SREE VIDYANIKETHAN ENGINEERING COLLEGE
(AUTONOMOUS)
Sree Sainath Nagar, Tirupati

Department of Electronics and Communication Engineering

Supporting Document for 1.1.2

Syllabus Revision carried out in 2019

Program: M.Tech.- Communication Systems

Regulations : SVEC-19

This document details the following:

1. Courses where syllabus has been changed 20% and more.
2. Course-wise revised syllabus with changes highlighted.

Note: *For SVEC-19 revised syllabus, SVEC-16 (previous syllabus) is the reference.*

List of Courses where syllabus content has been changed (20% and more)

S. No.	Course Code	Name of the course	Percentage of content changed	Page Number in which Details are Highlighted
1.	19MT13807	RF Circuit Design & Microwave Devices	100	3
2.	19MT16102	Digital Satellite Communications	40	5
3.	19MT10708	Research Methodology and IPR	40	9
4.	19MT13832	Communications and Signal Processing Lab	70	13
5.	19MT16131	RF Circuit Design and Microwave Devices Lab	40	17
6.	19MT1AC01	Technical Report Writing	100	21
7.	19MT23802	MIMO System	100	23
8.	19MT26305	Internet of Things	100	25
9.	19MT26102	Pattern Recognition	100	27
10.	19MT2AC01	Statistics with R	100	29
		Average %**(A)**	79	-
		Total No. of Courses in the Program **(T)**	28	
		No. of Courses where syllabus (more than 20% content) has been changed **(N)**	10	
		Percentage of syllabus content change in the courses **(C)=(A x N)/100**	7.9	
		Percentage of Syllabus Content changed in the Program (P)= C/T	**28.21**	

DEAN (Academics)

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SREE VIDYANIKETHAN ENGINEERING COLLEGE
Sree Sainath Nagar, A. RANGAMPET
CHITTOOR (DT.)-517 102, A.P.

PRINCIPAL

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SREE VIDYANIKETHAN ENGINEERING COLLEGE
(AUTONOMOUS)
Sree Sainath Nagar, A. RANGAMPET
Chittoor (Dist.) - 517 102, A.P., INDIA.

M.Tech. - I Semester
(19MT13807) RF CIRCUIT DESIGN & MICROWAVE DEVICES
(Common to DECS & CMS)
(Program Elective-2)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES:

Concept of Basic Electronics and Wave Theory at UG level

COURSE OBJECTIVES:

CEO1: To impart advanced knowledge in the fields of RF Circuits.
CEO2: To develop skills in analytical, problem solving, design and application skills in the broad area of RF circuit design.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1: Understand and apply the basic concepts of RF Electronics, analyze transmission lines, matching and biasing networks, and RF components, Design RF devices in Wireless Communications.
CO2: Realize, compare, and estimate problems in RF Passive and Active components as well as smart antenna techniques in the field of RF Circuits.
CO3: Analyze RF circuits and demonstrates use of Smith Chart for high frequency circuit design.
CO4: Apply techniques like MF-UHF for designing high-power microstrip circuits, directional couplers, transformers, composite and multilayer inductors, filters, combiners/dividers, and RFID systems in the field of wireless communication systems.
CO5: Analyze noise in RF devices like Oscillators, and synthesizers.

DETAILED SYLLABUS:

Unit-I: Introduction to RF Electronics (Hours: 09)
The Electromagnetic Spectrum, units and Physical Constants, Microwave bands, RF behavior of Passive components: Tuned resonant circuits, Vectors, Inductors and Capacitors. Voltage and Current in capacitor circuits, Tuned RF / IF Transformers.

Unit-II: Transmission Line Analysis (Hours: 12)
Examples of transmission lines, Transmission line equations and Biasing: Kirchoffs Voltage and current law representation, Traveling voltage and current waves, General Impedance definition, lossless transmission line model. Micro Strip Transmission Lines, Special Termination Conditions, sourced and Loaded Transmission Lines.
Single and Multiport Networks: The Smith Chart, Interconnectivity networks, Network properties and Applications, Scattering Parameters.

Unit-III: Microwave Components (Hours: 08)
Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.
Nonlinearity and Time Variance Inter-symbol interference, random process & noise, definition of sensitivity and dynamic range, conversion gain and distortion.

Unit-IV: Microwave Semiconductor Devices and Modeling (Hours: 08)
PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, HEMT.

Unit-V: Oscillators and Mixers (Hours: 08)
Oscillator basics, Low phase noise oscillator design, High frequency Oscillator configuration, LC Oscillators, VCOs, Crystal Oscillators, PLL Synthesizer, and Direct Digital Synthesizer.
RF Mixers: Basic characteristics of a mixer, Active mixers, Image Reject and Harmonic mixers, Frequency domain considerations.

Total Hours: 45

TEXT BOOKS:

1. Reinhold Ludwing, Pavel Bretchko, "*RF Circuit design: Theory and applications*", Pearson Education Asia Publication, 1st edition, New Delhi 2001.
2. D.M.Pozar, "*Microwave engineering*", Wiley, 4th edition, 2011.
3. Matthew M. Radmanesh, "*Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design*", Author House, 1st edition, 2009.

REFERENCE BOOKS:

1. Devendra K. Misra, "*Radio Frequency and Microwave Communication Circuits – Analysis and Design*", Wiley Student Edition, John Wiley & Sons, 2nd edition, July 2004.
2. Christopher Bowick, Cheryl Aljuni and John Biyler, "*RF Circuit Design*", Elsevier Science, 2nd edition, 2007.
3. S.Y. Liao, "*Microwave circuit Analysis and Amplifier Design*", Prentice Hall, 1st edition 1987.
4. Radmanesh, "*RF and Microwave Electronics Illustrated*", Pearson Education, 1st edition, 2004.

ADDITIONAL LEARNING RESOURCES

https://nptel.ac.in/courses/117102012/

M. Tech. - I Semester
(19MT16102) DIGITAL SATELLITE COMMUNICATIONS
(Program Elective-1)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Satellite Communications at UG level

COURSE DESCRIPTION:

Orbital mechanics and satellite sub-systems; Non-geostationary satellite systems; Demand assignment multiple access techniques and packet communications; VSAT & MSAT Networks, DBS satellite TV and GPS.

COURSE OBJECTIVES:

To impart knowledge in various satellite orbits, satellite sub-systems, LEO and NGSO satellites, VSAT and MSAT networks, Direct Broadcast Satellite Television systems and Global Positioning System.

CEO1: To develop skills in design, analysis, problem solving and research in orbital mechanics, satellite link design, NGSO satellites, digital satellite networks such as Demand Assignment Multiple Access (DAMA) and Aloha networks.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1: Analyze various satellite orbits and satellite sub-systems to solve problems in orbital motion of satellites and satellite subsystems.

CO2: Analyze various LEO, GEO & NGSO constellation satellites and their design aspects for various satellite applications

CO3: Apply efficient techniques such as Erlang's formula, DA-TDMA techniques to evaluate the performance of digital satellite networks such as Demand Assignment Multiple Access (DAMA) and Aloha networks.

CO4: Analyze VSAT and MSAT networks and its configurations.

CO5: Analyze Direct Broadcast Satellite Television systems and GPS Position Location Principles, Recent communication satellites launched by NASA/ISRO.

DETAILED SYLLABUS:

Unit-I: Satellite Orbits and Subsystems (Hours: 10)

Overview of Satellite Communications- Brief history, Orbital Mechanics, Look Angles determination, Orbital perturbations, Apogee- Perigee heights. Geo-stationary orbits-launching orbits, launch vehicles. Satellite Sub-Systems- Altitude and Orbit Control system, TT&C subsystem, Power systems, Communication subsystems, Satellite Antenna Equipment.

Unit-II: Low Earth Orbit and Non-Geostationary Satellite Systems (Hours: 09)

Introduction-Orbit Considerations, Equatorial Orbits, Inclined Orbits, Elliptical Orbits, Molniya Orbit. Coverage and Frequency Considerations- General Aspects, Frequency band, Elevation Angle Considerations, Number of Beams Per Coverage, Off-Axis Scanning, Determination of Optimum Orbital Altitude, Projected NGSO System Customer Service Base.

Delay and Throughput Considerations, System considerations- Incremental Growth, Interim Operations, Replenishment Options. Operational NGSO Constellation Designs- Ellipse, Global star, New ICO, Iridium, Orbcomn, Sky bridge, Teledesic.

Unit-III: Efficient Techniques and Satellite Packet Communications

(Hours: 10)

Demand Assignment Multiple Access and Digital Speech Interpolation: The ERLANG B Formula, Types of Demand Assignments, DAMA Characteristics, Real-Time Frame Reconfiguration- Frame and Burst Structures for DA-TDMA. DAMA Interfaces, SCPC-DAMA, SPADE, Digital Speech Interpolation.

Satellite Packet Communications: Preliminaries, Message Transmission by FDMA-The M/G/1 Queue, Message Transmission by TDMA, Pure ALOHA-Satellite Packet Switching, Slotted ALOHA, Packet Reservation, Tree Algorithm.

Unit-IV: VSAT and MSAT Networks (Hours: 08)

Very Small Aperture Terminal Networks: VSAT Technologies, Network Configurations, Multi-access and Networking, Network Error Control.

Mobile Satellite Networks: Operating Environment, MSAT Network Concept, CDMA MSAT Network, Statistics of Mobile Propagation.

Unit-V: Direct Broadcast Satellite Television and Global Positioning System (Hours: 08)

Direct Broadcast Satellite Television and Radio

C-Band and Ku-Band Home Satellite TV, Digital DBS TV, DBS-TV System Design, Error Control in Digital DBS-TV, Master Control Station and Uplink, Installation of DBS-TV Antennas, Satellite Radio Broadcasting.

Global Positioning System

Introduction, GPS Position Location Principles, Recent communication satellites launched by NASA/ISRO.

Total Hours: 45

TEXT BOOKS:

1. Timothy Pratt, Charles Bostian, Jeremy Allnutt, *"Satellite Communications",* John Wiley & Sons, 2nd edition, 2003.
2. Tri T. Ha, *"Digital Satellite Communications",* McGraw-Hill, 2nd edition, 1999.

REFERENCE BOOKS:

1. Dennis Roddy,*"Satellite Communications",* Tata McGraw-Hill Education Private Limited, 4th edition, 2009.
2. Wilbur L. Pritchard, H.G. Suyderhoud , Robert A.Nelson,*"Satellite Communication Systems Engineering*", Pearson Publications, 2nd edition, 2008.

ADDITIONAL LEARNING RESOURCES

NASA & ISRO Websites https://www.nasa.gov/, https://www.isro.gov.in

M. Tech.-I Semester
(16MT16102) DIGITAL SATELLITE COMMUNICATIONS
(PE-I)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: A Course on Satellite Communications at UG level

COURSE DESCRIPTION:
Orbital mechanics and satellite sub-systems; Non-geostationary satellite systems; Demand assignment multiple access techniques and packet communications; Spread spectrum communications; Satellite applications.

COURSE OUTCOMES:
After successful completion of the course, students will be able to:

1. Demonstrate advanced knowledge in
   - Satellite Orbits and Sub-Systems
   - NGSO Constellation Designs
   - DAMA Interfaces
   - Satellite Packet Communications and ALOHA systems
   - Spread spectrum Communications
   - Satellite Applications such as VSAT, MSAT, Direct Broadcast Satellite Television.
2. Investigate and analyze engineering problems critically in the field of satellite system design and communications.
3. Design efficient Digital Satellite Systems/ Subsystems and solve engineering problems in the area of satellite communications.
4. Solve engineering problems with feasible and economical solutions in digital satellite communications.
5. Apply appropriate techniques, resources and tools to engineering activities in the field of digital satellite communications.
6. Develop ethical attitude towards environment in the field of digital satellite communications.

DETAILED SYLLABUS

UNIT– I: SATELLITE ORBITS AND SUBSYSTEMS (Periods: 11)
Overview of Satellite Communications- Brief history, Orbital Mechanics, Look Angles determination, Orbital perturbations, Apogee- Perigee heights. Geo-stationary orbits-launching orbits, launch vehicles. Satellite Sub-Systems- Attitude and Orbit Control system, TT&C subsystem, Power systems, Communication subsystems, Satellite Antenna Equipment.

UNIT– II: LOW EARTH ORBIT AND NON-GEOSTATIONARY SATELLITE SYSTEMS (Periods:10)
Introduction-Orbit Considerations, Equatorial Orbits, Inclined Orbits, Elliptical Orbits, Molniya Orbit. Coverage and Frequency Considerations- General Aspects, Frequency band, Elevation Angle Considerations, Number of Beams Per Coverage, Off-Axis Scanning, Determination of Optimum Orbital Altitude, Projected NGSO System Customer Service Base. Delay and Throughput Considerations, System considerations- Incremental Growth, Interim

Operations, Replenishment Options. Operational NGSO Constellation Designs- Ellipse, Global star, New ICO, Iridium, Orbcomn, Sky bridge, Teledesic.

UNIT –III: EFFICIENT TECHNIQUES & SATELLITE PACKET COMMUNICATIONS (Periods:11)

Demand Assignment Multiple Access and Digital Speech Interpolation: The ERLANG B Formula, Types of Demand Assignments, DAMA Characteristics, Real-Time Frame Reconfiguration- Frame and Burst Structures for DA-TDMA. DAMA Interfaces, SCPC-DAMA, SPADE, Digital Speech Interpolation.

Satellite Packet Communications: Preliminaries, Message Transmission by FDMA-The M/G/1 Queue, Message Transmission by TDMA, Pure ALOHA-Satellite Packet Switching, Slotted ALOHA, Packet Reservation, Tree Algorithm.

UNIT– IV: SATELLITE SPREAD SPECTRUM COMMUNICATIONS (Periods:12)

Direct Sequence Spread Spectrum Systems- PN Sequence, Error Rate Performance in Uniform Jamming, Error Rate Performance in Pulsed Jamming. Direct Sequence Code Division Multiple Access- Sequence Synchronous DS-CDMA, Sequence Asynchronous DS-CDMA, Random Access DS-CDMA. Frequency HOP Spread Spectrum Systems-Frequency HOP Code Division Multiple Access. DS Acquisition and Synchronization, FH Acquisition and Synchronization, Satellite on Board Processing.

UNIT –V: SATELLITE APPLICATIONS (Periods: 11)

Very Small Aperture Terminal Networks: VSAT Technologies, Network Configurations, Multi-access and Networking, Network Error Control.

Mobile Satellite Networks: Operating Environment, MSAT Network Concept, CDMA MSAT Network, Statistics of Mobile Propagation.

Direct Broadcast Satellite Television and Radio

C-Band and Ku-Band Home Satellite TV, Digital DBS TV, DBS-TV System Design, DBS-TV Link Budget, Error Control in Digital DBS-TV, Master Control Station and Uplink, Installation of DBS-TV Antennas, Satellite Radio Broadcasting.

Total periods: 55

TEXT BOOKS:

3. Timothy Pratt, Charles Bostian, Jeremy Allnutt, "*Satellite Communications",* John Wiley & Sons, 2nd edition, 2003.
4. Tri T. Ha, "*Digital Satellite Communications",* McGraw-Hill, 2nd edition, 1999.

REFERENCE BOOKS:

3. Dennis Roddy,"*Satellite Communications",* Tata McGraw-Hill Education Private Limited, 4th edition, 2009.
4. Wilbur L. Pritchard, H.G. Suyderhoud , Robert A.Nelson,"*Satellite Communication Systems Engineering*", Pearson Publications, 2nd edition, 2008.

M. Tech. - I Semester
(19MT10708) RESEARCH METHODOLOGY AND IPR

(Common to all M. Tech. Programs)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	2	-	-	2

PRE REQUISITES:

COURSE DESCRIPTION:

Overview of research; research problem and design; various research designs; Data collection methods; Statistical methods for research;Interpretation& drafting reports and Intellectual property rights.

COURSE OBJECTIVES:

CEO1: To impart knowledge on research methodology and subsequent process involved for successful accomplishment of the research.
CEO2: To impart knowledge on intellectual property rights and subsequent process involved in filing patents and trade mark registration process.
CEO3: To inculcate attitude of reflective learning and contribute to the society through fruitful research.

COURSE OUTCOMES:

On successful completion of the course, students will be able to:

CO1. Apply the conceptual knowledge of research methodology to formulate the hypothesis, data collection and processing, analyzing the data using statistical methods, interpret the observations and communicating the novel findings through a research report.
CO2. Practice ethics and have responsibility towards society throughout the research process and indulge in continuous learning process.
CO3. Apply the conceptual knowledge of intellectual property rights for filing patents and trade mark registration process.

DETAILED SYLLABUS:

Unit-I: Introduction to Research Methodology (Hours: 07)
Objectives and Motivation of Research, Types of Research, Defining and Formulating the Research Problem; Features of research design, Different Research Designs; Different Methods of Data Collection, Data preparation and Processing.

Unit-II: Data Analysis and Hypothesis Testing (Hours: 09)
ANOVA; Principles of least squares-Regression and correlation; Normal Distribution-Properties of Normal Distribution; Testing of Hypothesis – Hypothesis Testing Procedure, Types of errors, t-Distribution, Chi-Square Test as a Test of Goodness of Fit.

Unit-III: Interpretation and Report Writing (Hours: 04)
Interpretation – Need, Techniques and Precautions; Report Writing – Significance, Different Steps, Layout, Types of reports,Mechanics of Writing a Research Report, Precautions in Writing Reports; Research ethics.

Unit-IV: Introduction to Intellectual property and Trade Marks (Hours: 07)
Importance of intellectual property rights; types of intellectual property, international organizations; Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Unit-V: Law of Copyrights (Hours: 08)
Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.
Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer
New Developments in IPR: Administration of Patent System.

Total Hours: 35

TEXT BOOKS:

1. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd revised edition, New Age International Publishers, New Delhi, 2004.
2. Deborah, E. Bouchoux, *Intellectual property right*, 5th edition, Cengage learning, 2017.

REFERENCE BOOKS:

1. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.
2. Prabuddha Ganguli, *Intellectual property right - Unleashing the knowledge economy*, Tata McGraw Hill Publishing Company Ltd, 2001.

M. Tech. – I Semester
(16MT13808) RESEARCH METHODOLOGY
(Common to all M. Tech. Programs)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
-	-	-	-	2	-	-

PREREQUISITES: --

COURSE DESCRIPTION:

Overview of Research, research problem and design, various research designs, data collection methods, statistical methods for research, importance of research reports and its types.

COURSE OUTCOMES:
After successful completion of the course, students will be able to:
1. Acquire in-depth knowledge on
   - Research design and conducting research
   - Various data collection methods
   - Statistical methods in research
   - Report writing techniques.
2. Analyze various research design issues for conducting research in core or allied areas.
3. Formulate solutions for engineering problems by conducting research effectively in the core or allied areas.
4. Carryout literature survey and apply research methodologies for the development of scientific/technological knowledge in one or more domains of engineering.
5. Select and Apply appropriate techniques and tools to complex engineering activities in their respective fields.
6. Write effective research reports.
7. Develop attitude for lifelong learning to do research.
8. Develop professional code of conduct and ethics of research.

DETAILED SYLLABUS:

Unit-I: Introduction to Research Methodology (Periods: 5)
Objectives and Motivation of Research, Types of Research, Research Approaches, Research Process, Criteria of good Research, Defining and Formulating the Research Problem, Problem Selection, Necessity of Defining the Problem, Techniques involved in Defining a Problem.

Unit-II: Research Problem Design and Data Collection Methods (Periods: 7)
Features of Good Design, Research Design Concepts, Different Research Designs, Different Methods of Data Collection, Data preparation: Processing Operations, Types of Analysis.

Unit-III: Statistics in Research (Periods:6)
Review of Statistical Techniques - Mean, Median, Mode, Geometric and Harmonic Mean, Standard Deviation, Measure of Asymmetry, ANOVA, Regression analysis.

Unit-IV: Hypothesis Testing (Periods: 7)

Normal Distribution, Properties of Normal Distribution, Basic Concepts of Testing of Hypothesis, Hypothesis Testing Procedure, Hypothesis Testing: t-Distribution, Chi-Square Test as a Test of Goodness of Fit.

Unit-V: Interpretation and Report Writing (Periods: 3)

Interpretation – Techniques and Precautions, Report Writing – Significance, Stages, Layout, Types of reports, Precautions in Writing Reports.

Total Periods: 28

TEXT BOOK:

1. C.R. Kothari, "*Research Methodology: Methods and Techniques*," New Age International Publishers, New Delhi, 2nd Revised Edition, 2004.

REFERENCE BOOKS:

1. Ranjit Kumar, "*Research Methodology: A step-by-step guide for beginners*," Sage South Asia, 3rd ed., 2011.
2. R. Panneerselvam, "Research Methodology," PHI learning Pvt. Ltd., 2009

M. Tech. – I Semester
(19MT13832) COMMUNICATIONS AND SIGNAL PROCESSING LAB
(Common to CMS & DECS)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES:

Simulation Lab at UG Level

COURSE DESCRIPTION:

Design and simulation of communication systems - QPSK communication system over AWGN channel and Rayleigh fading channel; Generation of maximal and Gold code sequences; Simulation of Rayleigh Fading Channel Using Either Clarke's Model or Jake's Model for different Doppler Spreads; Performance Evaluation of RAKE Receiver over Slow Fading Channel.

COURSE OBJECTIVES:

CEO1: To design, develop and simulate various components of digital communications and adaptive algorithms.
CEO2: To apply Knowledge and Skills to implement engineering Principles in the fields of Communications and Signal processing.

COURSE OUTCOMES:

On successful completion of this course the students will be able to

CO1: Analyze, measure, interpret and validate the practical observations by applying the conceptual knowledge of communication, signal and Image processing.
CO2: Design IIR and FIR filters for desired specifications.
CO3: Work individually and in groups to solve problems with effective communication.

LIST OF EXERCISES /EXPERIMENTS:

1. Design and Simulation FIR Filter Using any Windowing Technique.
2. Design of IIR Filters from Analog Filters.
3. Generation of Maximal Sequences and Gold Sequences.
4. Performance Evaluation of QPSK System over AWGN Channel.
5. Equalization of Multipath Channel using LMS or RLS Algorithms.
6. Simulation of Rayleigh Fading Channel Using Either Clarke's Model or Jake's Model for different Doppler Spreads (Ex. 50 Hz and 100 Hz).
7. Performance Evaluation of RAKE Receiver over Slow Fading Channel.
8. Performance Evaluation of QPSK System over Rayleigh Fading Channel.
9. Smoothening & Sharpening of a given image.
10. Color image in various color models.

REFERENCE BOOKS/LABORATORY MANUALS:

1. Communications and Signal Processing Lab Manual of the Department.

2. W.H. Tranter, K. Sam Shanmugham, T.S. Rappaport, and K.L. Kosbar, "*Principles of Communication System Simulation with Wireless Applications,"* Pearson, 2004.
3. J.G. Proakis, and M. Salehi, "*Contemporary Communication Systems using MATLAB and Simulink",* Cengage learning, 2nd edition, 2004.
4. R.C. Gonzalez, R. E. Woods, Steven L.Eddins, "*Digital Image Processing using MATLAB", Gatesmark Publishing*, 2nd edition, 2009

M. Tech. - I SEMESTER
(16MT16131) COMMUNICATIONS LAB-I

Int. Marks	Ext. Marks	Max. Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Simulation Lab at UG Level

COURSE DESCRIPTION:
Design and simulation of communication systems - Baseband Communication Systems with Optimum terminal filters, QPSK communication system for AWGN channel, Baseband Direct Sequence Spread Spectrum (DS/SS) System; Generation of different density and distribution functions; Generation of maximal and Gold code sequences.

COURSE OUTCOMES:
After successful completion of the course, students will be able to:
1. Gain advanced knowledge in
   - Generation of Maximal and Gold Sequences & verification of their properties.
   - Design of communication system for band limited channels for Zero ISI.
   - Evaluating the performance of QPSK over AWGN Channel, 16MPSK and 16QAM.
   - Simulation of Code matched filter in Spread Spectrum Communication System.
   - Design of Baseband Communication Systems with Optimum terminal filters.
   - Simulation of baseband Direct Sequence Spread Spectrum (DS/SS) System.
   - Equalization of Multipath Channel using LMS or RLS Algorithms.
2. Analyze complex and critical engineering problems in the field of communications.
3. Use MATLAB Toolbox to simulate complex engineering activities in the field of communication.
4. Demonstrate knowledge and understanding of engineering principles to execute the Projects effectively in the field of communications.
5. Understand ethical responsibility towards environment & society in the field of communications.
6. Communicate effectively in verbal & written forms.

LIST OF EXERCISES:
1. Generation of discrete time independent and identically distributed (IID) random processes with different distributions (Bernoulli, Binomial, Geometric, Poisson, Uniform, Gaussian, Exponential, Laplacian, Rayleigh, Rician). (2 time slots)
2. Communication system Design for Band limited Channels: System design for Zero ISI. (2 time slots)
3. Design of Baseband Communication Systems with Optimum terminal filters. (2 time slots)
4. Simulation of QPSK communication system and performance evaluation for AWGN channel. (1time slot)
5. Simulation of Maximal sequences of any length and verification of their properties. (1 time slot)
6. Generation of Gold codes, and verification of auto-correlation & cross correlation properties. (1 time slot)
7. Design and simulation of code matched filter in spread spectrum communication system. (2time slots)
8. Comparison of 16-MPSK and 16-QAM. (1time slot)

9. Design and simulation of baseband Direct Sequence Spread Spectrum (DS/SS) System. (2 time slots)
10. Equalization of Multipath Channel using LMS or RLS Algorithms. (1 time slot)

Total Time Slots: 14

Tools:

Numerical Computing Environments–GNU Octave or MATLAB

REFERENCE BOOKS:

1. W.H. Tranter, K. Sam Shanmugham, T.S. Rappaport, and K.L. Kosbar, "*Principles of Communication System Simulation with Wireless Applications",* Pearson,3 rd edition, 2004.
2. J.G. Proakis, and M. Salehi, "*Contemporary Communication Systems using MATLAB",* Bookware Companion Series,2 nd edition, 2006.
3. John G. Proakis, "*Digital Communications*", McGraw Hill, 4th edition, 2001.

M. Tech. – I Semester
(19MT16131) RF CIRCUIT DESIGN AND MICROWAVE DEVICES LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES:

Name of the Pre-requisite Course(s) Antennas, Microwaves and Optical Communication lab at UG level

COURSE OBJECTIVES:

CEO1: To design, develop and simulate various circuits at Radio frequency and Optical Communication Systems.
CEO2: To apply Knowledge and Skills to implement engineering Principles in the field of RF, Microwave and Optical Communications.

COURSE OUTCOMES:

On successful completion of this course, the students will be able to:

CO1: Analyze , measure, interpret and validate the practical observations by applying the conceptual knowledge of Antennas and transmission lines.
CO2: Design different antennas for RF, Microwave and Optical communications and measure the parameters using antenna set up.
CO3: Work individually and in teams collaboratively in implementing mini projects.

LIST OF EXERCISES /EXPERIMENTS:

1. Measurement of Frequency, Wavelength and Impedance.
2. Characteristics of branch line directional coupler.
3. Measurement of coupling & cross talk in 3 wire pick up.
4. Characterization of current probe with capacitive coupling or inductive coupling.
5. Study of non-ideal behaviour of lumped circuit components.
6. Measure characteristics of passive components such as attenuator, isolator, and coupler.
7. Measurement of the effect of CO-POLARIZATION and CROSS-POLARIZATIION sing vertical and horizontal polarization of antenna.
8. VSWR Measurement and Impedance Calculation. Measure the VSWR using normal method and double minima method. Measure the frequency using the frequency meter and compare with calculated guided wavelength. Calculate the input impedance of a given load from the VSWR measurements and shift in the minima.
9. To study the behavior of terminated coaxial transmission line in both frequency and time domains.
10. Design of an Antenna using FIKO suit, determine the radiation pattern with Antenna setup.

REFERENCE BOOKS/LABORATORY MANUALS:

1. RF Circuit & Optical Communications lab-II manual of the department.
2. RF Spice Pro User Manual.
3. Devendra K. Misra, " *Radio Frequency and Microwave Communication Circuits – Analysis and Design*", Wiley Student Edition, John Wiley & Sons, 2nd edition, July 2004.

SOFTWARES/TOOLS USED:
RF Spice Pro simulation software

ADDITIONAL LEARNING RESOURCES
MIC System, Motorized microstrip transmission line trainer, passive component, cable dispersion.

M. Tech. - I SEMESTER
(16MT16132) RF CIRCUITS & OPTICAL COMMUNICATIONS LAB

Int. Marks	Ext. Marks	Max. Marks	L	T	P	C
50	50	100	-	-	4	2

PRE- REQUISITES:
Antennas, Microwaves and Optical Communication lab at UG level

COURSE DESCRIPTION:
Design and simulation of Various antennas; Measurement of various parameters; characteristics of couplers; non-ideal behaviour of lumped circuit components; characteristics of microwave passive components; Measurement of 4 channel CWDM using modulation; PC to PC communication; Characterization of Optial circulator and Bragg-grating.

COURSE OUTCOMES:
After successful completion of the course, students will be able to:
1. Demonstrate advanced knowledge required in
   - Measurement of Impedance, Coupling and cross talk in 3 wire pickup.
   - Design and simulation of different antennas.
   - Design and measurement of PC to PC communication.
   - Characterization of branch line directional copupler, capacitive coupling and inductive coupling.
   - Study of non ideal behaviour of lumped circuit components, 3 dB power divider and filters.
   - Designing WDM system and measurement of 4 channel CWDM by internal and external modulation.
   - Wavelength division multiplexing & de-multiplexing of analog/digital signals over 1310 nm and 1550 nm wavelengths.
2. Analyse of engineering problems for feasible and optimal solutions in the core area of RF, Microwave and Optical Communications.
3. Use RF Spice Pro Software to complex engineering activities in the domain of RF, Microwave and Optical communications.
4. Demonstrate Knowledge and understanding of Engineering Principles to execute the Projects effectively in the field of RF, Microwave and Optical communications.
5. Understand ethical responsibility towards environment & society in the field of communications.
6. Communicate effectively in verbal & written forms in the core area of RF, Microwave and Optical communications

LIST OF EXERCISES:
1. Measurement of Frequency, Wavelength and Impedance.
2. Characteristics of branch line directional coupler.
3. Measurement of coupling & cross talk in 3 wire pick up.
4. Characterization of current probe with capacitive coupling or inductive coupling.
5. Study of non-ideal behaviour of lumped circuit components.
6. Measure characteristics of passive components such as attenuator, isolator, coupler and WDM.
7. Characterization of Optial circulator and Bragg-grating.
8. Measurement of 4 channel CWDM by internal & external modulation.

9. Wavelength division multiplexing & de-multiplexing of analog/digital signals over 1310 nm and 1550 nm wavelengths.
10. Design and Simulate any patch antenna given by the faculty in the lab.

Total Time slots : 10

TOOLS REQUIRED:

RF Spice Pro simulation software, MIC System, Motorized microstrip transmission line trainer, advanced fiber optic lab with Fiber optic laser source, passive component, cable dispersion, DWDM and bragg grating modules.

REFERENCE BOOKS:

4. RF Circuit & Optical Communications lab-II manual of the department.
5. RF Spice Pro User Manual
6. Devendra K. Misra, "Radio Frequency and Microwave Communication Circuits Analysis and Design", Wiley Student Edition, John Wiley & Sons, 2nd edition, July 2004.
7. S.E.Miller, A.G.Chynoweth, *Optical Fiber Telecommunication,* 1979.

M. Tech. - I Semester
(19MT1AC01) TECHNICAL REPORT WRITING
(Audit Course)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
-	-	-	*2*	-	-	-

PRE-REQUISITES: -

COURSE DESCRIPTION:

Introduction; Process of writing; Style of writing; Referencing; Presentation.

COURSE OBJECTIVES:

CEO1: To impart the knowledge of structure and layout of Business and Technical Reports.
CEO2: To learn styles and techniques of description for effective reports.
CEO3: To develop the ability to understand & interpret the writing techniques for effective communication in written documents.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Demonstrate knowledge of Technical Report Writing by examining kinds of reports and structure with scientific attitude.
CO2: Apply the techniques in preparing effective reports by examining Techniques of Description, Describing Machines and Mechanisms and Describing Processes.
CO3: Communicate effectively through writing technical reports by demonstrating the knowledge of Industry Reports, Survey Reports, Interpretive Report and Letter Report.

DETAILED SYLLABUS:

Unit I - Introduction (Hours: 06)
Introduction to Technical Report - Types of Reports - Planning Technical Report Writing - Components of a Technical Report - Report Writing in Science and Technology - Selecting and Preparing a 'Title' - Language Use in Report Writing.

Unit II - Process of Writing (Hours: 05)
Writing the 'Introduction' - Writing the 'Materials and Methods' - Writing the Findings/Results'- Writing the 'Discussion' - Preparing and using 'Tables'.

Unit III - Style of Writing (Hours: 06)
Preparing and using Effective 'Graphs' - Citing and Arranging References—I - Citing and Arranging References —II - Writing for Publication in a Scientific Journal.

Unit IV - Referencing (Hours: 09)
Literature citations - Introductory remarks on literature citations - Reasons for literature citations – Bibliographical data according to ISO - Citations in the text - Copyright and copyright laws - The text of the Technical Report - Using word processing and desktop

publishing (DTP) systems - Document or page layout and hints on editing - Typographic details - Cross-references.

Unit V - **Presentation** **(Hours: 04)**

Giving the presentation - Appropriate pointing - Dealing with intermediate questions - Review and analysis of the presentation - Rhetoric tips from A to Z.

Total Hours: 30

TEXT BOOKS:

1. R C Sharma – Krishna Mohan, *"Business Correspondence and Report Writing,"* Tata McGraw-Hill Publishing Company Limited, New Delhi, Third Edition, 2005 (reprint).
2. Patrick Forsyth*, "How to Write Reports and Proposals",* THE SUNDAY TIMES (Kogan Page), New Delhi, Revised Second Edition, 2010.

REFERENCE BOOKS:

1. John Seely, "*The Oxford Writing & Speaking"*, Oxford University Press, Indian Edition.
2. Anne Eisenberg, "*A Beginner's Guide to Technical Communication"*, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

ADDITIONAL LEARNING RESOURCES

1. http://www.resumania.com/arcindex.html
2. http://www.aresearchguide.com/writing-a-technical-report.html
3. http://www.sussex.ac.uk/ei/internal/forstudents/engineeringdesign/studyguides/techreportwriting

M.Tech. - II Semester
(19MT23802) MIMO SYSTEM
(Common to DECS & CMS)
(Program Elective-3)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES:

Concept of Basic Electronics and Wave Theory at UG level

COURSE OBJECTIVES:

CEO1: To impart advanced knowledge in the fields of MIMO.
CEO2: To develop analytical, problem solving, design and application skills in the broad area of MIMO System.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1: Understand multi-antenna systems, channel modeling and effect of LOS and XPD on MIMO Capacity.
CO2: Analyze diversity and spatial multiplexing in MIMO systems.
CO3: Apply MIMO coding techniques in the field of wireless communication systems.

DETAILED SYLLABUS:

Unit-I: Introduction to MIMO System (Hours: 06)

Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems.

Unit-II: The MIMO Wireless Channel (Hours: 10)

Introduction, preliminaries, MIMO System Model, MIMO System Capacity, Channel Unknown to the Transmitter, Channel known to the Transmitter, Deterministic Channel, Random Channels, Influence of Fading Correlation on MIMO Capacity, Influence of LOS on MIMO Capacity, Influence of XPD on MIMO Capacity, Keyhole Effect: Degenerate Channels, Capacity of Frequency Selective MIMO Channels.

Unit-III: MIMO Diversity and Spatial Multiplexing (Hours: 09)

Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code, MIMO spatial multiplexing. Space time receivers. ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade-off.

Unit-IV: Space Time Block Codes (Hours: 10)

Space time block codes on real and complex orthogonal designs, Code design criteria for quasistatic channels (Rank, determinant and Euclidean distance), Orthogonal designs, Generalized orthogonal designs, Quasi-orthogonal designs and Performance analysis.

Unit-V: Space Time Trellis Codes (Hours: 10)

Representation of STTC, shift register, generator matrix, state-transition diagram, trellis diagram, Code construction, Delay diversity as a special case of STTC and Performance analysis.

Total Hours: 45

TEXT BOOKS:

T1. Claude Oestges, Bruno Clerckx, "*MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design*", Academic Press, 1st edition, 2010.

T2. Mohinder Janakiraman, "*Space-Time Codes and MIMO Systems*", Artech House Publishers, 1st edition 2004.

REFERENCE BOOKS:

R1. David Tse and Pramod Viswanath, "*Fundamentals of Wireless Communication*", Cambridge University Press, 1st edition, 2005.

R2. Paulraj, R. Nabar and D. Gore, "*Introduction to Space-Time Wireless Communications*", Cambridge University Press, 1st edition, 2003

R3. E.G. Larsson and P. Stoica, "*Space-Time Block Coding for Wireless Communications*", Cambridge University Press 1st edition, 2008.

ADDITIONAL LEARNING RESOURCES

www.sabre.org, www.bookaid.org, NPTEL

M.Tech. - II Semester
(19MT26305) INTERNET OF THINGS

(Common to CNIS, CS, SE, DECS and CMS)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES:

Courses on Computer Networks, Python Programming.

COURSE DESCRIPTION:

Concepts of Domain Specific IoTs, M2M and system management with Netconf-Yang, IoT privacy and security, IoT physical devices, Amazon Web Services for IoT and case studies illustrating IoT design.

COURSE OUTCOMES:

CO1: Understand the concepts of IoT, IoT protocols, privacy and security issues in IoT applications to analyze domain specific IoT's.
CO2: Design solutions through implementing IoT applications on raspberry pi, AWS and develop security solutions to strengthen IoT environment.

DETAILED SYLLABUS:

Unit-I: Concepts of IoT (Hours: 07)
Definition and characteristics of IoT, Physical design of IoT – IoT protocols, Logical design of IoT, IoT enabling technologies, IoT levels and deployment templates.

Unit-II: Domain Specific IoTs & IoT and M2M (Hours: 09)
Domain Specific IoTs: Home automation, Cities, Environment, Energy, Logistics, Agriculture, Industry.
IoT and M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT.

Unit-III: IoT System Management with Netconf-Yang and Developing Internet of Things (Hours: 09)
Need for IoT systems management, Simple Network Management Protocol (SNMP), Network operator requirements, NETCONF-YANG, IoT systems management with NETCONF-YANG.
Developing Internet of Things: Introduction, IoT design methodology.

Unit-IV: IoT Privacy, Security and Vulnerabilities Solutions and IoT Physical Devices (Hours: 11)
Introduction, Vulnerabilities, Security requirements and treat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity management and establishment, Access control and secure message communication, Security models, Profiles and protocols for IoT.
IoT Physical Devices & Endpoints: What is an IoT device, Exemplary device, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python and other IoT devices.

Unit-V: Amazon Web Services for IoT and Case Studies Illustrating IoT Design (Hours: 09)

Amazon Web Services for IoT: Amazon EC2, Amazon AutoScaling, Amazon S3, Amazon RDS, Amazon DynamoDB.

Case Studies Illustrating IoT Design: Home automation, Cities, Environment and Agriculture.

Total Hours: 45

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, "*Internet of Things: A Hands-on Approach"*, Universities Press, 2015.
2. Raj Kamal, "*Internet of Things: Architecture and Design Principles*", McGraw Hill, 1st Edition, 2017.

REFERENCE BOOKS:

1. Adrian McEwen, Hakim Cassimally, "*Designing the Internet of Things"*, Wiley, 2013.
2. Jeeva Jose, "*Internet of Things"*, Khanna Publishing, 1st Edition, 2018.

M. Tech. - II Semester
(19MT26102) PATTERN RECOGNITION
(Program Elective – 4)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES:

A course on Digital Image processing.

COURSE DESCRIPTION:

Importance of pattern recognition; Baye's Decision Theory; Linear and non linear classifiers; Feature selection based on statistical hypothesis testing; Feature Generation; KL Transform; SVD; ICA; Clustering of features and clustering algorithms.

COURSE OBJECTIVES:

CEO1: To impart Knowledge in fundamentals that helps to develop various algorithms to classify the patterns of the objects.
CEO2: To develop skills in analysis, formulating, problem solving of Features, clustering categories of objects in digital image processing.

COURSE OUTCOMES:

On successful completion of this course the students will be able to

CO1: Understand the importance of pattern recognition, classifiers, supervised & unsupervised and analyze the bayes classifier to solve the unknown probability density function between the patterns.
CO2: Analyze the linear classifier algorithms such as LMS to determine minimum mean square error between the pattern classes using various approaches.
CO3: Analyze the Non-linear classifier algorithms such as back propagation algorithms to determine cost function and to seperate the pattern classes using various approaches.
CO4: Understand the concepts of feature selection and feature generation. Analyze feature selection & generation techniques to determine the features from the image using various techniques.
CO5: Understand the concepts of feature Clustering, Proximity Measures and analyze Clustering Algorithms Such as Sequential Clustering Algorithms, A Modification of BSAS, A Two-Threshold Sequential Scheme. Apply the appropriate techniques to cluster the features of the image.

DETAILED SYLLABUS:

Unit-I: Introduction to Pattern Recognition (Hours: 10)
Importance of pattern recognition, Features, Feature Vectors and Classifiers, Supervised, Unsupervised and Semi Supervised Learning, Classifiers based on Baye's Decision Theory **-** Baye's decision theory, Discriminant Functions and decision surfaces, Bayesian classification for Normal Distributions, Estimation of Unknown probability density functions, The Nearest Neighbor Rule.

Unit-II: Linear Classifiers (Hours: 09)
Linear Discriminant functions and Decision Hyperplanes, The perceptron Algorithm, Least Squares Method- Mean Square Error Estimation, Stochastic Approximation and the LMS Algorithm, Sum of Error Squares Estimation Least Squares Method; Mean Square Estimation Revisited- Mean Square Error Regression; Support Vector Machine**-** Separable classes, Nonseparable classes

Unit-III: Non Linear Classifiers (Hours: 09)
The XOR problem, The two layer perceptron, Three layer perceptrons, The Back propagation Algorithm, The cost function choice, choice of the network size, A simulation example, Networks with weight sharing, generalized linear classifiers, polynomial classifiers, Radial basis Function Networks.

Unit-IV: Feature Selection and Generation (Hours: 09)
Feature Selection- Pre processing, The peaking phenomenon, Feature selection based on statistical hypothesis testing, ROC curve, class separability measures, feature subset selection; Feature Generation - Basis Vectors and Images, The KL Transform, The Singular Value Decomposition, Independent Component Analysis, Non negative Matrix Factorization, Regional features, Features for shape and size characterization.

Unit-V: Clustering (Hours: 08)
Introduction, Types of Features, Definitions of Clustering, Proximity Measures-Proximity Measures between Two Points, Proximity Functions between a Point and a Set, Proximity Functions between Two Sets; Categories of Clustering Algorithms, Sequential Clustering Algorithms, A Modification of BSAS, A Two-Threshold Sequential Scheme, Refinement Stages

Total Hours: 45

TEXT BOOK:

1. Sergios Theodoridis, Konstantinos Koutroumbas, "*Pattern Recognition*", Academic Press, Second Edition, 2009.

REFERENCE BOOKS:

1. Richard Duda, Peter E Hart, David G Stork, "*Pattern Classification*", John Wiley & Sons, Second Edition, 2001.
2. Pattern Recognition and Machine Learning, Christopher M.Bishop, Springer Publications 2006.

M. Tech. – II Semester
(19MT2AC01) STATISTICS WITH R
(Audit Course)
(Common to All M. Tech. Programs)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
-	-	-	2	-	-	-

PRE-REQUISITES: A course on Statistics.

COURSE DESCRIPTION:
Concepts of R programming basics, Bivariate and multivariate data, Confidence intervals, Goodness of fit, Analysis of variance.

COURSE OUTCOMES:
After successful completion of the course, students will be able to:
CO1: Import, manage, manipulate, and structure data files using R programming.
CO2: Implement models for statistical analysis of a given dataset and visualize the results to identify trends, patterns and outliers in data.

DETAILED SYLLABUS:

UNIT I - INTRODUCTION (Hours : 05)
Data, R's command line, Variables, Functions, The workspace, External packages, Data sets, Data vectors, Functions, Numeric summaries, Categorical data.

Unit II - BIVARIATE AND MULTIVARIATE DATA (Hours : 07)
Lists, Data frames, Paired data, Correlation, Trends, Transformations, Bivariate categorical data, Measures of association, Two-way tables, Marginal distributions, Conditional distributions, Graphical summaries, Multivariate data - Data frames, Applying a function over a collection, Using external data, Lattice graphics, Grouping, Statistical transformations.

UNIT III - POPULATIONS (Hours : 06)
Populations, Discrete random variables, Random values generation, Sampling, Families of distributions, Central limit theorem, Statistical Inference - Significance tests, Estimation, Confidence intervals, Bayesian analysis.

UNIT IV - CONFIDENCE INTERVALS (Hours : 06)
Confidence intervals for a population proportion, p - population mean, Other confidence intervals, Confidence intervals for differences, Confidence intervals for the median, Significance test - Significance test for a population proportion, Significance test for the mean (t-tests), Significance tests and confidence intervals, Significance tests for the median.

UNIT V - GOODNESS OF FIT (Hours : 06)
The chi-squared goodness-of-fit test, The multinomial distribution, Pearson's χ^2-statistic, chi-squared test of independence and homogeneity, Goodness-of-fit tests for continuous distributions, ANOVA - One-way ANOVA, Using *lm* for ANOVA.

Total Hours: 30

TEXT BOOKS:

1. John Verzani, *Using R for Introductory Statistics*, CRC Press, 2nd Edition, 2014.
2. Sudha G Purohit, Sharad D Gore, Shailaja R Deshmukh, *Statistics Using R*, Narosa Publishing house, 2nd Edition, 2015.

REFERENCE BOOKS:

1. Francisco Juretig, *R Statistics Cookbook*, Packt Publishing, 1st Edition, 2019.
2. Prabhanjan N. Tattar, Suresh Ramaiah, B. G. Manjunath, *A Course in Statistics with R*, Wiley, 2018.