel reuse value for a cluster size of 12? a. 3 b. 4.58 c. 6 d. 3	**1**	**4**	**1**	**4**

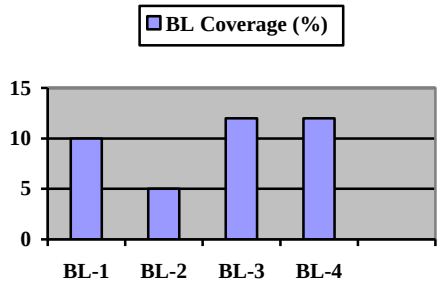
5	What is the cluster Size for i=4 and j=3? a. 37 b. 19 c. 49 d. 7	**1**	**4**	**1**	**4**
	Part – B **(2 x 4 = 8 Marks)** **Instructions: Answer any two questions**				
6	Compare blocked call cleared system and blocked call delayed systems.	**4**	**3**	**1**	**12**
7	"Hexagonal shape are chosen to be the optimum cell geometry", Ornate the importance of the aforementioned statement.	**4**	**3**	**1**	**12**
8	Neatly sketch the handoff strategies employed at cell boundary.	**4**	**2**	**1**	**1**
	Part – C **(1 x 12 = 12 Marks)** Either or				
9	a. Consider a cellular system in which total available voice channels to handle the traffic are 900.The area of each cell is 5 km^2 and the total coverage area of the system is 2000 km^2. Calculate: i. The system capacity if the cluster size N is 4 ii. The system capacity if the cluster size is 7. iii. Does decreasing N increase the system capacity? b. How the umbrella cell approach reduces the number of handoffs?	10 2	4 2	1 1	4 4
	or				
10	a. With the aid of a timing diagram, elaborate the call establishment process from a mobile to another mobile user in a cellular environment. b. How many users can be supported for 0.2% blocking probability for the 10,20 trunked channels in a blocked call cleared system? Assumed that each user generates 0.1 Erlangs of traffic. **Refer table**	8 4	1 3	1 1	1 4

Table Capacity of an Erlang B System

Number of Channels *C*	Capacity (Erlangs) for GOS = 0.01	= 0.005	= 0.002	= 0.001
2	0.153	0.105	0.065	0.046
4	0.869	0.701	0.535	0.439
5	1.36	1.13	0.900	0.762
10	4.46	3.96	3.43	3.09
20	12.0	11.1	10.1	9.41

Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Evaluation Sheet

Name of the Student: **Register No.:**

Part- A (5 x 1= 5 Marks)					
Q. No	**CO**	**PO**	**Maximum Marks**	**Marks Obtained**	**Total**
1	1	1	1		
2	1	1	1		
3	1	4	1		
4	1	4	1		
5	1	4	1		
Part- B (2 x 4= 8 Marks)					
6	1	12	4		
7	1	12	4		
8	1	1	4		
Part- B (2 x 4= 8 Marks)					
9a	1	1	10		
9b	1	4	2		
10a	1	1	8		
10b	1	4	4		

Consolidated Marks:

CO	Maximum Marks	Marks Obtained
1	25	
Total		

PO	Maximum Marks	Marks Obtained
1	14	
4	19	
12	8	
Total	41	

Signature of Course Teacher

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Key
SET A

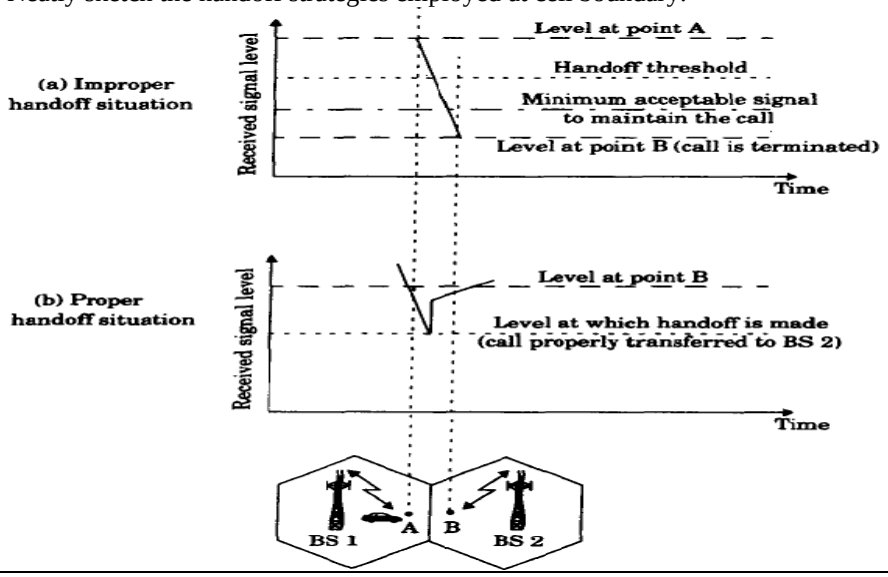
Academic Year: 2023-24 (ODD)

Test: CLAT-1 **Date: 8/8/2023**
Course Code & Title: 18ECC301T, WIRELESS COMMUNICATION **Duration:** 1Hr
Year & Sem: IV & VII **Max. Marks:** 25

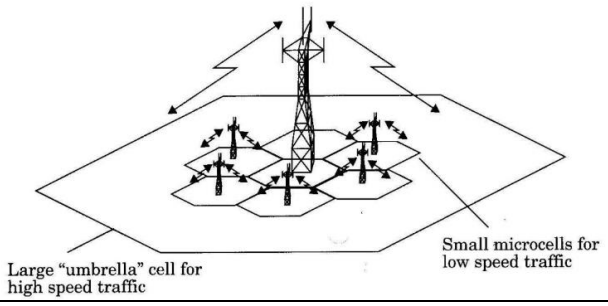
Course Articulation Matrix:

	18ECC301T - Wireless Communication	**Program Outcomes (POs)**														
		Graduate Attributes												**PSO**		
COs	**Course Outcomes (COs)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	Interpret the concepts of Wireless communication and basic cellular networks	3	-	-	3	-	-	-	-	-	-	-	2	-	-	-
CO-2	Analyze different Radio wave propagation models for cellular communication	-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

Part - A **(5 x 1 = 5 Marks)** **Instructions: Answer all Questions**					
Q. No	**Questions**	**Marks**	**BL**	**CO**	**PO**
1	c. Turn 60 deg counter clockwise & Move j cells	**1**	**1**	**1**	**1**
2	b. Reverse Control Channel	**1**	**1**	**1**	**1**
3	b. R $\sqrt{3N}$	**1**	**2**	**1**	**4**
4	c. 6	**1**	**4**	**1**	**4**
5	a.37	**1**	**4**	**1**	**4**
	Part – B **(2 x 4 = 8 Marks)** **Instructions: Answer any two questions**				
6	**Compare blocked call cleared system and blocked call delayed systems** Blocked calls cleared (BCC) or Lost Call Cleared(LCC) or Erlang B systems – The probability of a call being delayed beyond a certain amount of time before being granted access Blocked call delayed or Lost Call Delayed (LCD) or Erlang C systems- Blocked Call Cleared Systems. Queues are used to hold call requests that are initially blocked. When a user attempts a call and a channel is not immediately available, the call request may be delayed until a channel becomes available.	**4**	**3**	**1**	**12**
7	"Hexagonal shape are chosen to be the optimum cell geometry", Ornate the importance of the aforementioned statement A hexagon is a tessellating cell shape in that cells can be laid next to each other	**4**	**3**	**1**	**12**

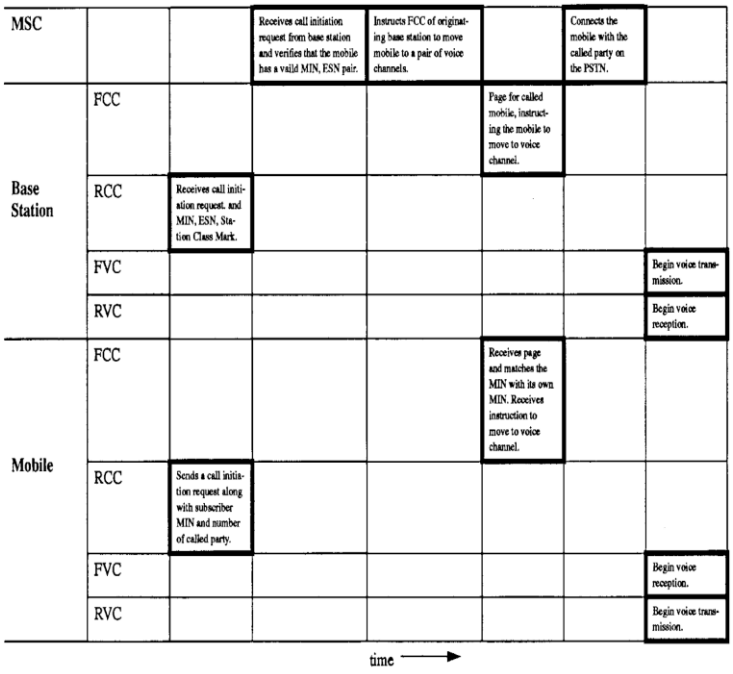
	with no overlap; therefore, they can cover the entire (maximum)geographical region without any gaps. This approximation is frequently employed in planning and analysis of cellular networks. A hexagon layout requires fewer cells to cover a given area. Hence, it envisages fewer base stations and minimum capital investment.				
8	Neatly sketch the handoff strategies employed at cell boundary.  	**4**	**2**	**1**	**1**
	Part – C **(1 x 12 = 12 Marks)** Either or				
9	**a. Consider a cellular system in which total available voice channels to handle the traffic are 900.The area of each cell is 5 km^2 and the total coverage area of the system is 2000 km^2.** **Calculate:** **i. The system capacity if the cluster size N is 4** **ii. The system capacity if the cluster size is 7.** **iii. Does decreasing N increase the system capacity?** Total available channels =900 , Cell area = 5 km^2 Total coverage area = 2000 km^2 a. N = 4 [4 marks] Area of a cluster = 4 × 5 = 20 km^2 M= Number of clusters for covering total area = 2000/20 = 100 Number of channels per cell = K/N = 900/4 = 225 System capacity = 100 × 900 = 90000 channels b. N = 7 [4 marks] Area of cluster = 7 × 5 = 35 km^2 M=Number of clusters for covering total area = 2000/35 = 57.1 ~ 57 Number of channels per cell = K/N = 900/7 = 128.57 ~ 129 System capacity = 57 × 900 = 51300 channels [2 marks] It is evident when we decrease the value of N from 7 to 4, we increase the system capacity from 51,300 to 90,000 channels. Thus, decreasing N increases the system capacity.	10	4	1	4
	a. How the umbrella cell approach reduces the number of handoffs? If high speed user in the large umbrella cell is approaching the base station, and its velocity is rapidly decreasing, the base station may decide to hand the user into the co-located microcell without MSC permission. This approach is basically used to reduce number of hand off for high speed users.	2	2	1	4

Umbrella Cells



or

10 **a. With the aid of a timing diagram, elaborate the call establishment process from a mobile to another mobile user in a cellular environment.** (8 | 1 | 1 | 1)



When a mobile originates a call, a call initiation request is sent on the reverse control channel. With this request the mobile unit transmits its telephone number (MIN), electronic serial number (ESN), and the telephone number of the called party. The mobile also transmits a station class mark (SCM) which indicates what the maximum transmitter power level is for the particular user. The cell base station receives this data and sends it to the MSC. The MSC validates the request, makes connection to the called party through the PSTN, and instructs the base station and mobile user to move to an unused forward and reverse voice channel pair to allow the conversation to begin. The above figure shows the sequence of events involved with connecting a call which is initiated by a mobile user in a cellular system. All cellular systems provide a service called roaming. This allows subscribers to operate in service areas other than the one from which service is subscribed. When a mobile enters a city or geographic area that is different from its home service area, it is registered as a roamer in the new service area. This is accomplished over the FCC, since each roamer is camped on to a FCC at all times. Every several minutes, the MSC issues a global command over each FCC in the system, asking for all mobiles which are previously unregistered to report their MIN and ESN over the RCC. New unregistered mobiles in the system periodically report back their subscriber information upon receiving the registration request, and the MSC then uses the MIN/ESN data to request billing status from the home location register (HLR) for each roaming mobile. If a particular roamer has roaming authorization for billing purposes, the MSC registers the subscriber as a valid roamer. Once registered, roaming mobiles are allowed to receive and place calls from that area, and billing is routed automatically to the subscriber's home service provider.

	b. **How many users can be supported for 0.2% blocking probability for the 10,20 trunked channels in a blocked call cleared system? Assumed that each user generates 0.1 Erlangs of traffic. Refer table**	4	3	1	4

Table Capacity of an Erlang B System

Number of Channels *C*	Capacity (Erlangs) for GOS = 0.01	= 0.005	= 0.002	= 0.001
2	0.153	0.105	0.065	0.046
4	0.869	0.701	0.535	0.439
5	1.36	1.13	0.900	0.762
10	4.46	3.96	3.43	3.09
20	12.0	11.1	10.1	9.41

Given Au=0.1, GOS=0.002, to find U for C=10 [2 marks]
A=3.43
U=A/Au = 3.43/0.1=34 users

Given C=20, GOS=0.002, Au=0.1, [2 marks]
From Table C=5 and GOS=0.002,A=10.1
Total Number of users U=A/Au=10.1/0.1=101 users

Signature of Course Teacher

Signature of the Course Coordinator **Signature of the Academic Advisor**

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CO-1	Interpret the concepts of Wireless communication and basic cellular networks	3	-	-	3	-	-	-	-	-	-	-	2	-	-	-
CO-2	Analyze different Radio wave propagation models for cellular communication	-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

Part - A
(5 x 1 = 5 Marks)
Instructions: Answer all Questions

Q. No	**Questions**	**Marks**	**BL**	**CO**	**PO**
1	Adjacent channel interference can be minimized through_____ a. Changing frequency of base stations b. Careful filtering and channel assignments c. Increasing number of base stations d. Increasing number of control channels	**1**	**1**	**1**	**1**
2	Hard handoff is also known as _____ a. Partial Handoff b. Make before Make c. Break before make d. Make before break	**1**	**1**	**1**	**1**
3	During the handoff process in the cellular system, the margin (Threshold) is given by a. Δ = Pr(HANDOFF) - Pr (MAX. USABLE) b. Δ = Pr(HANDOFF) - Pr (MIN. USABLE) c. Δ = Pr(SAR OF THE MOBILE) - Pr (MIN.USABLE) d. Δ = Pr(CELL) - Pr (BASE STATION)	**1**	**2**	**1**	**4**
4	In hexagonal shaped type of cell with 6 vertices, how many antennas are needed for edge excitation a. 1 b. 6 c. 3 d. 2	**1**	**4**	**1**	**4**

5	What is the Co-Channel reuse value for a cluster size of 7? a. 3 b. 4.58 c. 6 d. 6.24	**1**	**4**	**1**	**4**
	Part – B **(2 x 4 = 8 Marks)** **Instructions: Answer any two questions**				
6	Distinguish between Fixed channel assignment and Dynamic channel assignment in a cellular network.	**4**	**3**	**1**	**12**
7	"Cell splitting increases the capacity of a cellular system:", Justify the statement.	**4**	**3**	**1**	**12**
8	Sketch the various types of handoff scenario in mobile cellular system.	**4**	**2**	**1**	**1**
	Part – C **(1 x 12 = 12 Marks)** Either or				
9	a. If a signal-to-interference ratio of 15 dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity if the path loss exponent is (a) n = 4, (b) n = 3? Assume that there are six co-channel cells in the first tier, and all of them are at the same distance from the mobile. Use suitable approximations. b. For a specific geographic area in cellular concept, how would you calculate the frequency reuse ratio.	10 2	4 2	1 1	4 4
	or				
10	a. With the aid of a timing diagram, elaborate the call establishment process from a Landline to another mobile user in a cellular environment. b. How many users can be supported for 0.5% blocking probability for the 10, 20 trunked channels in a blocked call cleared system? Assumed that each user generates 0.1 Erlangs of traffic. **Refer table**	8 4	1 3	1 1	1 4

Table Capacity of an Erlang B System

Number of Channels *C*	Capacity (Erlangs) for GOS = 0.01	= 0.005	= 0.002	= 0.001
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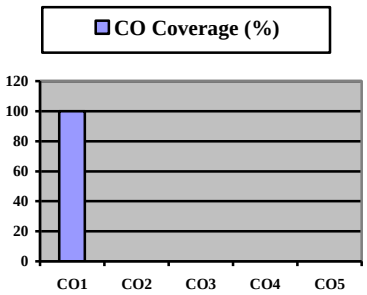
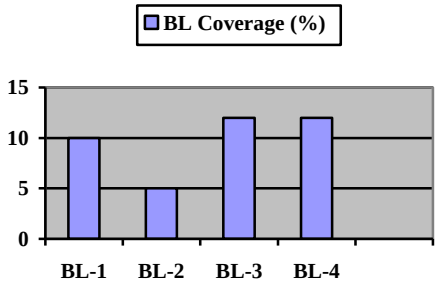
Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Evaluation Sheet

Name of the Student: **Register No.:**

Part- A (5 x 1= 5 Marks)					
Q. No	**CO**	**PO**	**Maximum Marks**	**Marks Obtained**	**Total**
1	1	1	1		
2	1	1	1		
3	1	4	1		
4	1	4	1		
5	1	4	1		
Part- B (2 x 4= 8 Marks)					
6	1	12	4		
7	1	12	4		
8	1	1	4		
Part- B (2 x 4= 8 Marks)					
9a	1	1	10		
9b	1	4	2		
10a	1	1	8		
10b	1	4	4		

Consolidated Marks:

CO	Maximum Marks	Marks Obtained
1	25	
Total		

PO	Maximum Marks	Marks Obtained
1	14	
4	19	
12	8	
Total	41	

Signature of Course Teacher

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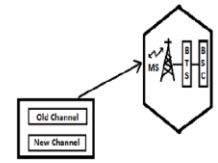
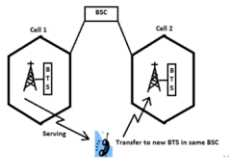
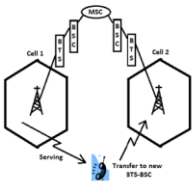
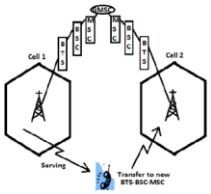
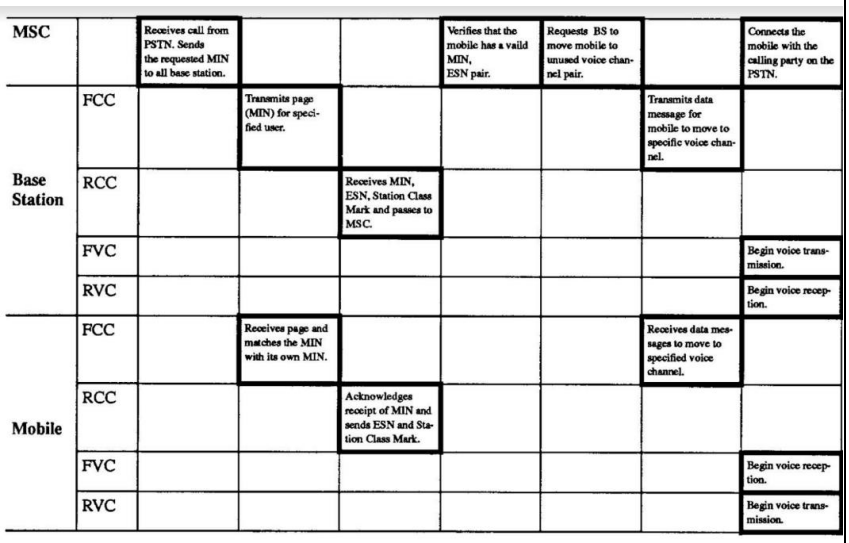
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

Part - A **(5 x 1 = 5 Marks)** **Instructions: Answer all Questions**					
Q. No	**Questions**	**Marks**	**BL**	**CO**	**PO**
1	b. Careful filtering and channel assignments	**1**	**1**	**1**	**1**
2	c. Break before make	**1**	**1**	**1**	**1**
3	b. Δ = Pr(HANDOFF) - Pr (MIN. USABLE)	**1**	**2**	**1**	**4**
4	c. 3	**1**	**4**	**1**	**4**
5	b. 4.58	**1**	**4**	**1**	**4**
	Part – B **(2 x 4 = 8 Marks)** **Instructions: Answer any two questions**				
6	**Distinguish between Fixed channel assignment and Dynamic channel assignment in a cellular network.** Fixed channel assignment [2 marks] • each cell is allocated a predetermined set of voice channel • any new call attempt can only be served by the unused channels • the call will be blocked if all channels in that cell are occupied Dynamic channel assignment [2 marks] • Channels are not allocated to cells permanently. • Allocate channels based on request. • Reduce the likelihood of blocking, increase capacity.	**4**	**3**	**1**	**12**
7	"Cell splitting increases the capacity of a cellular system:", Justify the statement Cell splitting is the process of subdividing a congested cell into smaller cells, each with its own base station and a corresponding reduction in antenna height and transmitter power. Cell splitting increases the capacity of a cellular system since it	**4**	**3**	**1**	**12**

	increases the number of times that channels are reused Area of bigger cell = $A_o = \pi R^2$ Area of smaller cell = $A_N = \pi (R/2)^2 = \pi R^2/4$ $4 A_N = A_o$ or $A_N = A_o/4$ Therefore New Area is ¼ of the older area. As New Area is 1⁄4 of the older area (now one bigger cell include approximately 4 smaller cell), therefore the capacity of system is increased by 4 times.				
8	Sketch the various types of handoff scenario in mobile cellular system.  1) Intra-cell-Intra BSC Handover  2) Inter-cell-Intra BSC Handover  3)Inter-cell-Inter BSC Handover  4) Inter MSC Handover	**4**	**2**	**1**	**1**
	Part – C **(1 x 12 = 12 Marks)** Either or				
9	a. If a signal-to-interference ratio of 15 dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity if the path loss exponent is (a) n = 4, (b) n = 3? Assume that there are six co-channel cells in the first tier, and all of them are at the same distance from the mobile. Use suitable approximations. (a) $n = 4$ [5 marks] First, let us consider a 7-cell reuse pattern. Using equation (2.4), the co-channel reuse ratio $D/R = 4.583$. Using equation (2.9), the signal-to-noise interference ratio is given by $S/I = (1/6) \times (4.583)^4 = 75.3 = 18.66$ dB. Since this is greater than the minimum required S/I, $N = 7$ can be used. (b) $n = 3$ [5 marks] First, let us consider a 7-cell reuse pattern. Using equation (2.9), the signal-to-interference ratio is given by $S/I = (1/6) \times (4.583)^3 = 16.04 = 12.05$ dB. Since this is less than the minimum required S/I, we need to use a larger N. Using equation (2.3), the next possible value of N is 12, ($i = j = 2$). The corresponding co-channel ratio is given by equation (2.4) as $D/R = 6.0$. Using equation (2.3) the signal-to-interference ratio is given by $S/I = (1/6) \times (6)^3 = 36 = 15.56$ dB. Since this is greater than the minimum required S/I, $N = 12$ can be used.	10 2	4 2	1 1	4 4
	b. For a specific geographic area in cellular concept, how would you calculate the frequency reuse ratio. d = distance b/w centre of two adjacent cells, R = Radius of cell D = Minimum distance b/w centre of cells that use same channels or frequency band (co-channels) N= number of cells in a cluster Frequency reuse distance: $D^2 = 3R2\ (i2 + j2 + i.j)$ $D^2 = 3R2\ .N$ $D = (3N)^{1/2}.\ R$ or $D/R = (3N)^{1/2}$ As $d = 3^{1/2}.R$ $D/d = (N)^{1/2}$				

				or							
10	a.	With the aid of a timing diagram, elaborate the call establishment process from a Landline to another mobile user in a cellular environment.							8	1	1	1



The mobile switching centre (MSC) dispatches the request to all base station in a cellular system.
The Mobile Identification Number (MIN) which is subscriber telephone number is then broadcast as a paging message over all of the forward control channels throughout the cellular system.
The mobile receives the paging message sent by BS which s monitors, and responds by identifying itself over the RCC.
The BS relays the acknowledgement sent by the mobile and informs the MSC of handshake.
The MSC instructs the BS to move the call to an unused voice channel pair within the cell.
The BS signals the mobile to change frequencies to an unused forward and reverse voice channel pair.
Another data message is transmitted on forward channel to instruct the mobile telephone to ring and mobile user to answer the phone.

b. **How many users can be supported for 0.5% blocking probability for the 10 , 20 trunked channels in a blocked call cleared system? Assumed that each user generates 0.1 Erlangs of traffic. Refer table**

Table Capacity of an Erlang B System

Number of Channels *C*	Capacity (Erlangs) for GOS = 0.01	= 0.005	= 0.002	= 0.001
2	0.153	0.105	0.065	0.046
4	0.869	0.701	0.535	0.439
5	1.36	1.13	0.900	0.762
10	4.46	3.96	3.43	3.09
20	12.0	11.1	10.1	9.41

4 3 1 4

Given C=10, GOS=0.005, Au=0.1, [2 marks]
From Table C=5 and GOS=0.005,A=3.96
Total Number of users U=A/Au=3.96/0.1=39 users

Given Au=0.1, GOS=0.005, to find U for C=20 [2 marks]
A=11.1
U=A/Au = 11.1/0.1 =110 users

Signature of Course Teacher

Signature of the Course Coordinator **Signature of the Academic Advisor**