

Program Name : Electronics Engineering Programme Group
Program Code : DE/EJ/ET/EN/EX/EQ
Semester : Fifth
Course Title : Mobile and Wireless Communication
Course Code : 22533

1. RATIONALE

In this world of connectivity and collaborative work environment, it is necessary to connect to the network from anywhere, with anybody, at anytime. Wireless communication provides connectivity with mobility, flexibility and convenience. Wireless devices are used across the various industries like Healthcare, Education, Automation, Renewable energy sector, Automobile etc. Effective use of Social networking has become possible due to high end wireless devices. This course will help the students to develop skills to handle wireless and mobile communication systems.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain mobile communication systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above-mentioned competency:

- Troubleshoot mobile handsets.
- Assess cellular systems capacity.
- Assess performance of standards of different cellular mobile systems.
- Select relevant wireless technology suitable for various applications.
- Test the performance of various wireless protocols.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
Max	Min	Max	Min		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit
 ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)



This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

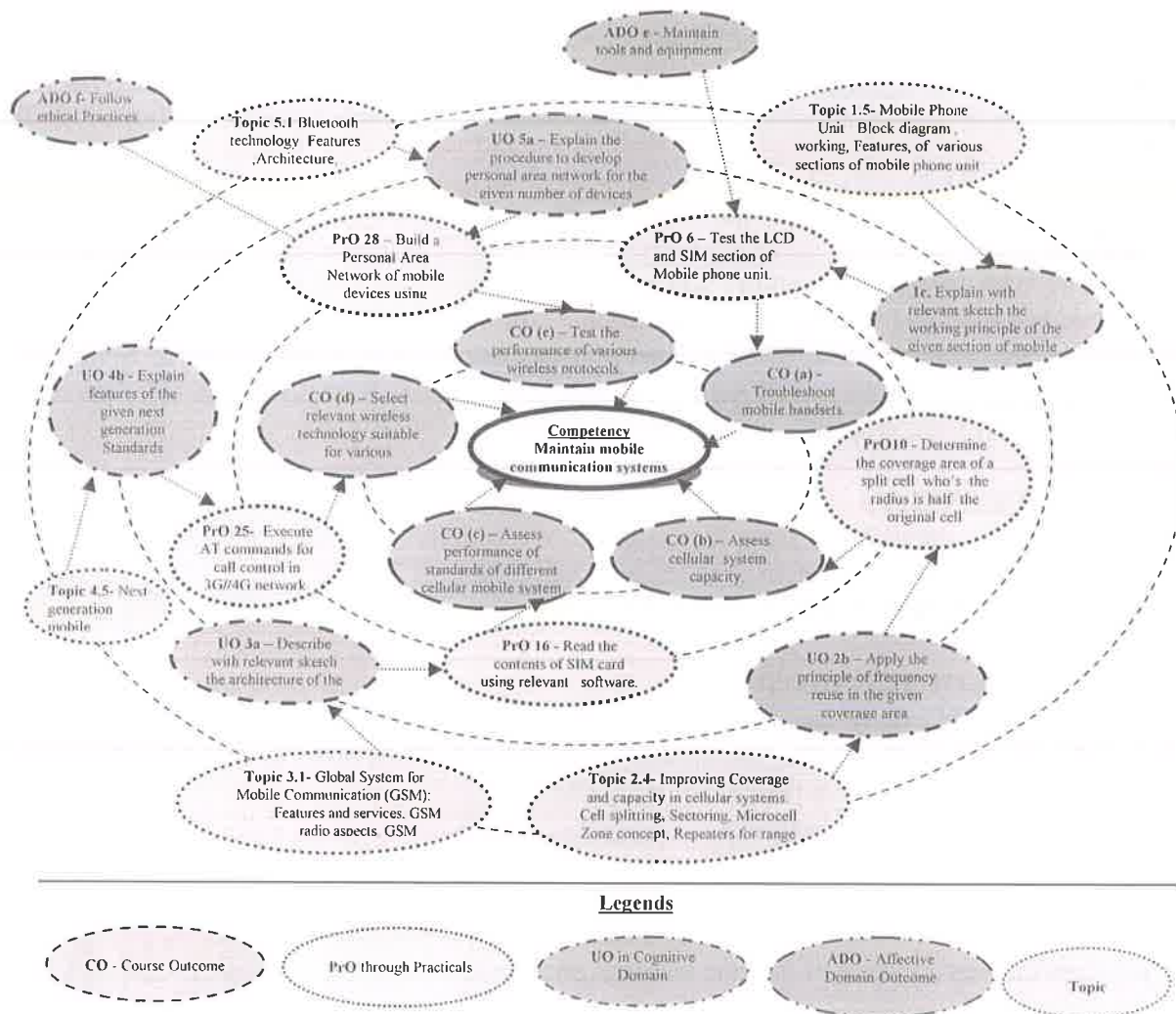


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify different sections and components of mobile phone such as ringer section, dialer section, receiver section and transmitter section, camera, microphone, speaker, flash light.	1	02*
2	Identify the inbuilt sensors of mobile handset and test their performance.	1	02
3	Perform cold test of different sections of mobile phone unit.	1	02*
4	Test the supply of the Transmitter /Receiver section of mobile phone unit.	1	02*
5	Test the Battery charger section and power management unit of	1	02



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	mobile phone unit.		
6	Test the LCD and SIM section of mobile phone unit.	I	02
7	Test the user Interface section (Keyboard Buzzer, Vibrator, LED, Mic, and Speaker) of Mobile phone unit.	I	02*
8	Troubleshoot the Battery charger section, LCD section and SIM card section of the mobile handset.	I	02*
9	Troubleshoot the speaker problem, Ringer problem, Microphone problem, vibrator problem (User Interface section).	I	02
10	Determine the coverage area of a split cell which has radius half the radius of original cell.	II	02*
11	Determine the channel capacity of a cellular system service area comprised of 4/7/12 microcells with 8/12/16 channels per microcell.	II	02*
12	Determine the channel capacity if each microcell in the above lab exercise split into 4 minicells and each minicell is further split into 4 microcells.	II	02
13	For the 7- cell cluster and 168-voice channels cellular system, determine the assignment of voice channel to each cell if Omni-directional antenna is used at the cell site.	II	02*
14	For the 7- cell cluster, 168-voice channels cellular system, determine the assignment of voice channel to each sector if 3-sector 120 ⁰ and 6 -sector 60 ⁰ directional antenna are used at the cell site.	II	02*
15	Perform installation, registration, activation and authentication of mobile applications on mobile handset.	III,IV	02
16	Read/Retrieve the contents of SIM card using relevant software.	III,IV	02*
17	Execute call control commands using relevant software.	III,IV	02*
18	Execute Network service commands using relevant software.	III,IV	02
19	Execute Security commands using relevant software.	III,IV	02
20	Execute Phone book commands using relevant software.	III,IV	02*
21	Execute Short message commands using relevant software.	III,IV	02*
22	Execute Data commands using relevant software.	III,IV	02
23	Execute Specific AT commands using relevant software.	III,IV	02
24	Execute AT commands for call control in 3G/4G network.	IV	02*
25	Execute AT commands for Video call and Phone camera related commands in 3G/4G network.	IV	02
26	Execute AT commands for Microphone and Loudspeaker volume control related commands in 3G/4G network.	IV	02
27	Build a Personal Area Network of mobile devices using Bluetooth.	V	02*
28	Test the hard reset function, hotspot and other networking functions of the given smart phone.	V	02
	Total		56

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 24 or more practicals need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student



reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		100

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Practice energy conservation.
- d. Work as a leader/a team member.
- e. Follow ethical Practices.

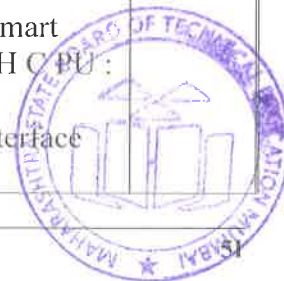
The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No	Equipment Name with Broad Specifications	PrO. No.
1	Mobile Phone Trainer kit: Cellular System : EGSM/GSM 900/ 1800 MHz (3GDualband), Rx frequency band (Downlink): EGSM 900 : 925-960 MHz GSM 900 : 935- 960 MHz GSM 1800 : 1805-1880MHz Tx frequency band (Uplink) : EGSM 900 : 880- 890MHz GSM 900 : 890- 915 MHz GSM 1800 : 1710-1785MHz Output power : +5 ,+33 dBm / 3.2 mW , Channel spacing : 200 KHz Display : TFT, 256 K colours,128X 160 Pixels, 2.0", SIM support : Smart Dual SIM, Dual stand by (both GSM), Battery type : Li-Ion 1000m AH CPU : 208 MHz, Sound : Speaker and Earphone Jack (3.5 mm) On board sections : Keypad, Dual SIM, Charging.Circuit, Clock, User interface such as Buzzer,Vibrator, LEDs. Test points: 50 nos. (Gold plated)	1,2 to 8,



S. No	Equipment Name with Broad Specifications	PrO. No.
	Features that can be set :Screen savers, Ring tones, Logos, SMS	
2	3G GSM Mobile Phone trainer: GSM capability: GSM 900 /1800, E-GSM GSM data services: Asynchronous, Transparent & Non Transparent modes. 14.4 K bits/s, SIM Interface : 3 V RF , Transmitter : Maximum output power : 33 dBm +/- 23dB,(EGSM) Maximum output power : 30 dBm +/- 2 dB (DCS) Minimum output power : 5 dBm +/- 5 dB (EGSM) Minimum output power : 0 dBm +/- 5 dB (DCS1800)	2,4,5,6
3	Spectrum Analyzer: 9Khz to 1.5 GHz frequency range, Typical 135dBm Displayed average noise level(DANL) 80dBc/Hz @ 10KHz offset, phase noise Total amplitude Uncertainty < 1.5dB, 100Hz Minimum Resolution Bandwidth (RBW), Frequency Resolution 1Hz, Frequency span range 0 Hz, 100 Hz to maximum Frequency of instrument, Video bandwidth (-3db) 1Hz to 3 MHz in 1-3-10 sequence	2 to 08
4	Digital Multimeter (¾ Digital Multimeter): 4000 counts large LCD display with auto/manual range, No Power OFF under natural operation ,Data Hold, Max/Min value Hold Capacitance, Frequency/Duty Cycle	2 to 8
5	CRO: Bandwidth : DC-30 MHz (-3 dB)] Rise time : 12 ns approx Accuracy : ± 3 % Input Impedance : 1 MΩ 30 pF approx Sensitivity : Internal 5 mm, Ext 0.8 V approx Deflection coefficients : Micro-controller based 12 calibrated steps 5mV/Div – 20V/Div 1-2-5 sequence X-Y mode : Component Testing	2to 8
6	Digital Storage Oscilloscope : 100 MHz with 64K color TFT, 16kbps memory, FFT function, alternate triggering, Roll Mode, Math Function, digital filter, waveform recorder,20 automatic measurements, Standard USB host, USB device with waveform analysis software	2to 12
7	SIM Card Reader: Trainer for SIM card reader, USB SIM card reader, store, read and save the SIM card data	2 to 09
8	Fast Battery charger: 5 to 20 V,100W,1Amp or 2 Amp.	8 to 09
9	Mobile handset Tools:- Tools to repair any smart phone or mobile phone include - soldering iron, soldering station, solder wire, solder paste, liquid flux, paste flux, jumper wire, tweezers, screwdriver, multimeter, dc power supply, ESD-Safe antistatic wrist strap, mat, apron, hand gloves, LCD tester, Battery tester, PCB holder, PCB Cleaner	2 to 09
10	Computer system with 3G/4G modem	14 to 27

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.



Unit	Unit Outcomes (Uos) (in cognitive domain)	Topics and Sub-topics
Unit– I Wireless Communication System	1a. Explain the features of the given mobile radio standards. 1b. Describe with relevant sketch the working of the specified application of the mobile/ fixed wireless communication system. 1c. Explain with relevant sketch the working principle of the given section of mobile handset unit. 1d. Describe with relevant sketch the working of the given fixed wireless network system. 1e. Describe step-by-step trouble shooting procedure for the given section of mobile phone.	1.1 Wireless network generations 1.2 Mobile Radio standards- AMPS, N-AMPS, IS -95, GSM, UMTS, CDMA 2000 1.3 Mobile wireless systems : Cordless Telephone system and Cellular telephone system 1.4 Fixed wireless networks : Wireless Local Loop (WLL) & Local Multipoint Distribution System (LMDS) 1.5 Mobile Phone Unit : Block diagram , working, features, of transmitter, and receiver section, Frequency Synthesizer, Control unit and Logic Unit of Mobile phone, sensors: speakers, camera, touch screen, motion sensors and other common sensors
Unit– II Fundamentals of Cellular System	2a. Explain the given terms, with respect to Cellular systems. 2b. Apply the principle of frequency reuse for the given coverage area. 2c. Choose the handoff mechanism for the given situation with justification. 2d. Explain the effect of the given interference on cellular system performance. 2e. Select the relevant method to improve coverage and system capacity of the given cellular system with justification. 2f. Calculate number of traffic channels and control channels for the given frequency spectrum and the given frequency reuse ratio.	2.1 Cellular concept fundamentals: Cell, cell structure, Cluster, Reuse factor, minimum reuse distance, basic cellular system : mobile station, base station, Traffic channel (Forward and Reverse) , Control channel (Forward and Reverse), Frequency reuse, channel assignment strategies 2.2 Handoff strategies: Concept of handoff, Types of Handoffs: Hard, Soft, Queued, delayed, MAHO (Mobile Assisted Handoff) , Proper and Improper Handoff, Umbrella cell approach 2.3 Interference and system capacity: Co-Channel interference, Adjacent Channel Interference, Channel Planning for wireless systems 2.4 Improving Coverage and capacity in cellular systems: Cell splitting, Sectoring, Microcell Zone concept, Repeaters for range extension
Unit-III Digital Cellular Mobile Standards	3a. Describe with relevant sketch the architecture of the given 3G cellular standard. 3b. Explain features, of the given mobile communication standard. 3c. Describe with relevant sketch call	3.1 Global System for Mobile Communication (GSM): Features and services, GSM radio aspects, GSM architecture, GSM channel types, Security aspects 3.2 GSM call routing : Mobile terminated call and mobile

Unit	Unit Outcomes (Uos) (in cognitive domain)	Topics and Sub-topics
	<p>processing stages in the given cellular standard.</p> <p>3d. Describe with relevant sketch the layered architecture of the given SS7 protocol.</p> <p>3e. Explain the features of the services and performance of the given type of signaling system.</p>	<p>originated call sequence , stages of call processing in GSM</p> <p>3.3 IS-95/CDMA One: features, Radio aspects, comparison with GSM standards</p> <p>3.4 Signaling System No.7 (SS7): Network services part(NSP) , Message transfer Part (MTP), Signaling Correction Control part (SCCP), Services and performance of SS7</p>
Unit –IV Advance Wireless Standards	<p>4a. Explain compatibility requirements of the given wireless standard.</p> <p>4b. Explain features of the given next generation wireless standard.</p> <p>4c. Describe with relevant sketch the functions of the given section of UMTS network architecture.</p> <p>4d. Compare features of two given next generation mobile communication standards.</p> <p>4e. Select the relevant wireless technology for the given application.</p>	<p>4.1 Need for 3G and 4G technology</p> <p>4.2 IMT-2000 global standards: Vision, Compatibility, service and spectrum requirements</p> <p>4.3 UMTS /W-CDMA standard: Features, architecture, UMTS Air-interface specification, security procedure</p> <p>4.4 CDMA 2000, features and advanced versions, advantages of CDMA 2000 over 3G- GSM standards</p> <p>4.5 Next generation mobile standards: Features of 4G & 4G LTE, VoLTE, 4.5G, 5G</p>
Unit-V Wireless Network Technologies	<p>5a. Explain the procedure to develop personal area network for the given number of devices using Bluetooth.</p> <p>5b. Describe with relevant sketch given IEEE protocol standard for wireless communication networks</p> <p>5c. Classify RFID tags on the basis of the given type of parameters.</p> <p>5d. Compare the performance of given wireless network technologies based on given parameters.</p> <p>5e. Describe with relevant sketch the given type of wireless networking technologies applications.</p>	<p>5.1 Bluetooth technology: Features, architecture, frequency band , IEEE 802.15.1 and other wireless protocol, applications , personal area network(PAN)</p> <p>5.2 RFID: Concept, frequency band, classification of RFID tags, applications</p> <p>5.3 WLAN technology: IEEE 802.11, WLAN system architecture, radio spectrum</p> <p>5.4 WMAN /Wi-max/ :IEEE 802.16 WMAN and IEEE 802.16a Wimax</p> <p>5.5 Mobile Ad-hoc networks (MANET's): MANET topologies, applications.</p>

Note: To attain the Cos and competency, above listed Uos need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'



9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Wireless Communication System	10	04	04	04	12
II	Fundamental of Cellular System	12	04	04	04	12
III	Digital Cellular Mobile Standards	12	04	06	06	16
IV	Advance Wireless Standards	18	04	04	10	18
V	Wireless Network Technologies	12	02	04	06	12
Total		64	18	22	30	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of Uos. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Visit nearby MTNL/BSNL exchange and prepare detail report of entire setup of their cellular system.
- Visit nearby CDMA based cellular switching center and prepare details of the entire setup of their cellular system
- Demonstrate the general steps to repair Mobile handset.
- Prepare a detail list of equipment and software required to troubleshoot the mobile handset.
- Interpret the IS code 15040:2010 CISPR 25:2008. (Radio Disturbance Characteristics for Protection of receivers Used on Board Vehicles, Boats and Internal Combustion Engines – Limits and Methods of Measurement)

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- 'L' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the Cos through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- Guide student(s) in undertaking micro-projects.
- Correlate subtopics with Electronics communication and Digital communication(like: modulation ,wave propagation, Frequency modulation, multiplexing).



- g. Use proper equivalent analogy to explain different concepts.
- h. Use Flash /Animations to explain functions of mobile handset.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more Cos which are in fact, an integration of PrOs, Uos and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented Cos.

A suggestive list of micro-projects is given here. The concerned faculty could add similar micro-projects:

- a. Compare the specifications/ features / technology of different types of mobile phones available in the market (Min 12 specifications).
- b. Collect the information regarding the special services provided by various mobile service providers (Min 4) in your area.
- c. Prepare a report on TRAI regulations related to mobile communication.(spectrum allocation)
- d. Prepare a report on FCC regulations for spectrum allocation/interference/ Qos for mobile communication.
- e. Prepare a brief report on how radiations from BTS and handsets affect Human beings.
- f. Market survey on various wireless devices available in the market.(wireless hands free, wireless speaker, wireless charger)
- g. Prepare a short report on Li-Fi (light fidelity) technology.
- h. Collect detailed information on various wireless technologies based on IEEE standard, frequency band, speed, range, advantages and disadvantages and submit the brief report of it.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Mobile Cellular Telecommunications System	Lee, C. Y. William	Mcgraw Hill Education, New Delhi, 2017 ISBN-13: 978-0070635999
2	Wireless communication- Principles and practice	Rappaport, S.Theodore	Pearson publication New Delhi, 2005 ISBN: 978-81-317-3186-4
3	Wireless Communication	Singal, T. L.	McGraw Hill Education Private Limited, New Delhi, 2010, ISBN: 978-0-07-068178-1
4	Wireless and mobile network Architectures	Lin Yi-Bang Clamtac Imrich	John Wiley& sons, New Delhi,2001 ISBN : 978-81-265-1560-8



14. SOFTWARE/LEARNING WEBSITES

- a. eBook:-
www.philadelphia.edu.jo/newlibrary/.../file101fc6e5c77f4675b2958dc10a8c99c9.pdf
- b. Mobile network standards:- <https://gallucci.net/blog/gsm-cdma-and-lte-a-guide-to-mobile-network.../3/4>
- c. Mobile phone repairing tools and equipments : -
www.mobilecellphonerepairing.com › Mobile Phone Repairing Tools
- d. Bluetooth technology:- www.radio-electronics.com/info/wireless/Bluetooth/bluetooth_overview.php
- e. VoLTE:- [/www.gsma.com/futurenetworks/wp-content/uploads/2014/.../FCM.01-v1.1.pdf](http://www.gsma.com/futurenetworks/wp-content/uploads/2014/.../FCM.01-v1.1.pdf)
- f. The Evolution of mobile technologies: - <https://www.qualcomm.com/.../the-evolution-of-mobile-technologies-1g-to-2g-to-3g->
- g. Wireless tutorials:-
https://www.octoscope.com/English/.../octoScope_WirelessTutorial_20090209.pdf
- h. 5G Wireless Technology:- <https://www.qualcomm.com/invention/5g/technologies>
- i. Wireless Networks : NPTEL Video lectures :-
https://www.youtube.com/watch?v=Eu_mTZxPofI
- j. TRAI official website: www.trai.gov.in/

