MOBILE & WIRELESS COMMUNICATION **Course Code : 315339**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics**
Programme Code	**: DE/ EJ/ ET/ EX/ IE**
Semester	**: Fifth**
Course Title	**: MOBILE & WIRELESS COMMUNICATION**
Course Code	**: 315339**

I. RATIONALE

The next generation of mobile communications technology has already begun to bring various services to consumers and businesses. Mobile communications technology will be one of the most important drivers of industry, economic ,societal growth and will also generate millions of new jobs. This course will develop the skills to maintain the latest wireless communication based applications like Media, Entertainment, Internet of Things (IoT), Smart cities, Education,Vehicular communication etc. This course will account students with revolution in mobile and wireless communication.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences:
"Maintain mobile and wireless communication system"

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Describe concept of cellular mobile communication systems
- CO2 - Describe terminologies used in GSM systems,features and its architecture.
- CO3 - Compare generations of mobile communication system
- CO4 - Interpret 5G system architecture.
- CO5 - Use relevant wireless technology suitable for various 5G applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315339	MOBILE & WIRELESS COMMUNICATION	MWC	DSC	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175

MOBILE & WIRELESS COMMUNICATION **Course Code : 315339**

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Suggest radio spectrum bands used for mobile and wireless communication. TLO 1.2 Describe the features of the given mobile radio standards. TLO 1.3 Explain the given terms with respect to Cellular systems. TLO 1.4 Describe the Basic Cellular systems. TLO 1.5 Explain with relevant sketch the working principle of the different sections of mobile handset unit (3G).	**Unit - I Wireless Communication System** 1.1 Radio spectrum bands for mobile & wireless communication. 1.2 Wireless network generations Mobile Radio standards-AMPS, N AMPS, IS -95, GSM, UMTS . 1.3 Cellular fundamentals: cell, cell structure, cluster, reuse factor, minimum reuse distance. 1.4 Basic cellular system : mobile station, base station, traffic channel (Forward and Reverse) , control channel (Forward and Reverse), frequency reuse, channel assignment strategies. 1.5 Mobile communication system-Block diagram, Mobile Phone Unit : Block diagram of 3G, working, features of transmitter, receiver section, Frequency Synthesizer, Control unit ,Logic Unit of Mobile phone, sensors, speakers, camera, touch screen, motion sensors and other common sensors.	Lecture Using Chalk-Board Video Demonstrations Assignments

MOBILE & WIRELESS COMMUNICATION **Course Code : 315339**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the effect of the given interference on cellular system performance TLO 2.2 Select the relevant method to improve coverage and system capacity of the given cellular system with justification. TLO 2.3 Describe GSM system with relevant sketch.	**Unit - II Basics of Mobile Communication System.** 2.1 Interference : Co-Channel interference, Adjacent Channel Interference. 2.2 Improving Coverage and capacity in cellular systems: Cell splitting, Sectoring, Microcell Zone concept. Repeaters for range extension 2.3 Global System for Mobile Communication(GSM): Architecture,Features and service aspects, GSM and radio aspects. channel types, GSM call routing , Mobile terminated call & mobile originated call sequence, stages of call processing in GSM.	Lecture Using Chalk-Board Video Demonstrations Assignments
3	TLO 3.1 Explain Feature of the 4G standards. TLO 3.2 Describe LTE(4G) Network architecture with relevant sketch . TLO 3.3 Compare Features of next generation wireless standards. TLO 3.4 Describe multiple-input, multiple-output (MIMO). TLO 3.5 Interpret AAS system .	**Unit - III Fundamentals of 4G Communication** 3.1 Limitation of 3G and motivation for 4G. 3.2 LTE enabler Technologies: LTE(4G) Network architecture including eNodeB, MME, SGW, PGW,HSS, PDN. 3.3 Comparison of 1G ,2G, 3G, 4G ,4.5G, 5G. 3.4 Basics of MIMO. 3.5 Massive MIMO (Advanced Antenna Systems - AAS)Defination,diagram,benefits,Beamforming.	Lecture Using Chalk-Board Video Demonstrations Assignments
4	TLO 4.1 Describe 5G network architecture. TLO 4.2 List features of IMT 2020 standards TLO 4.3 Sketch 5G Radio spectrum. TLO 4.4 Elaborate 5G network slicing.	**Unit - IV Introduction to 5G Technology** 4.1 Introduction to 5G: 5G network architecture, 5G enable technologies, 4.2 IMT 2020 standards. 4.3 5G Radio spectrum : low band, medium band,millimeterwave(Ultrahigh) band,5G service providers, 4.4 5G network slicing.	Lecture Using Chalk-Board Video Demonstrations Assignments

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain the procedure to connect WiFi. TLO 5.2 Explain the procedure to connect bluetooth. TLO 5.3 List out NFC services . TLO 5.4 Describe Applications of Mobile and Wireless applications.	**Unit - V Recent Wireless Technologies & applications** 5.1 Features ,architecture, frequency band of Wi-Fi , IEEE 802.11a & 802.11g 5.2 Features ,architecture, frequency band of Bluetooth- BLE (Bluetooth 4.0, Bluetooth Low Energy), IEEE 802.15.1. 5.3 NFC services , Introduction to 3GPP Release 18 List of services . 5.4 Applications such as Vehicular communication : V2V,Industrial Automation Application(in detail) & other application such as Media and entertainment ,Retail Industry, Education, Industrial Automation ,Smart Cities, Internet of Things (IoT)Application.	Lecture Using Chalk-Board Video Demonstrations Assignments

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different sections and components of mobile phone such as ringer section, dialer section, receiver section and transmitter section, camera, microphone, speaker, Dash light.	1	*Identification of different sections of mobile phone	2	CO1
LLO 2.1 Measure voltages of various sections of mobile handset(such as supply of the transmitter /receiver section, battery charger section and power management unit of mobile phone unit).	2	*Measurement of different sections of mobile phone unit	2	CO1
LLO 3.1 Test user Interface section (Keyboard Buzzer, Vibrator, LED,Mic and Speaker) of Mobile phone unit.	3	*Testing of different sections of mobile phone unit	2	CO1
LLO 4.1 Find out relevant information of mobile phone using open source software applications a)Detect the hardware details of mobile handset. b)find out operating system c)locating the tower	4	*Finding out Relevant information of the mobile using relevant softwares	2	CO2
LLO 5.1 Install and authenticate eSIM(virtual SIM) on mobile handset.	5	Installation of eSim on mobile handset	2	CO3
LLO 6.1 Identify Dual sim interface section,Touch screen display section, battery charging circuit, power management unit of 4G or 5G smartphone and test working.	6	Identification of different parts of smartphones using 4G or 5G experimental setup	2	CO4
LLO 7.1 Using appropriate mobile app locate and find Internet signal strength of mobile tower.	7	*Location of nearby tower and find internet connection strength	2	CO4
LLO 8.1 Test functioning of various user interface section of smart phone : buzzer, vibrator, MIC /speaker, handsfree using 4G/5G Kit.	8	Check performance of user interface section of smartphone(4G/5G)	2	CO4
LLO 9.1 Test the hard reset function, hotspot and other networking functions of the given smart phone.	9	Make Hotspot connection on Wifi on any 2 devices	2	CO5
LLO 10.1 Build a Personal Area Network of mobile devices using Bluetooth.	10	*Establish Personal Area Network of at least two devices	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Initiatives by Standard Telecom Agencies.
- 5G Initiatives Taken By Government and Standard Agencies.
- 5G Developments Across the World.
- Key areas in which satellites can play a part in 5G.
- Recent Trends in Telecommunication domain.
- 5G network technology & impact on society.
- Roadmap for 5G Architecture in India.
- By using relevant learning material/tutorials,learn how to simulate 4G/5G/6G.
- Collect relevant information/technical specifications required for 4G/5G/6G communication.
- Compare various service providers considering quality of service and cost.

Industrial Visit

- Industrial Visit to nearest service provider base station.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Mobile Phone Trainer kit: Cellular System : EGSM/GSM 900/ 1800 MHz 1,2 to (3GDualband),Rx frequency band(Down link): 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 : 1710-1 785MHz Output power : +5 ,+33 dBm 3.2 m W . Channel spacing : 200 KHz Display : TFT, 256 K colours,128X 160 Pixels, 2.0	1,2

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
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 +/- 236dB,(EGSM) Maximum output power : 30 dBm +/- 2 dB (DCS) Minimum output power : 5 dBm +/- 5 dB (EGSM) Minimum output power : 0 dBm +/- 5 dB (DCS 1800)	1,2,3
3	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	1,2,3,7,4,8,9,6,5
4	Digital Multimeter (3,-4 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	2,3
5	CRO: Bandwidth : DC-30 MHz (-3 dB)] Ri se time : 12 ns approx Accuracy : ± 3 % Input Impedance : 1 MD 30 pF approx Sensitivity : Internal 5 mm, Ext 0.8 V approx Deflection coefficients : Micro-controller based 12 calibrated steps SmV/Div - 20V/Div 1 -2-5 sequence X-Y mode : Component Testing	2,3
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	2,3
7	5G VoLTE Smart Phone Training System: Technology : 5G Sub 6 FDD, 5G Sub 6 TDD, 4G LTE FDD, 4G LTE TDD, 3G WCDMA, 2G GSM ,On board sections : Touch display, Dual SIM interface, user interface, Battery charging circuit, Power management unit, and RF Spectrum Aanalyzer module User interface : Buzzer, Vibrator, Mic, Speaker, Hands free port, and display LEDs Test points : More than 55 nos.	6,10,5
8	4G VoLTE Smart Phone Scientech 2139 :Cellular system : GSM - Band (2 / 3 / 5 / 8); WCDMA - Band (1 / 2 / 5 /8); 4G VoLTE (TDD) - Band (38 / 40 / 41), LTE (FDD) - Band (1 / 3 / 5 / 7 / 8 / 20) Tx/Rx Frequency band : GSM / HSPA / LTE (850, 900, 1800, 1900 MHZ) UMTS/HSPA+ (850, 900, 1900, 2100 MHZ) 4G VoLTE ,WLAN :Wi-Fi 802.11 b/g/n, Wi-Fi Direct	6,8
9	Software app on phone such as AIDA64,Network cell info lite,LTE coverage map,open signal	7,4

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Wireless Communication System	CO1	10	2	4	6	12
2	II	Basics of Mobile Communication System.	CO2	10	4	6	8	18
3	III	Fundamentals of 4G Communication	CO3	8	2	4	4	10
4	IV	Introduction to 5G Technology	CO4	12	4	6	8	18
5	V	Recent Wireless Technologies & applications	CO5	10	2	4	6	12
Grand Total				**50**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks. End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	1	3	2	1	3			
CO2	1	1	1	2	2	1	3			
CO3	1	2	3	2	2	1	3			
CO4	1	2	3	2	3	1	3			
CO5	1	2	3	3	3	3	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	William C.Y. Lee	Mobile Cellular Telecommunications:	McGraw Hill Education; 2nd edition (1 July 2017); McGraw Hill Education (India) Private Limited. ISBN : 978-0070635999
2	Theodore S. Rappaport	Wireless Communications principles & practice	Pearson Education India; 2nd edition (1 January 2010), ISBN : 978-8131731864
3	T.L.Singal	Wireless Communications	McGraw Hill Education (1 July 2017) (India) Private Limited,New Delhi ISBN : 978-0070681781
4	Leeladhar Malviya, Rajib Kumar Panigrahi, M.V. Kartikeyan.	MIMO Antennas for Wireless Communication	CRC Press; 1st edition (16 December 2020) ISBN : 978-0367530471
5	Simon Haykin,Michael Moher	Modern Wireless Communication	Pearson Education India; 1st edition (1 January 2011), ISBN: 978-8131704431

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.gsma.com/connectivity-for-good/spectrum/5g-spectrum-guide-2/	Spectrum bands
2	https://www.ericsson.com/en/reports-and-papers/white-papers/advanced-antenna-systems-for-5g-networks	5G-networks
3	http://www.eitc.org/research-opportunities/5g-and-beyond-mobile-wireless-technology/5g-and-beyond-technology-roadmap/novel-antennas-and-semiconductor-technology/5g-nr-massive-mimo-technology	MIMO
4	https://telcomatraining.com/what-is-aas-adaptive-antenna-system	AAS antenna
5	https://mobilepacketcore.com/lte-4g-network-architecture/	4G architecture
6	https://www.linkedin.com/pulse/applications-5g-technology-ramya-chandran-swprc	Applications of 5G
7	https://www.rantcell.com/5g-antenna-5g-mmwave-components-for-connectivity.html	mmwave antenna

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students