MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

Estd. 2000

IQAC

MUST KNOW CONCEPTS

MKC

ECE

2021-22

Subject		19ECE14 & WIRELESS COMMUNICATION		
Unit I		Introduction to Wireless Communication		
S.No	**Term**	**Notation (Symbol)**	**Concept/Definition/Meaning/Units/ Equation/Expression**	**Units**
1	Types of mobile radio transmission systems	-	• Simplex • Half- duplex • Full - duplex	-
2	Simplex	-	A communication channel that sends information in one direction only. That is In simplex mode, Sender can send the data but that sender can't receive the data.	-
3	Half- duplex	-	Half duplex mode is a two-way directional communication but one at a time.	-
4	Full - duplex	-	Full duplex mode is a two-way directional communication simultaneousl y.	-
5	Base station	-	A Fixed station in a mobile radio communication with mobile station. Base stations are located at the center or on the edge of a coverage region and consist of radio channels and Transmitter and receiver antennas mounted on a tower	-
6	Control channel	-	Radio channels used for transmission of call setup, call request, call initiation and control purpose.	-
7	Forward Channel	-	Radio channels used for transmission of information from the base station to the mobile	
8	Handoff	-	The process of transferring a mobile station form one channel or base station to another	-

9	M S		A mobile station in the cellular radio service intended for use while in motion at unspecified locations. Mobile stations may be hand held personal units	
10	MSC		Mobile Switching Center which coordinates the routing of calls in a large service area.	
11	Reverse Channel		Radio channel used for transmission of information from the mobile to the base station.	
12	Subscriber		A user who pays subscription charges for using a mobile communication system	
13	Transceiver		A device capable of simultaneously transmitting and receiving radio signals.	
14	Frequency Reuse		The design process of selecting and allocating channel groups for all of the cellular base station within a system.	
15	Total number of available radio channel		S = kN, Where N – Cells, k- Channels	
16	Cluster		The N cells which collectively use the complete set of available frequencies.	
17	Channel assignment		• Fixed channel assignment • Dynamic channel assignment	
18	Dwell time		The time over which a call may be maintained within a cell, without handoff.	
19	Cell dragging		The practical handoff problem in microcell system	
20	LOS		Line of sight, the radio path between the subscriber and the base station	
21	Interference		the interference another mobile in the same cell, a call in progress in a neighboring cell, other base station operating in the same frequency band	

22	Trunking		It is a technique which allows a large number of users to share the relatively small number of channels in a cell by providing access to each user, on demand, from a pool of available channels	-
23	Holding Time		Average duration of a typical call. Denoted by H	
24	Traffic Intensity		Measure of channel time utilization, which is the average channel occupancy measure in Erlangs.	
25	GOS		• The Grade of service (GOS) is a measure of ability of mobile subscriber to access a cellular system during the busiest hour. • GOS is typically specified as the probability that a cell is blocked, or the probability of a call experiencing a delay greater than the predefined queuing time.	
Unit II Mobile Radio Propagation				
26	Free Space Propagation Model		The free space propagation model is used to predict received signal strength. when the transmitter and receiver have a clear, unobstructed line-of-sight path between them.	
27	Friis free space equation,		$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$	
28	Effective isotropic radiated power		$EIRP = P_t G_t$	
29	The path loss for the free space model when antenna gains are included is		$PL\,(\text{dB}) = 10\log\frac{P_t}{P_r} = -10\log\left[\frac{G_t G_r \lambda^2}{(4\pi)^2 d^2}\right]$	
30	Free space, the power flux density Pd		$P_d = \frac{EIRP}{4\pi d^2} = \frac{P_t G_t}{4\pi d^2} = \frac{E^2}{R_{fs}} = \frac{E^2}{\eta}$ W/m^2	
31	The Three Basic Propagation Mechanisms		• Reflection • Diffraction • Scattering	

32	Fresnel reflection coefficient		It is a function of the material properties and generally depends on the wave polarization and the frequency of the propagating wave.	
33	Reflection from Perfect Conductors		$\theta_i = \theta_r$	
34	Brewster Angle		The Brewster angle is the angle at which no reflection occurs in the medium of origin. • $\sin(\theta_B) = \sqrt{\frac{\varepsilon_1}{\varepsilon_1 + \varepsilon_2}}$	
35	Ground Reflection (2-ray) Model		The 2-ray ground reflection model Propagation model that is based on geometric optics, and considers both the direct path and a ground reflected propagation path between transmitter and receiver.	
36	Parameters of Mobile Multipath Channels		• Time Dispersion Parameters • Coherence Bandwidth • Doppler Spread and Coherence Time	
37	Types of Small-Scale Fading		• Small-Scale Fading • (Based on multipath time delay spread) • Small-Scale Fading • (Based on Doppler spread) • Fast Fading • Slow Fading • Flat Fading • Frequency Selective Fading	
38	Fast Fading		• High Doppler spread • Coherence time c Symbol period • Channel variations faster than base- band signal variations	
39	Slow Fading		• Low Doppler spread • Coherence time> Symbol period • Channel variations slower than • baseband signal variations	
40	Practical Link Budget design using path loss model		• Log distance Path Loss Model • Log Normal Shadowing • Determination of Percentage of Coverage Area	
41	Outdoor Propagation Models		• Longley-RIce Model • Durkin's Model • Okumura's model • Hata model • PCS Extension to Hata Model • Walfisch and Bertoni Model	

			• Wldeband PCS Microcell Model	
42	Indoor Propagation Models		• Partition Losses (same floor) • Partition Losses between Floors • Log-distance Path Loss Model • Ericsson Multiple Breakpoint Model • Attenuation Factor Model	
43	Signal Penetration into Buildings		The signal strength received inside of a building due to an external transmitter is important for wireless systems that share frequencies with neighboring buildings or with outdoor systems.	
44	Small-Scale Fading effects.		Most important effects are: • Rapid changes in signal strength over a small travel distance or time interval • Random frequency modulation due to varying Doppler shifts on different multipath signals • Time dispersion (echoes) caused by multipath propagation delays.	
45	Slow fading channel		If the baseband signal bandwidth is much greater than BD, the effects of Doppler spread are negligible at the receiver. This is a slow fading channel	
46	The average received power over a local area		$E_{a,\theta}[P_{CW}] \approx \sum_{i=0}^{N-1} \overline{a_i^2} + 2\sum_{i=0}^{N-1}\sum_{i,j\neq i}^{N} r_{ij}\,\overline{\cos(\theta_i - \theta_j)}$	
47	Factors Influencing Small-Scale Fading		• Multipath propagation • Speed of mobile • Speed of surrounding objects • The transmission bandwidth of the signal	
48	Doppler Shift		the Doppler shift to the mobile velocity and the spatial angle between the direction of motion of the mobile and the direction of arrival of the wave.	
49	Relationship between Doppler spread and coherence time		The Doppler spread and coherence time are Inversely proportional to one another. $T_C \approx \frac{1}{f_m}$	
50	Small-Scale Multipath Measurements		• Direct RF Pulse System • Spread Spectrum Sliding Correlator Channel Sounding • Frequency Domain Channel Sounding	

Unit III	**Fading and design parameters of Base and Mobile Station**			
51	Important effects of small-scale fading effects.		• Rapid changes in signal strength over a small travel distance or time interval. • Random frequency modulation due to varying Doppler shifts on different multipath signals. • Time dispersion caused by multipath propagation delays.	
52	Factors Influencing small scale fading		• Multipath propagation. • Speed of the mobile. • Speed of surrounding objects. • The transmission bandwidth of the signal	
53	Diversity technique concept		The simple concept of diversity is that even if a radio signal path experiences a deep face, there will be another independent signal path available for analysis.	
54	Types of fading		• Small-scale fading • Large-scale fading	
55	Small scale Multipath Measurements Techniques		• Direct pulse measurement • Spread spectrum sliding correlator measurement • Swept frequency measurements	
56	Direct pulse measurement		This technique to determine rapidly power delay profile of and channel	
57	Spread spectrum channel sounder		A carrier signal is spread over large bandwidth by mixing it with a binary pseudo –noise (PN) Sequence having a chip duration Tc and chip rate Rc	
58	Advantage of a spread spectrum system		• Cross-talk elimination • Better output with data integrity • Reduced effect of multipath fading • Better security • Reduction in noise • Co-existence with other systems • Longer operative distances • Hard to detect • Not easy to demodulate/decode • Difficult to jam the signals	
59	Processing gain		$PG = \frac{2R_c}{R_{bb}} = \frac{2\tau_{bb}}{T_c} = \frac{(S/N)_{out}}{(S/N)_{in}}$	

60	Actual Propagation Time		$\text{Actual Propagation Time} = \frac{\text{Observed Time}}{\gamma}$	
61	Disadvantage of the spread spectrum		• Increased complexity needs synchronization between Transmitter & Receiver • Large Bandwidth	
62	Small scale fading		It is used to describe the rapid fluctuation of the amplitude of a radio signal over a short period of time or travel distance	
63	Parameters of mobile multipath channels		• Time Dispersion parameters • Coherence Bandwidth • Doppler Spread • Coherence Time	
64	Time Dispersion parameters		• Mean excess delay, • RMS delay spread, and • Excess delay spread	
65	Coherence Bandwidth		It is a statistical measure of the range of frequency over which the channel can be considered "flat"	
66	Doppler Spread		The range of frequency over which the received Doppler spectrum is essentially non zero. The components range f_c-f_d to f_c+f_d where, f_c transmitted frequency and f_d is Doppler shift	
67	Coherence Time		Coherence time is the time duration over which the channel impulse response is considered to be not varying.	
68	Types of Small Scale Fading		• Based on multipath time delay spread(Small Scale Fading) • Based on Doppler spread(Small Scale Fading)	
69	Based on multipath time delay spread		• Flat Fading • Frequency Selective Fading	
70	Multipath time delay spread(Flat Fading)		• BW of signal < BW of Channel • Delay spread < Symbol period	
71	Multipath time delay spread(Frequency Selective Fading)		• BW of signal > BW of Channel • Delay spread > Symbol period	
72	Based on Doppler spread		• Flat Fading • Slow Fading	

73	Doppler spread(Flat Fading)		• High Doppler Spread • Coherence time < Symbol period • Channel variations faster than baseband signal variations	
74	Doppler spread(Slow Fading)		• low Doppler Spread • Coherence time > Symbol period • Channel variations slower than baseband signal variations	
75	Rayleigh Fading Distribution.		It is commonly used to describe the statistical time varying nature of the received envelope of a flat fading signal or the envelope of an individual multipath component.	
Unit IV Multiple Access Schemes				
76	Techniques used to improve the received signal quality		• Equalization • Diversity • Channel coding	
77	Equalization		Equalization is used to compensate the inter symbol interference created by multipath within time dispersive channel.	
78	Various non linear equalization methods		• Decision feedback equalization. • Maximum likelihood symbol detection • Maximum likelihood sequence estimation	
79	Various linear equalization methods		• Transversal • Lattice	
80	Adaptive equalizer		The equalizer which tracks the time varying characteristics of mobile channel is known as adaptive equalizer.	
81	Mode of Adaptive equalizer		• Training • Tracking	
82	Linear Equalizer		Output of the decision maker is not used in the feedback path to adapt the equalizer	
83	Non-linear Equalizer		Output of the decision maker is used in the feedback path to adapt the equalizer	
84	Algorithm for adaptive equalization		• Constant Modulus algorithm • Spectral coherence restoral algorithm	

85	Algorithm used for LTE		• Zero forcing algorithm. • LMS algorithm • RLS algorithm. • Fast RLS • Square root RLS	
86	Zero forcing algorithm		Which applies the inverse of the frequency response of the channel. To eliminate the inter symbol interference at decision time instants	
87	LMS algorithm		Least Mean Squares algorithm is steepest descent and it is meant for convergence towards Minimum Mean Square Error(MMSE)	
88	RLS algorithm		Recursive Least Squares Algorithm is faster convergence, but is computationally more complex than LMS	
89	DFE		Decision Feedback Equalization consists of feed forward filter (FFF) and feedback filter (FBF). The FBF is driven by decisions on the output of the detector, and its coefficients can be adjusted to cancel the ISI on the current symbol from past detected symbols.	
90	Use of Decision Feedback Equalization		The DFE is particularly is useful for the channel with severe amplitude distortion and has been widely used in wireless communications.	
91	MLSE		Maximum likelihood sequence estimation (MLSE) which entails making measurement of channel impulse response and then providing a means for adjusting the receiver to the transmission environment.	
92	Diversity		Diversity is used to compensate the fading channel impairments and is usually implemented by using two or more receiving antennas.	
93	Macro diversity		It is a kind of space diversity scheme using several antennas or transmitter antennas for transferring the same signals. The distance between the transmitters is longer than the wavelength.	
94	Types of Diversity		• Frequency Diversity • Time Diversity • Polarization diversity • Angle Diversity • Space Diversity	
95	Frequency Diversity		The same information signal is transmitted on different carriers, the frequency separation between them being at least the coherence bandwidth.	
96	Time Diversity		• The information signal is transmitted repeatedly in time at regularly	

			intervals. • The separation between the transmit times should be greater than the coherence time, Tc. • The time interval depends on the fading rate, and increases with the decrease in the rate of fading.	
97	Polarization diversity		The electric and magnetic fields of the signal carrying the information are modified and many such signals are used to send the same information. Thus, orthogonal type of polarization is obtained.	
98	Angle Diversity		Directional antennas are used to create independent copies of the transmitted signal over multiple paths.	
99	Space Diversity		It is also known as antenna diversity. It consists of an elevated base station antenna and a mobile antenna closed to the ground.	
100	Classification of Space Diversity		• Selection diversity • Feedback diversity • Maximal ratio combining • Equal gain diversity	
Unit V Wireless Systems and Standards				
101	AMPS		• Advanced Mobile Phone Service (AMPS) is a standard system for analog signal cellular telephone service in the United States and is also used in other countries. • It is a 1G system	
102	CDMA 2000		• CDMA2000 is a multi-carrier code-division multiple access version of IMT-2000 standard • It is a 3Gwireless technology	
103	GSM		• **G**lobal **S**ystem for **M**obile Communication. It is a digital cellular technology used for transmitting mobile voice and data service • a globally accepted standard for digital cellular communication • uses narrowband Time Division Multiple Access (TDMA) for providing voice and text based services over mobile phone networks.	
104	Why GSM		• Improved spectrum efficiency • International roaming • Low-cost mobile sets and base stations (BSs) • High-quality speech	

			• Compatibility with Integrated Services Digital Network (ISDN) and other telephone company services • Support for new services	
105	Functional units in GSM		• The Mobile Station (MS) • The Base Station Subsystem (BSS) • The Network Switching Subsystem (NSS) • The Operation Support Subsystem (OSS	
106	Modulation used in GSM		Gaussian Minimum Shift Keying (GMSK) modulation	
107	IMEI		International Mobile Station Equipment Identity	
108	Parts of IMEI		• **Type Approval Code (TAC)** : 6 decimal places, centrally assigned. • **Final Assembly Code (FAC)** : 6 decimal places, assigned by the manufacturer. • **Serial Number (SNR)** : 6 decimal places, assigned by the manufacturer. • **Spare (SP)** : 1 decimal place.	
109	IMSI		International Mobile Subscriber Identity	
110	Parts of IMSI		• **Mobile Country Code (MCC)** : 3 decimal places, internationally standardized. • **Mobile Network Code (MNC)** : 2 decimal places, for unique identification of mobile network within the country. • **Mobile Subscriber Identification Number (MSIN)** : Maximum 10 decimal places, identification number of the subscriber in the home mobile network.	
111	MSRN		Mobile Station Roaming Number	
112	Structure of MSRN		• **Country Code (CC)** : of the visited network. • **National Destination Code (NDC)** : of the visited network. • **Subscriber Number (SN)** : in the current mobile network.	

113	TMSI, LMSI CI		Temporary Mobile Subscriber Identity Local Mobile Subscriber Identity Call Identifier	
114	Categories of Mobile services		• Bearer services • Tele services • Supplementary services	
115	Subsystems in GSM system		• Radio subsystem (RSS) • Network & Switching subsystem (NSS) • Operation subsystem (OSS)	
116	Control channel groups in GSM		• Broadcast control channel (BCCH) • Common control channel (CCCH) • Dedicated control channel (DCCH)	
117	Interfaces used in the GSM		• GSM radio air interface • Abis interface • A interface	
118	OFDM		Orthogonal frequency-division multiplexing (OFDM) is a method of digital signal modulation in which a single data stream is split across several separate narrowband channels at different frequencies to reduce interference and crosstalk.	
119	Forward CDMA channel		The Forward CDMA channel is the cell-to-mobile direction of communication or the downlink path.	
120	Reverse CDMA channel		The Reverse CDMA channel is the mobile-to-cell direction of communication or the uplink path.	
121	Conferencing		It allows a mobile subscriber to establish a multiparty conversation, i.e., a simultaneous conversation between three or more subscribers to setup a conference call.	
122	Call Barring		Call Barring is useful to restrict certain types of outgoing calls such as ISD or stop incoming calls from undesired numbers.	
123	Call forwarding		Call Forwarding is used to divert calls from the original recipient to another number.	
124	Call hold		This service allows a subscriber to put an incoming call on hold and resume after a while.	

125	Call Waiting		• This service notifies a mobile subscriber of an incoming call during a conversation. • The subscriber can answer, reject, or ignore the incoming call.	
Placement Questions				
126	Flat Fading		1. BW of signal <BW of channel 2. Delay spread <Symbol period	
127	Frequency Selective Fading		1. BW of signal > SW of channel 2. Delay spread> Symbol period	
128	Standard for Bluetooth and other Personal Area Networks (PAN)		IEEE 802.15	
129	Different Types of Transmission Impairment		• Attenuation. • Noise. • Delay Distortion.	
130	Difference Between 3G and 4G		• 3G stands for 3rd generation as it is just that in terms of the evolutionary path of the mobile phone industry. 4G means 4th generation. This is a set of standard that is being developed as a future successor of 3G in the very near future. • 4G speeds are meant to exceed that of 3G. • 3G uses the technique of circuit switching while 4G uses the technique of packet switching.	
131	3G		• 3G, known as 3rd Generation, is a standard for mobile / cellular phones. It provides the services that fulfill the International Telecommunication Union specifications.	
132	RAKE receiver		Reduces the multipath interference by combining direct and reflected signals in the receiver	
133	3G standards		• UMTS - Universal Mobile Telecommunications System • CDMA 2000	
134	How is 3G different from 2G?		Packet data speed is higher in 3G, and it is up to 384 KBPS	

135	EDGE		• EDGE is an acronym for Enhanced Data GSM Environment • An improved wireless technology over GSM • A 2nd generation cell phone technology	
136	WiMax		• It is a protocol designed to provide an extension to wireless communication • It provides wireless communication at a distance of around 50kms.	
137	Advantages of WiMax		• Relatively higher data rates compared to 3G or such mobile standards • Wireless communication across city • Data rates comparable to cable or DSL connection • Lower cost of deployment • Much faster installation	
138	GPRS		• Short form of General Packet Radio System. • GPRS is the next generation of GSM, and the basis of the 3G networks. • A packet-oriented data service available to users of GSM	
139	Bluetooth		• Bluetooth is a wireless technology standard used to exchange data over short distances.	
140	IS-95		• a CDMA standard of second generation network	
141	Modulation technique is used by EDGE		8-PSK	
142	Disadvantage of EDGE in comparison to HSCSD and GPRS		Small coverage range	
143	IMT 2000		the term used by ITU for a set of global standards of 3G systems	
144	Multiple access technique used in UMTS		CDMA	
145	Standard of WLAN		HIPER-LAN HIPERLAN/2 IEEE 802.11b	
146	WLAN standard named as Wi-Fi		DSSS IEEE 802.11b	
147	DSSS IEEE 802.11b		High Performance Radio Local Area Network	

148	Nominal range of Bluetooth		10m	
149	Bluetooth operates in which band		2.4 GHz ISM Band	
150	Modulation scheme is used by Bluetooth		GFSK - Gaussian Frequency Shift Keying	

Faculty Team Prepared	1. Mrs.V.Hema, AP / ECE 2. Mr.S.Bhoopalan, AP / ECE 3. Mrs.S.Punitha, AP/ECE	1. Signatures: 2. 3.

HoD