PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

PERIYAR MANIAMMAI
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University)
Established Under Sec. 3 of UGC Act, 1956 - NAAC Accredited
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Criterion1 –Curricular Aspects

Key Indicator	1.1	Curriculum Design and Development
Metric	1.1.2	Percentage of Programmes where syllabus revision was carried out during academic year2022-23

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Sl. No.	Programme Code	Programme name	Year of Introduction	Year of revision	Percentage of Syllabus content added or replaced
01.	015	M.TECH- Wireless Communications (Fulltime)	2010 -11	2022-23	26%

S.No	Contents
1	Minutes of Board of Studies
2	Extracts of minutes of the Academic Council Meeting
3	Curriculum and Syllabus of the programme –Before Revisio
4	Curriculum and Syllabus of the programme–After Revision

Legend : Highlighted Color - Red – Indicates courses which are removed from syllabus before revision

Highlighted Color - Green – Indicates courses which are removed from syllabus after revision

1. a. Minutes of the Board of Studies for M.TECH - Wireless Communication (FullTime) held on07.07.2022

Department of
Electronics and Communication Engineering

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M.Tech Wireless Communication

Board of Studies Meeting

Date: 07.07.2022 **Time: 11:00 AM** **Venue: MarieCurie Hall**

Agenda

1. Implementation of Actions on curricular aspects from stake holders for Regulation 2022.
2. Presentation of PEOs, Pos, PSOs for M.Tech in Wireless Communications.
3. Presentation of Curriculum for M.Tech in Wireless Communications PG Degree Programme for Regulation 2022.
4. Presentation of Syllabi from I to IV semester for wireless communications PG Degree Programme for Regulation 2022.
5. Discuss on Programme articulation matrix (PO coverage by all Cos).

HOD / ECE 2/2/22

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Electronics and Communication Engineering
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PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

BOARD OF STUDIES MEETING

M.Tech FULL TIME PROGRAMME

Minutes of Meeting

Date: 07.07.2022**Time:** 11:00 AM**Venue:** TBI – Marie Curie Hall, PMIST

The Board of Studies meeting was held on 07.07.2022 for framing the M.Tech Wireless Communications– FT Curriculum and Syllabi of I to IV semester for Regulation 2022.

Agenda:

1. Implementation of actions on curricular aspects from stake holders for Regulation 2022
2. Presentation of PEOs, POs, PSOs for M.Tech in Wireless Communications
3. Presentation of Curriculum for Wireless CommunicationsPG degree programme for Regulation 2022
4. Presentation of syllabi from I to IV semesters for Wireless CommunicationsPG Degree programme of Regulation 2022
5. Discuss on programme articulation matrix (PO coverage by all COs)

Members present:

Table I -Members of the BoS

Sl.No.	Name	Designation	Representing	Signature
1.	Dr.C.Narmadha	HoD/ECE	Chairperson	7/7/22
2.	Dr.S.Senthamailkumar,	Dean(FET)	Special Invitee	07/7/22
2.	Dr. P.Muthuchidambaranathan	Professor, Department of Electronics and Communication Engineering, National Institute of Technology Tiruchirappalli -620015	Member - Academic	
3.	Mr.A.KaliaperumalM.Tech	Junior Telecom Officer, BSNL, Thanjavur	Member – Industry	
4.	Dr.SPK.Babu	Prof/ECE	Member	
5.	Dr.V.VioletJuli	Asso.Prof/ECE	Member	V. Violet Juli

6.	Dr.S.Janani	Asso. Prof/ECE	Member	
6.	Ms.C.Rajanandhini	AP/ECE	Member	
7.	Mr. U .Saravanakumar	AP/ECE	Member	
8.	Mr. R. Rakesh	AP/ECE	Member	
9.	M. Praveena	M.Tech/ECE	Student Member	
10.	B. Sohil khan	M.Tech/ECE		
11.	R. Tamilmozhi	M.Tech/ECE		
12.	K. Vishali	M.Tech/ECE		
13.				

A. Presentation of PEOs and POs

Four PEOs and seven POs were presented to the members. The following changes were recommended

Program Educational Objectives (PEOs)

Graduates from M.Tech Wireless Communication Systems will be able to

1. Demonstrate their knowledge, skills and proficiency in usage of modern tools in analysis and design of wireless communication systems.
2. Will be able to involve in innovation, optimization, design and development of present and future wireless communication systems according to international standards as an individual or as a group.
3. Will be able to carry out research and development and pursue higher education in field of wireless and mobile communication.
4. Design Electronic components for present and future wireless communication taking sustainability and environment issues.

Programme Outcomes (POs)

A graduate at the end of the programme will be able to

1. *Demonstrate* in depth knowledge in field of wireless communications with upto date information on latest technologies and global trends.
2. *Analyze* complex wireless communication systems and *formulate* solutions as an individual or group through skills, tools, techniques, methods or literature survey.
3. *Create, select, learn* and *apply* appropriate techniques, resources, and modern engineering and IT tools to complex wireless communication problems with an understanding of the limitations
4. *Demonstrate* knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, *manage* projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
5. *Communicate* with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to *comprehend* and *write* effective reports and *design* documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
6. *Recognize* the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
7. *Demonstrate* professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and *understand* the responsibility to contribute to the community for sustainable development of society.

7. Richards, Sheer and Holm (eds), "Principles of modern radar, basic principles", 2010

Year 2

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Year 3 - Nil

Lab equipment to be purchased

Year 1 - Nil
Year 2 - HFSS software
Year 3 - Nil

Specialized Staff to be augmented

Year 1 - RF
Year 2 - Nil
Year 3 - Nil

Teaching Aids needed

Year 1 - Nil
Year 2 - Nil
Year 3 - Nil

The BoS members recommended to submit the outcome of this meeting in the forthcoming Academic council meeting for approval.

Dr. P. MUTHU CHIDAMBARANATHAN)
NIT - TRICHY.

A. KALIA PERUMAL
(JTO - BSNL - THANJAVUR)

Head / ECE **Dean/FETDean Academic**

The developed POs was presented. The members agreed that there need not be any changes in the PO.

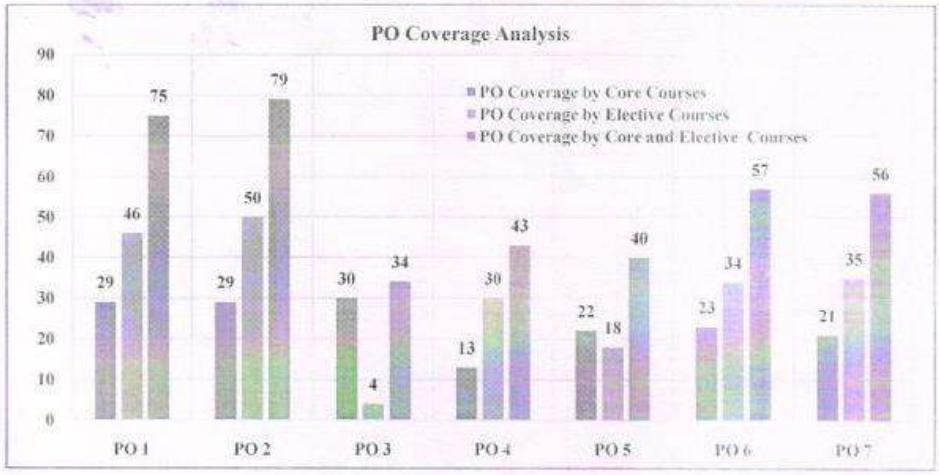


Figure I PO coverage by various courses

It is found that PO3 which is modern tool and technique usage by few courses. Other than that, the curriculum covers all POs with small deviations.

a. The BoS member Dr. P.Muthuchidambaranathan recommended to introduce various software tools if available in courses. He also asked to add assessment tools to assess the skill.
b. Dr.V.VioletJuli explained that "Real Time Project" part of the assessment template can be used effectively to assess such skills.

Similarly Dr.C.Narmadha pointed out that PO 4 has to be addressed where team work and project management are key skills.

K. Teaching Aids/Books/Infra/Lab Requirement

Books to be purchased

Year 1

1. Theodore S. Rappaport, Robert W. Heath, Robert C. Daniels and James N. Murdock,"Millimeter Wave Wireless Communications", 1st edition, 2014, Pearson
2. Hemadeh, K. Satyanarayana, M. El-Hajjar and L. Hanzo, "Millimeter-Wave Communications: Physical Channel Models, Design Considerations, Antenna Constructions, and Link-Budget," in IEEE Communications Surveys & Tutorials, vol. 20, no. 2, pp. 870-913
3. Chong, Chia-Chin & Hamaguchi, Kiyoshi & Smulders, Peter & Yong, Su. (2007). Millimeter-Wave Wireless Communication Systems: Theory and Applications. EURASIP J. Wireless Comm. and Networking. 2007. 10.1155/2007/72831.
4. Manuel Garcia Sanchez (Ed.), "Millimeter-Wave (mmWave) Communications" 2020 MDPI Books, ISBN 978-3-03928-431-3 (PDF)
5. Bassem R. Mahafza, "Radar Systems Analysis and Design Using MATLAB, CRC Press. Boca Raton, FL, United States, 2000
6. Sullivan, "Radar foundations for imaging and advanced concepts", 2004

7.	Research Methodology and IPR	entrepreneurship / skill
8.	English for Research Paper Writing	entrepreneurship / skill
9.	Wireless Networks Lab	skill
10.	MultiCarrierCommunication	employability
11.	MicrowavePassive and Active Systems	employability /
12.	AdvancedRadiationSystems	employability /
13.	Elective–III	employability/ entrepreneurship / skill
14.	Elective IV	employability/ entrepreneurship / skill
15.	Radio Frequency Systems lab	skill
16.	MiniProject	employability /entrepreneurship / skill
17.	Constitution of India	
18.	Dissertation Phase – I	employability / entrepreneurship / skill
19.	Elective -V	employability / entrepreneurship / skill
20.	1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects	employability / entrepreneurship / skill
21.	Dissertation Phase – II	employability / entrepreneurship / skill
22.	Modern Radar communication	employability / entrepreneurship / skill
23.	Mobile Satellite Communication	employability / entrepreneurship / skill
24.	AdvancedDigitalSignalProcessing	employability / entrepreneurship / skill
25.	Free space optics	employability / entrepreneurship / skill
26.	Mathematics for Communication Systems	employability / entrepreneurship / skill
27.	RF MEMS	employability / entrepreneurship / skill
28.	Antenna Systems for Wireless Applications	employability / entrepreneurship / skill
29.	Detection and Estimation Theory	employability / entrepreneurship / skill
30.	Wireless Network Security	employability / entrepreneurship / skill
31.	~~Adhoc Networks~~ MIMO Communication	employability / entrepreneurship / skill
32.	High Performance Computing Networks	employability / entrepreneurship / skill
33.	Internet of Things	employability / entrepreneurship / skill
34.	Soft Computing	employability / entrepreneurship / skill
35.	~~Multimedia Compression Techniques~~ Millimeter Wave Wireless Communications	employability / entrepreneurship / skill
36.	Software Defined Radio	employability / entrepreneurship / skill
37.	Fundamentals of 5G Mobile and Wireless Technology	employability / entrepreneurship / skill
38.	Quality of Service in Wireless Communication	employability / entrepreneurship / skill
39.	Telecom Network Planning and Management	employability / entrepreneurship / skill
40.	Regulation and Policy in the Telecommunications Industry	employability / entrepreneurship / skill

J. DISCUSSION ON PROGRAMME ARTICULATION MATRIX (PO COVERAGE BY ALL COS)

b. The courses which are mandatory and as Open Electives in the AICTE curriculum are present in the designed curriculum.

b. IEEE Wireless Communication Engineering Technologies Certification learning syllabus, outcomes and books are taken into consideration. Important aspects pertaining to **international needs**such as Emerging New Paradigms and Servicesare taken into account.

H. NOTES ON CREDIT DISTRIBUTION AND COMPARISION WITH AICTE GUIDELINES

Table IV: Credit distribution

Course Type	Symbol	Credits	Total	AICTE recommendation	Deviation
Professional Core Course	PCC	19	19	12	7
Professional Elective Course	PEC	15	15	15	0
Open Elective Course	OEC	3	6	8	-2
Professional Core Course - Lab	PCC-L	6	28	28	0
Project	Proj	28	3	3	0
AICTE Course - Audit	ACIET – Audit	0	0	0	0
AICTE Course - Mandatory	ACIET – Mandatory	2	2	2	0
			73	68	

It is found that there is deviation in core courses from the curriculum structure proposed by AICTE and the one presented. The members approved the deviation.

I. COURSES ON EMPLOYABILITY/ENTREPRENEURSHIP/SKILL DEVELOPMENT

The curriculum focus of including 96.07% of courses with either/and employability/entrepreneurship/skill development. The courses are given below:

Table V Categorization of courses

S.No	COURSE TITLE	
1.	~~ModernDigitalCommunication~~ Fundamentals of wireless communication	employability
2.	~~WirelessCommunication~~ Advanced Digital Communication	employability
3.	Wireless Networks	employability /
4.	Elective I	employability / entrepreneurship / skill
5.	Elective–II	employability / entrepreneurship / skill
6.	Digital Communication Lab	skill

34.	Soft Computing				
35.	~~Multimedia Compression Techniques~~ **Millimeter Wave Wireless Communications**		New course		Feedback by Teachers
36.	Software Defined Radio				
37.	Fundamentals of 5G Mobile and Wireless Technology				
38.	Quality of Service in Wireless				
39.	Telecom Network Planning and Management				
40.	Regulation and Policy in the Telecommunications Industry				

D. LIST OF NEWLY INTRODUCED COURSES IN REGULATION 2022

a. MIMO Communication
b. Millimeter Wave Wireless Communications
c. Modern Radar communication
d. Advanced Technologies in Wireless Networks

E. LIST OF COURSES REMOVED

Table III Table of courses removed with remarks

S.No	Course Code and Name	Remarks
1	Adhoc Networks	The contents are covered in wireless networks
2	Multimedia Compression Techniques	Courses in signal processing areas covers these topics
3	Radar Communication	New radar technologies which have emerged for civilian use is added. Therefore new course syllabus is presented
4	High Performance computing	Updated with respect to wireless

F. PERCENTAGE CHANGE IN THE SYLLABUS

Number of new or 50% change courses added = **6 core** + 2 Electives=25 credits
Number of courses removed = 4 = 03 credits
% change = (18/68) x 100 = 26 %

G. NOTES ON BENCHMARKING WITHUGC/AICTE/CoA/NCTE/World Top Universities MODEL CURRICULUM

a. It is found that AICTE has not given any model syllabus for Wireless Communication. The AICTE model curriculum related to Electronics was presented in the BoS. The members compared the credit distribution of the designed curriculum and discussed the following
   a. The credits of the both the curriculum was found to be same.

	Networks				
4.	Elective I				
5.	Elective–II				
6.	Digital Communication Lab		PSD, CTO, CFO added	50%	
7.	Research Methodology and IPR				
8.	English for Research Paper Writing				
9.	Wireless Networks Lab				
10.	MultiCarrierCommunication				
11.	MicrowavePassive and Active Systems			50%	Feedback by staff
12.	AdvancedRadiationSystems			50%	
13.	Elective–III				
14.	Elective IV				
15.	Radio Frequency Systems lab	Basic Experiments removed	More antennas experiment added	80%	Feedback by students
16.	MiniProject				
17.	Constitution of India				
18.	Dissertation Phase – I				
19.	Elective -V				
20.	1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects				
21.	Dissertation Phase – II				
22.	**Modern Radar communication**	Basics and redundant removed	Civilian application and new technologies added	80%	Feedback by Teachers
23.	Mobile Satellite Communication				
24.	AdvancedDigitalSignalProcessing				
25.	Free space optics				
26.	Mathematics for Communication				
27.	RF MEMS				
28.	Antenna Systems for Wireless				
29.	Detection and Estimation Theory				
30.	Wireless Network Security				
31.	~~Adhoc Networks~~ **MIMO Communication**		Detailed MIMO syllabus	60%	
32.	High Performance Computing Networks				
33.	Internet of Things				

7. Richards, Sheer and Holm (eds), "Principles of modern radar, basic principles", 2010

Year 2

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Year 3 - Nil

Lab equipment to be purchased

Year 1 - Nil
Year 2 - HFSS software
Year 3 - Nil

Specialized Staff to be augmented

Year 1 - RF
Year 2 - Nil
Year 3 - Nil

Teaching Aids needed

Year 1 - Nil
Year 2 - Nil
Year 3 - Nil

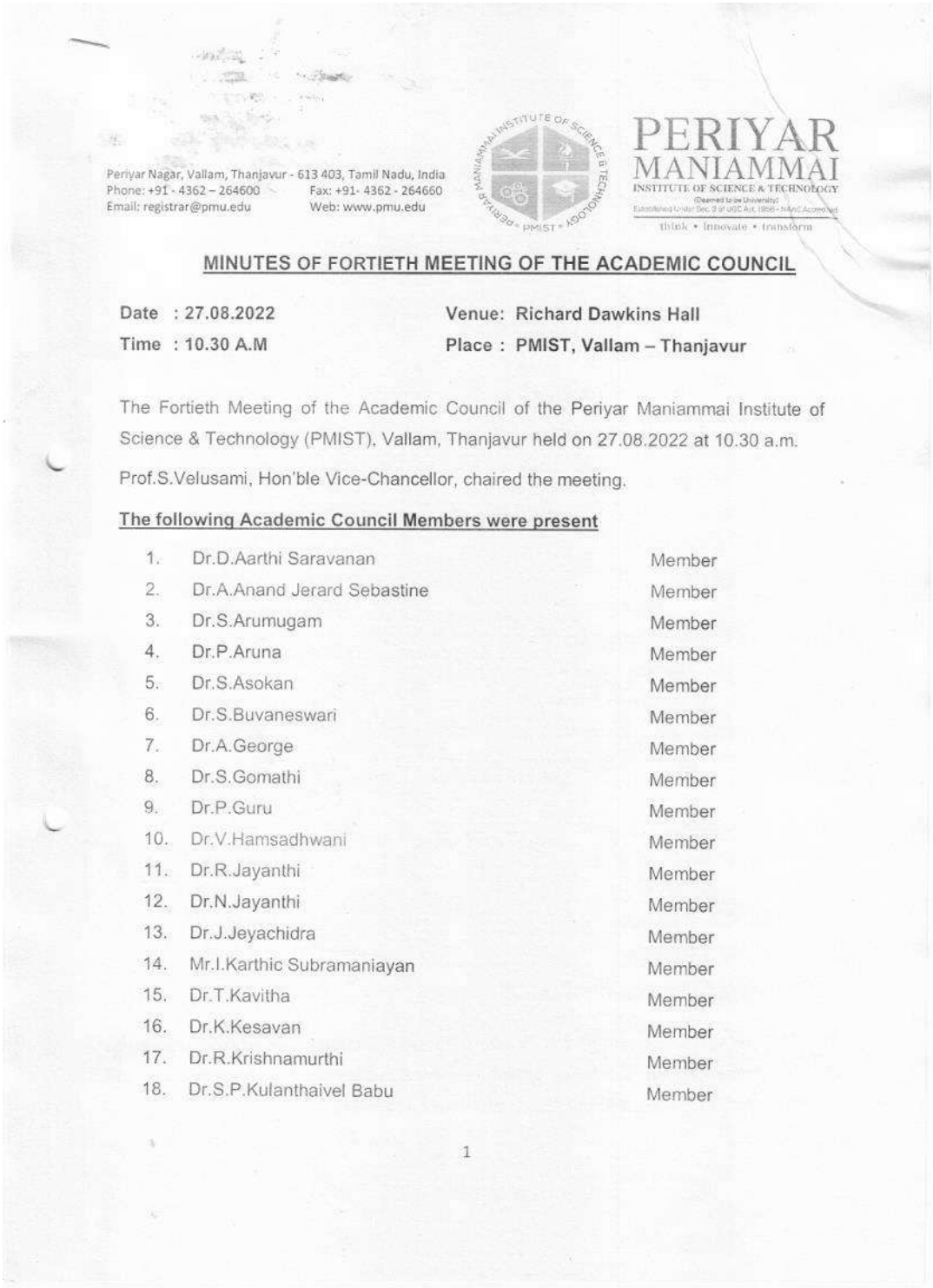
The BoS members recommended to submit the outcome of this meeting in the forthcoming Academic council meeting for approval.

CDr. P. MUTHU CHIDAMBARANATHAN)
NIT - TRICHY.

A. KALIA PERUMAL
(JTO - BSNL - THANJAVUR)

Head / ECE

2.a.Extracts of the Minutes of 40thACM Meeting for M.Tech held on 27.08.2022



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MINUTES OF FORTIETH MEETING OF THE ACADEMIC COUNCIL

Date : 27.08.2022 **Venue: Richard Dawkins Hall**
Time : 10.30 A.M **Place : PMIST, Vallam – Thanjavur**

The Fortieth Meeting of the Academic Council of the Periyar Maniammai Institute of Science & Technology (PMIST), Vallam, Thanjavur held on 27.08.2022 at 10.30 a.m.

Prof.S.Velusami, Hon'ble Vice-Chancellor, chaired the meeting.

The following Academic Council Members were present

1.	Dr.D.Aarthi Saravanan	Member
2.	Dr.A.Anand Jerard Sebastine	Member
3.	Dr.S.Arumugam	Member
4.	Dr.P.Aruna	Member
5.	Dr.S.Asokan	Member
6.	Dr.S.Buvaneswari	Member
7.	Dr.A.George	Member
8.	Dr.S.Gomathi	Member
9.	Dr.P.Guru	Member
10.	Dr.V.Hamsadhwani	Member
11.	Dr.R.Jayanthi	Member
12.	Dr.N.Jayanthi	Member
13.	Dr.J.Jeyachidra	Member
14.	Mr.I.Karthic Subramaniayan	Member
15.	Dr.T.Kavitha	Member
16.	Dr.K.Kesavan	Member
17.	Dr.R.Krishnamurthi	Member
18.	Dr.S.P.Kulanthaivel Babu	Member

1

POST GRADUATE PROGRAMMES (FULL-TIME)

Sl.No.	Programme	Duration	Intake
1	M. Arch.	2 Years	20
2	M.Tech.-Environmental Engineering	2 Years	18
3	M.Tech.-Nano Technology	2 Years	18
4	M.Tech.-Renewable Energy	2 Years	18
5	M.Tech.-Wireless Communications	2 Years	18
6	M.Tech. -Power Electronics and Drives	2 Years	18
7	M.B.A. (Dual Specialization) • Finance • Human Resource • Marketing • Operations • Business Analytics	2 Years	120
8	M.S.W.	2 Years	20
9	M.Sc.-Chemistry	2 Years	20
10	M.Sc.-Mathematics	2 Years	20
11	M.Sc.-Physics	2 Years	20
12	M.Sc - Computer Science	2 Years	20
13	M.A.-English	2 Years	20
14	M.A.-Political Science	2 Years	20
15	M.A.-Periyar Thought	2 Years	20
16	M.A.-History	2 Years	20
17	M.A.-Tamil	2 Years	20
18	M.C.A.	2 Years	120
19	M.Com.	2 Years	20

Ph.D Programmes (Full-Time & Part-Time)

Architecture	
Sl. No	**Programme**
1	Architecture
Engineering & Technology	
1	Biotechnology
2	Civil Engineering
3	Electrical & Electronics Engineering
4	Electronics & Communication Engineering
5	Mechanical Engineering
6	Nano Technology
Humanities, Sciences and Management	
1	Chemistry
2	Commerce
3	English
4	Management Studies
5	Mathematics
6	Periyar Thought
7	Physics
8	Social Work
9	Political Science
Computing Sciences and Engineering	
1	Computer Science and Applications

- Lateral Entry 10% of sanctioned Intake of each of the B.Tech First Year Programmes and Lapsed Seats in the respective First Year Programmes.

The matter is placed before the Academic Council for approval.

7

3. a.Curriculum and Syllabus of the programme–M.Tech Before Revision 2022

SEMESTER I

	CODE NO.	COURSE TITLE	L	T	P	C	H
PCC	YWC101	Applied Mathematics for Communication Systems	3	0	3	3	3
PCC	YWC102	Wireless Communication	3	0	0	3	3
PCC	YWC103	Modern Digital Communication	3	0	0	3	3
PEC	YWC104*	Elective I	3	0	0	3	3
PEC	YWC105*	Elective–II	3	0	0	3	3
PCC-L	YWC106	Wireless Networks Lab	0	0	1	1	2
PCC-L	YWC 107	Digital Communication Lab	0	0	1	1	2
MC	108	Research Methodology and IPR	2	0	0	0	2
MC - Audit	109	English for Research Paper Writing	2	0	0	0	2

Total Hours:23 **Total Credits: 17**

SEMESTER II

	CODE NO.	COURSE TITLE	L	T	P	C	H
PCC	YWC201	Multi Carrier Communication	3	0	0	3	3
PCC	YWC202	Microwave Passive and Active Systems	3	0	0	3	3
PCC	YWC203	Advanced Radiation Systems	3	0	0	3	3
PEC	YWC204*	Elective–III	3	0	0	3	3
PEC	YWC205*	Elective IV	3	0	0	3	3
PCC-L	YWC206	Radio Frequency Systems lab	0	0	1	1	2
PCC-L	YWC207	MiniProject	0	0	1	2	4
MC- Audit	208	Constitution of India	2	0	0	0	2

Total Hours: 21 **Total Credits: 18**

SEMESTER III

	CODE NO.	COURSE TITLE	L	T	P	C	H
PCC	YWC301	Dissertation Phase – I	0	0	10	10	20
PEC	YWC302*+	Elective -V	0	0	0	3	3
OEC	Open Elective*+	1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects	3	0	0	3	3

*+ Directed study - Only SA.

Total Hours: 26 **Total Credits: 16**

SEMESTER IV

	CODE NO.	COURSE TITLE	L	T	P	C	H
PCC	YWC401	Dissertation Phase – II	0	0	16	16	32

Total Hours: 32 **Total Credits: 16**

Overall Credits:68

Legend

PCC – Professional Core Course
PEC- Professional Elective Course
OEC – Open Elective Course
PCC-L – Professional Core Course - Lab

LIST OF ELECTIVES

Sl.No	CodeNo	CourseTitle	L	T	P	C
ELECTIVE-I						
1	YWC106A	Radar communication	3	0	0	3
2	YWC106B	Mobile Satellite Communication	3	0	0	3
3	YWC106C	AdvancedDigitalSignalProcessing	3	0	0	3
4	YWC106D	Free space optics	3	0	0	3
ELECTIVE-II						
1	YWC205A	Wireless Networks	3	0	0	3
2	YWC205B	RF MEMS	3	0	0	3
3	YWC205C	Antenna Systems for Wireless Applications	3	0	0	3
4	YWC205D	Detection and Estimation Theory	3	0	0	3
ELECTIVE-III						

1	YWC206A	Wireless Network Security	3	0	0	3
2	YWC206B	Adhoc Networks	3	0	0	3
3	YWC 206C	High Performance Computing Networks	3	0	0	3
4	YWC206D	Internet of Things	3	0	0	3
ELECTIVE-IV						
1	YWC207A	Soft Computing	3	0	0	3
2	YWC207B	Multimedia Compression Techniques	3	0	0	3
3	YWC 207C	Software Defined Radio	3	0	0	3
4	YWC207D	Fundamentals of 5G Mobile and Wireless Technology	3	0	0	3
ELECTIVE-V						
1	YWC2302A	Quality of Service in Wireless Communication	3	0	0	3
2	YWC302B	Telecom Network Planning and Management	3	0	0	3
3	YWC 302C	Regulation and Policy in the Telecommunications Industry	3	0	0	3

SUBCODE	**SUB NAME**	**L**	**T**	**P**	**C**
YWC101	**APPLIEDMATHEMATICS FOR COMMUNICATION SYSTEMS**	**3**	**1**	**0**	**4**

UNITI **9**

VECTOR SPACES

Vector Spaces, Subspaces, Linearly Independence and dependence, Dimension and Bases, Rank – Nullilty dimension theorem, Inner product spaces, Orthogonality and Gram-Schmidt orthogonalization process, Diagonalization

UNIT II **9**

ALGEBRA

Sets-Relationsand functions-Definitions; Groups-Definition and elementary properties-subgroups-abelian groups-Lagranges theorem-properties; Field-Finitefields-elementary properties-subfields-statements, properties.**Matrix Theory–**Some important matrix factorizations– The Choleskyde composition–QR factorization–Least squares method–ingular value decomposition.

UNIT III **9**

RANDOM VARIABLES AND THEIR DISTRIBUTIONS

Random variables - Probability function – Moments – Moment Generation Function, Characteristic Function, Binomial Distribution, Negative Binomial Distribution, Hypergeometric distribution, Multinomial, Poisson Distributions and Relationship between various Discrete-Type distributions Normal, Log - Normal, Multivariate Normal, Gamma, Exponential, Chi-square, Weibull, Rayleigh distributions. Relationship between continuous distributions.

UNIT IV **9**

STOCHASTIC PROCESSES

Introduction- Classification of stochastic process, Stationary process (SSS and WSS) Stationary process, Ergodic Process, Independent increment Process, Markov Process, Counting Process, Narrow- Band Process, Normal Process, Wiener-Levy Process, Poisson, Bernoulli, Shot noise Process, Autocorrelation Function.

UNIT V	9

QUEUEING MODELS

Poisson Process – Markovian queues – Single and Multi-server Models – Little's Formula – Machine Interference Model – Steady State analysis – Self Service queue.

LECTURE	TUTORIAL	TOTAL
45	15	60

REFERENCES

1. Grewal B.S., "Numerical methods in Engineering and Science", 40th edition, Khanna Publishers, 2007. [unit I]
2. Moon, T.K., Sterling, W.C., "Mathematical methods and algorithms for signal processing", Pearson Education, 2000.
3. Richard Johnson, Miller & Freund, "Probability and Statistics for Engineers", 7th Edition, Prentice – Hall of India, Private Ltd., New Delhi (2007).[unit III &IV]
4. Michel K. Ochi , "Applied Probability and Stochastic Processes," John Wiley & Sons .ISSN – 0271- 6356, 2008.
5. Kenneth Hoffman, "Linear Algebra", Prentice Hall of India Private Limited, New Delhi.[unit II]
6. Grewal,B.S, Higher Engineering Mathematics, 37th edition, Khanna Publishers,2003. [unit I]

SUBCODE	SUB NAME	L	T	P	C
YWC102	WIRELESSCOMMUNICATION	3	1	0	4

UNIT I	9

WIRELESS CHANNEL

Introduction to wireless systems, Transmitter-Receiver Architecture-Wireless Standards.Physical modeling for the wireless channel-Free space, fixed transmit and receive antennas; Free space, moving antenna; Reflecting wall, fixed antenna reflecting wall; moving antenna Reflection from a ground plane; Power decay with distance and shadowing; Moving antenna, multiple reflectors; Input /output model of the wireless channel - The wireless channel as a linear time-varying system; Baseband equivalent model; A discrete-time baseband model; Additive white noise; Time and frequency coherence ; Doppler spread and coherence time; Delay spread and coherence bandwidth ,Statistical channel models- Rayleigh and Rician fading.

UNIT II	9

POINT TO POINT COMMUNICATION, DETECTION, DIVERSITY

Non-coherent detection, Coherent detection from BPSK to QPSK: exploiting the degrees of freedom Diversity, Time diversity Repetition coding, Time diversity code design criterion, Time diversity in GSM. Antenna diversity- Receive diversity Transmit diversity, space-time codes MIMO, MIMO schemes Frequency diversity-Basic concept Single-carrier with ISI equalization Direct-sequence spread-spectrum, Orthogonal frequency division multiplexing Communication over frequency-selective channels. Impact of channel uncertainty -Non-coherent detection for DS spread-spectrum, Channel estimation, other diversity scenarios

UNIT III	9

CELLULAR SYSTEMS AND CHANNEL CAPACITY

Multiple access and interference management , Narrowband and wideband systems, Capacity of wireless channels -AWGN channel capacity, Resources of the AWGN channel, Linear time-invariant Gaussian channels, Capacity of fading channels, Multiuser capacity-uplink AWGN channel, Downlink AWGN channel, uplink fading channel, downlink fading channel

UNIT IV	9

MIMOI: SPATIAL MULTIPLEXING AND CHANNEL MODELING

Multiplexing capability of deterministic MIMO channels- Capacity via singular value decomposition - Physical modeling of MIMO channels- Modeling of MIMO fading channels- capacity and multiplexing architectures -The V-BLAST architecture, Fast fading MIMO channel- Receiver architectures

UNIT V **9**

MIMOII: MULTIUSER COMMUNICATION

Uplink with multiple receive antennas -MIMO uplink- Downlink with multipletransmit antennas. MIMO downlink-Multiple antennas in cellular networks: a system view

	LECTURE	TUTORIAL	TOTAL
	45	15	60

REFERENCES

1. 1.David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005.
2. T.S.Rappaport "Wireless Communication" Pearson Education, 2002
3. E.A.Lee and D.G.Messerschmitt "Digital Communication" 2nd Ed., AlliedPub,1994.
4. John .G.Proakis "Digital Communications" 4th Ed. Mc Graw Hill Int. Ed.,2000.
5. Rappaport T.S., "Wireless Communications; Principles and Practice", Prentice Hall, NJ, 1996.
6. Lee W.C.Y., "Mobile Communications Engineering: Theory and Applications", Second Edition, McGraw-Hill, New York, 1998.
7. Schiller, "Mobile Communications", Pearson Education Asia Ltd., 2000
8. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005

SUBCODE	SUB NAME	L	T	P	C
YWC103	MODERNDIGITALCOMMUNICATION	3	0	1	4

UNIT I **8**

POWERSPECTRUM AND COMMUNICATIONOVERMEMORYLESSCHANNEL

Review of Autocorrelation and Spectral density, PSD of a synchronous data pulse stream; M-ary Markov source; Continuous phase modulation – Scalar and vector communication over memoryless channel – Detection criteria.

UNIT II **12**

BLOCKCODEDDIGITALCOMMUNICATION

Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Tran orthogonal; Linear block codes; Hamming; Golay; Cyclic; BCH; Reed – Solomon codes.

CONVOLUTIONALCODEDDIGITALCOMMUNICATION

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods, Turbo Coding

UNIT III **8**

OPTIMUMRECEIVERS

Shannon's channel coding theorem; Channel capacity; Optimum Receiver;Correlation demodulator, Matched filter demodulator, properties of the matched filter, Frequency domain interpretation of the matched filter.

UNIT IV **9**

COHERENTANDNON-COHERENTCOMMUNICATION

Coded BPSK and DPSK demodulators Detections of Signals in Gaussian Noise: Decision Regions-correlation receivers- coherent detection- detection of PSK and multiple PSK-BER analysis-sampled matched filter-coherent detection of FSK - BER analysis. Non coherent Detection: Detection of DPSK, FSK-BER analysis- Performance of Non Coherent detection in Random phase, Rayleigh and Rician channels.

UNIT V	**8**

COMMUNICATIONS LINK ANALYSIS

Channel and sources of signal loss, Received Signal Power and Noise Power, Link Budget Analysis, Noise Figure, Noise Temperature, and System Temperature, Sample Link Analysis, Satellite Repeaters

	LECTURE	**PRACTICAL**	**TOTAL**
	45	**30**	**75**

REFERENCES

1. M.K.Simon, S.M.Hinedi and W.C.Lindsey, Digital communication techniques; Signalling and detection, Prentice Hall India, New Delhi. 1995.
2. Simon Haykin, Digital communications, John Wiley and sons, 2007
3. Bernard Sklar,"Digital Communications Fundamentals and Applications", 2nd Edition, Prentice Hall PTR, Upper Sadle River, New Jersey,2002.
4. B.P.Lathi Modern digital and analog communication systems, 3rd Edition, Oxford University press 1998.
5. Haykins, “Communication Systems”, 5th ed., John Wiley, 2008. [Unit-I, III, V].
6. M. K. Simon and M. S. Alouini,” Digital Communication over Fading Channels”,Wiley-Interscience, 2nd Edition 2005.
7. R. G. Gallager, “Principles of Digital Communication”, Cambridge University Press, 2008.

SUBCODE	**SUB NAME**	**L**	**T**	**P**	**C**
YWC106	**WIRELESS NETWORKS LAB**	**0**	**0**	**1**	**1**
	LIST OF EXPERIMENTS				

1. Analysis of wireless network with Wireshark.
2. TCL scripts and Xgraph.
3. Comparison of DSDV,DSR and AODV Routing protocols.
4. Implementation of MAC algorithm for wireless network.
5. Program to implement energy models for wireless nodes.
6. Implementation of symmetric key encryption using Ns2.
7. Implementation of Gray hole and wormhole attack in Ns2.
8. Program to calculate packet delivery ratio,packet loss,throughput,end to end delay and routing overhead for Wireless Networks.
9. Implementation of congestion control algorithms.
10. Simulate a wireless Personal Area Networks.
11. Measurement on the effect of RTS/CTS on a wireless link.
12. Performance comparison of GSM and CDMA networks

REFERENCES:

1. Advanced Network Technologies Virtual Lab @ www.virtual-

2. www.winlab.rutgers.edu/zhibinwu/pdf/tr_ns802_11.pdf
3. www.ittc.ku.edu/jpgs/courses/.../lecture-lab-intro2ns3-print.pdf
4. www.isi.edu/nsnam/ns/

SUBCODE	SUB NAME	L	T	P	C
YWC107	DIGITAL COMMUNICATION LAB	0	0	1	1
	LIST OF EXPERIMENTS				

1. Demonstrate the theoretical and simulated BER for M-ary PSK using MATLAB.
2. Demonstration of theoretical and simulated BER for M- QAM in AWGN using MATLAB
3. Rayleigh fading channel simulation
4. BER for BPSK/QPSK/QAM under Rayleigh channel
5. Single parity: Encoding and Decoding
6. Hamming code: Encoding and Decoding
7. Equalizers
8. Direct Sequence Spread Spectrum
9. Simulation of OFDM IN MATLAB
10. BER performance of BPSK using convolutional code under AWGN channel

REFERENCES:

http://www.vlab.co.in/
http://203.110.240.139/
http://iitg.vlab.co.in/?sub=59&brch=163
http://solve.nitk.ac.in/

SUBCODE	SUB NAME	L	T	P	C
	RESEARCH METHODOLOGY AND IPR	3	1	0	4

UNIT I — **9**

Meaning of research problem, Sources of research problem, Criteria-Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II — **9**

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III — **9**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation ,patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT IV — **9**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V — **9**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

	LECTURE	TUTORIAL	TOTAL
	45	15	60

REFERENCES

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

SUBCODE	SUB NAME	L	T	P	C
YWC201	MULTICARRIERCOMMUNICATION	3	1	0	4

UNIT I — **9**

FUNDAMENTALSOFOFDM/OFDMASYSTEMS

Mobile channel modeling- Parameters of wireless channels, Categorization of fadingchannels. Conventional methods for channel fading mitigation-Time-selective fading, Frequency-selective fading. OFDM systems- System architecture, Discrete-time model of an OFDM system, Spectral efficiency, Strengths and drawbacks of OFDM. OFDM-based multiple access schemes.

UNIT II — **9**

SYSTEMIMPERFECTIONS

Time and frequency Synchronizations-Sensitivity to timing and frequency errors, Synchronizations for downlink transmission, Synchronizations for uplink transmissions. Peak-to-Average Power Ratio (PAPR)-definitions, Statistical properties of PAPR, PAPR reduction techniques. Channel estimation and equalization techniques.

UNIT III — **9**

OFDMPERFORMANCE

OFDM System Performance over AWGN Channels-Clipping Amplification, BER Performance Using Clipping Amplifiers, Signal Spectrum with Clipping amplifier. Analogue- to-Digital Conversion, Phase Noise -Effects of phase noise, White Phase Noise Model, coloured phase noise, OFDM transmission over wideband channel-channel model,Effects of Time Dispersive Channels on OFDM, system performance over dispersive channel.

UNIT IV — **9**

MCCDMA

OFDM versus MC-CDMA, CDMA- MC-CDMA, MC-DS-CDMA, MT- CDMA,MC- MC-CDMA System. Basic spreading sequences, MC-CDMA System Performance in Synchronous Environment, Advanced peak factor reduction techniques.

UNIT V — **9**

APPLICATIONSOF OFDMANDMC-CDMA

Digital Broadcasting- Digital Audio Broadcasting, Terrestrial Digital Video Broadcasting, Terrestrial Integrated Services Digital Broadcasting, GHz-Band Wireless LANs- IEEE 802.11g , IEEE 802.11h , IEEE 802.16a.

	LECTURE	TUTORIAL	TOTAL
	45	15	60

REFERENCES

1. Man-On Pun Michele Morelli C-C Jay Kuo, "Multi-Carrier Techniques For Broadband Wireless Communications A Signal Processing Perspective" 2007 by Imperial College Press
2. Hara, Shinsuke. Multicarrier techniques for 4G mobile communications Artech House Universal personal communications series 2003
3. OFDM and MC-CDMA A Primer L. Hanzo, T. Keller 2006 John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
4. Liu, Hui, OFDM-based broadband wireless networks: design and optimization 2005 by John Wiley & Sons
5. Lie Liang Yang, "Multicarrier Communications", John Wiley & Sons Ltd, 2009
6. Andreas F. Molisch, "Wireless Communications", Wiley IEEE, 2011.
7. James B. Y. Tsui, "Special Design Topics in Digital Wideband Receivers", Artech House Radar Library, 2009.

SUBCODE	SUB NAME	L	T	P	C
YWC202	MICROWAVE PASSIVE AND ACTIVE SYSTEMS	3	0	1	4

UNIT I **9**

MICROWAVE CIRCUITS:

S parameters reciprocal networks, Lossless networks, Planar transmission Lines: Micro strip, Slot line, Strip and coplanar lines. Impedance matching: Matching with lumped elements, Stub matching-Single and double stub using Smith chart solutions, Quarter wave transformer, tapered lines-Exponential taper, triangular taper.

UNIT II **9**

PASSIVE CIRCUIT DESIGN wave guide based Directional coupler, E & H plane Tee junction, hybridT, isolator, circulator, slotted line section, Frequency meter, Attenuator, microwave Antenna

UNIT III9

MICROWAVE INTEGRATED PASSIVE CIRCUITS

Power divider coupler Wilkinson power divider90 degreeHybrid Coupler,180 degree coupler, Filter design: Periodic structures, Insertion loss method, maximally flat low pass filter, stepped impedance low pass filter, filter transformation, filter implementation.

UNIT IV9

MICROWAVE SYSTEMS RF transceiver, Microwave standards, Satellite link, Cellular Communication system, Radar systems

UNIT V9

ACTIVE MICROWAVE CIRCUIT DESIGN

Characteristics of microwave diodes and transistors. Linear and nonlinear behavior and models-Amplifier design; gain and stability, design for noise figure- Noise in microwave circuits; dynamic range and noise sources, equivalent noise temperature, system noise figure considerations

	LECTURE	PRACTICAL	TOTAL
	45	30	75

Reference Books

1. David M. Pozar," Microwave Engineering," John Wiley & Sons, 1998.
2. David M. Pozar," Microwave & RF Design of Wireless Systems," John Wiley & Sons, 1998.
3. R.E.Collin," Foundations of Microwave Engineering," Tata McGraw Hill, 1995.
4. www.agilent.com

SUBCODE	SUB NAME	c	T	P	C
YWC204	ADVANCED RADIATION SYSTEMS	3	0	0	3

UNITI **9**

BASICCONCEPTSOFRADIATION

Radiation from surface current and current line current distribution, Basic antennaparameters, Radiation mechanism-Current distribution of an Antennas, Impedance concept-Balance to Unbalanced transformer.

UNITII **9**

RADIATIONFROMAPERTURES

Field equivalence principle, Rectangular and circular apertures, Uniform distributionon an infinite ground plane, Aperture fields of Horn antenna-Babinets principle, Geometrical theory of diffraction, Reflector antennas, and Design considerations - Slot antennas.

UNITIII **9**

SYNTHESISOFARRAYANTENNAS

Types of linear arrays, current distribution in linear arrays, Phased arrays,Optimization of Array patterns, Continuous aperture sources, Antenna synthesis techniques.

UNITIV **9**

MICROSTRIPANTENNAS

Radiation mechanisms, Feeding structure, Retangular patch, Circular patch, Ringantenna. Input impedance of patch antenna, Microstrip dipole, Microstrip arrays

UNITV **9**

EMIS/EMC/ANTENNAMEASUREMENTS

Log periodic, Bi-conical, Log spiral ridge Guide, Multi turn loop, Travelling Waveantenna, Antenna measurement and instrumentation ,Amplitude and Phase measurement, Gain, Directivity. Impedance and polarization measurement, Antenna range, Design and Evaluation

LECTURE	TUTORIAL	TOTAL
45	0	45

REFERENCES:

1.Kraus.J.D.,"Antennas"IIEdition,JohnwileyandSons,1997
2.Balanis.A,"AntennaTheoryAnalysisandDesign",JohnWileyandSons,NewYork,19823
3.Collin.R.E.andZucker.F.,"AntennaTheory"PartI,McGrawHill,NewYork,1969
4.QizhengGu,"RFSystemDesignofTransceiversforWirelessCommunications" ,Springer,2010.
5.MichaelB.Steer,"MicrowaveandRFDesign:ASystemsApproach",SciTech Publishing,2009.
6.KenKuang,FranklinKimandSeanS.Cahill,"RFandMicrowaveMicroelectronics Packaging",Springer,2009.
7.R.JacobBaker,"CMOSCircuitDesign,Layout,andSimulation",3rdEdition(IEEE PressSeriesonMicroelectronicSystems),2010

SUBCODE	SUB NAME	L	T	P	C
YWC206	RADIO FREQUENCY SYSTEMS LAB	0	0	1	1
	LIST OF EXPERIMENTS				

EM simulator

1. Experimentation with:
   - Directional coupler
   - Circulator
   - Isolator
   - Attenuator
   - Slotted line bench
   - Microwave horn antenna
2. Directional Simulation of Planar Transmission Lines and matching network
3. Simulation of Microwave Filters
4. Couplers and Power dividers
5. Patch antenna

REFERENCES:

ELECTIVES LIST

SUBCODE	SUB NAME	L	T	P	C
YWC106A	RADAR COMMUNICATION	3	0	0	3
UNIT I					9

INTRODUCTIONTORADAR

Basic Radar–The simple form of the Radar Equation-Radar Block Diagram-Radar Frequencies–plications of Radar–The Origins of Radar, The Radar Equation.Introduction-Detection of Signals in Noise – Receiver Noise and the Signal-to-Noise Ratio-Probability Density Functions-Probabilities of Detection and False Alarm-Integration of Radar Pulses-Radar Cross Section of Targets- Radar cross Section Fluctuations-Transmitter Power-Pulse Repetition Frequency-Antenna Parameters -System losses–Other Radar Equation Considerations.

UNIT II 9

MTIANDPULSEDOPPLERRADAR

Introduction to Doppler and MTI Radar- Delay–Line Cancelers-Staggered Pulse Repetition Frequencies–Doppler Filter Banks- Digital MTI Processing- Moving Target Detector-LimitationstoMTI Performance-MTI from a Moving Platform(AMIT)-Pulse Doppler Radar–Other Doppler Radar Topics-tracking with Radar–MonopulseTracking–ConicalScanandSequentialLobing-LimitationstoTrackingAccuracy-Low-AngleTracking-TrackinginRange-Other Tracking Radar Topics-Comparison of Trackers-Automatic Tracking with Surveillance Radars(ADT).

UNIT III 9

TRANSMITTERANDRECEIVERS

RadarTransmitters-Introduction–LinearBeamPowerTubes-SolidStateRFPowerSources-Magnetron-CrossedFieldAmplifiers-OtherRFPowerSources-OtheraspectsofRadarTransmitter.RadarReceivers-TheRadarReceiver-ReceivernoiseFigure-SuperheterodyneReceiver-DuplexersandReceiverProtectors-Radar Displays.

UNIT IV 9

DIRECTIONFINDINGANDRANGEMEASUREMENTS

Introduction –Four methodsofNavigation.RadioDirectionFinding-TheLoopAntenna-LoopInputCircuits – An Aural Null Direction Finder-TheGoniometer-Errorsin DirectionFinding-Adcock Direction Finders-Direction Findingat VeryHighFrequencies-AutomaticDirectionFinders-TheCommutatedAerialDirectionFinder-RangeandAccuracyofDirectionFinders,RadioRanges-TheLF/MFFourcourseRadioRange-VHFOmniDirectionalRange(VOR)-VORReceivingEquipment-RangeandAccuracyofVOR-RecentDevelopments.

UNIT V **9**

DISTANCE MEASURING, LANDING SYSTEMSAND DOPPLER NAVIGATION

DME and TACAN –Distance Measuring Equipment –Operation of DME-TACAN-TACAN Equipment Aids to Approach and Landing- Instrument Landing System-GroundControlledApproachSystem-MicrowaveLandingSystem(MLS)DopplerNavigation-TheDopplerEffect-BeamConfigurations-DopplerFrequencyEquations-TrackStabilization-DopplerSpectrum-Component so f the DopplerNavigationSystem-DopplerrangeEquation-AccuracyofDopplerNavigationSystems. Inertial Navigation –Principles of Operation-Navigation Over the Earth-Component sofan Inertial NavigationSystem-EarthCoordinateMechanization-Strapped-DownSystems-AccuracyofInertialNavigationSystems. Satellite Navigation System-The Transit System-Navstar Global Positioning System(GPS)

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. MerrillI.Skolnik,"IntroductiontoRadarSystems",TataMcGraw-Hill(3rd Edition)2003
2. PeytonZ.Peebles:,"RadarPrinciples",Johnwiley,2004
3. J.CToomay,"PrinciplesofRadar",2nd Edition–PHI,2004

SUBCODE	SUB NAME	L	T	P	C
YWC106B	MOBILESATELLITECOMMUNICATION	3	0	0	3

UNIT I **9**

INTRODUCTIONTOSATELLITECOMMUNICATION: SatelliteOrbits–SatelliteConstellations–OrbitalMechanics–Equationoforbit–OrbitalElements–Lookangledetermination–orbitalperturbation–Satellitecoverage–Spaceenvironment–Eclipse–SunTransitoutage–Limitsofvisibility–subsatellitepoint-launchingproceduresandLaunchVehicles.

UNIT II **9**

RADIOLINKANDSATELLITEACCESS:Spectrumissues–Propagationcharacteristicsandfrequencyconsiderations–Radiolinkanalysis–Modulation–codingandmultipleaccessschemesandcomparisonofmultipleaccessschemes.

UNIT III **9**

SPACECRAFTTECHNOLOGY:Satellitesubsystems–SatelliteforMSS,Intersatellitelinks–EmergingTechnologies–LaunchingSatelliteconstellation-Gateways–MobileTerminals–Environmentalissues.

UNIT IV **9**

SYSTEMARCHITECTURE: Systemplanning–ServiceDistributionmodel–Investment Routes–Regulatoryissues–TrafficForecast–Airinterface–systemdevelopment–networkconsiderationsandnetworkmanagement–Licensingissues.

UNIT V	9
SATELLITESYSTEM&SERVICES: RepresentativeMSSsystem–DistressandSafetySystems-navigationsystems–DirectSatellitebroadcast–DirectTVBroadcastsystem–VerySmallApertureTerminalsystems-TerrestrialCellularsystem–FutureTrends–Broadbandsystems–ATMoverSatellite–RoleofSatelliteinFeatureNetworks.	

LECTURE	TUTORIAL	TOTAL
45	0	45

REFERENCES

1. M.Richharia,"MobileSatelliteCommunications-Principles&Trends",PearsonEducation,2003
2. T.PrattandBostian,"SatelliteCommunications",JohnWiley,2001.
3. W.L.PrichandandA.Sciulli,"SatelliteCommunicationsystemsEngineering",Prentice Hall,1986
4. T.Ha,"DigitalSatelliteCommunicationSystemsEngineering",McGrawHill,1998
5. GerardMaral,MichelBousquetandZhili,"SatelliteCommunicationsSystems:Systems,TechniquesandTechnology",Wiley,2010.
6. AnilK.MainiandVarshaAgrawal"SatelliteTechnology:PrinciplesandApplications",Wiley,2010.
7. BruceR.Elbert"IntroductiontoSatelliteCommunication(ArtechHouseSpace Applications)",2008.

SUBCODE	SUB NAME	L	T	P	C
YWC106C	ADVANCEDDIGITALSIGNALPROCESSING	3	1	0	4

UNIT I	10
DISCRETERANDOMSIGNALPROCESSING Discrete Random Processes-Ensemble averages, stationary processes,Auto correlation and Auto covariance matrices. Parseval's Theorem, Wiener-Khintchine Relation- Power Spectral Density-Periodogram Spectral Factorization, Filtering random processes. Low Pass Filtering of White Noise. Parameter estimation: Bias and consistency--Multirate signal Processing	

UNIT II	8
SPECTRUMESTIMATION Estimation of spectra from finite duration signals, Non-Parametric Methods-Correlation Method , Periodogram Estimator, Performance Analysis of Estimators -Unbiased, Consistent Estimators-Modified periodogram, Bartlett and Welch methods, Blackman – Tukey method. Parametric Methods - AR, MA, and ARMA model based spectral estimation. Parameter Estimation -Yule-Walker equations, solutions using Durbin's algorithm	

UNIT III	9
LINEARESTIMATIONANDPREDICTION Linear prediction- Forward and backward predictions, Solutions of the Normal equations - Levinson-Durbin algorithms. Least mean squared error criterion -Wiener filter for filtering and prediction, FIR Wiener filter and Wiener IIR filters.	

UNIT IV	9
ADAPTIVEFILTERS FIR adaptive filters -adaptive filter based on steepest descent method-Widrow-Hoff LMS adaptive algorithm, Normalized LMS. Adaptive channel equalization-Adaptive echo cancellation-Adaptive noise cancellation- Adaptive recursive filters (IIR). RLS- adaptive filters-Exponentially weighted RLS-sliding window RLS.	

UNIT V	9

FILTERBANKANDWAVELETS

Quadrature Mirror Filter- Paraunitary Filter Banks- Biorthogonal Linear Phase Filter banks – Uniform M Channel Filter banks – Tree Structured Filter Banks- Wavelet Transform- Filter Banks and Wavelet – Properties of Wavelets – Scaling Function – Construction of wavelets- Examples of Wavelet Systems- Applications of Wavelets

	LECTURE	TUTORIAL	TOTAL
	45	15	60

REFERENCES:

1. John G.Proakis, Dimitris G.Manolakis, Digital Signal Processing Pearson Education, 2009.
2. John G.Proakiset.al.,'Algorithms for Statistical Signal Processing', Pearson Education, 2002.
3. Dimitris G.Manolakiset.al.,'Statistical and adaptive signal Processing', McGraw Hill, Newyork,2000.
4. N.J.Fliege, "Multirate Signal Processing'PHI, 1995
5. C.Sidney Burrus, Ramesh A Gopinath and Haitao Guo," Introduction to Wavelets and Wavelet Transforms – A Primer" Prentice Hall International, editions, 1998.
6. Rabiner and Crochier, "Multirate Signal Processing" PHI, 1987.
7. Raghuveer M Rao, "Introduction to Wavelet Transform", New Age International, 2000.
8. Monson H.Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc.,Singapore, 2002.
9. Rafael C. Gonzalez, Richard E.Woods, 'Digital Image Processing', Pearson Education, Inc., Second Edition, 2004.(For Wavelet Transform Topic)
10. Richard G. Lyons "Understanding Digital Signal Processing" , Prentice Hall, 3rd Edition,2010
11. Alan V. Oppenheim and Ronald W. Schafer "Discrete-Time Signal Processing" 3rd Edition, Prentice Hall, 2009.

SUBCODE	SUB NAME	L	T	P	C
YWC106D	FREESPACEOPTICS	3	0	0	3

UNIT I — **9**

FUNDAMENTALS

Fundamentals of FSO Technology: Introduction– Maxwell's Equations–Electromagnetic wave propagation in free space-alternatebandwidthtechnologies–FiberVsFSO-FiberAccess–Overview of FSO Optical Transmitters–Receivers–Subsystems–Pointing,AcquisitionandTracking–Lineofsightanalysis.

UNIT II — **9**

FSONETWORKS

The Role of FSO in the network–factor affecting FSO–line of sight(LOS)–Selecting transmission wave integration of FSO in Optical networks–installation of FSO systems–moving toward sedge–and residential areas.

UNIT III — **9**

LONGDISTANCEFSOCOMMUNICATION

The FSO model–Applications–System descriptions and design–Introduction to Laser Satellite Communications–Characteristics,ModulationTechniquesandRadiationeffects–LaserSources.

UNIT IV — **9**

PLANE EM WAVES IN ISOTROPIC MEDIA OPTICAL COMPONENTS FOR FSO

Optical wave guides–Optical Filters, Couplers, Amplifiers, Switches, Antennas ,Interconnecting Equipment's, etc.–Optical integrated circuits–semiconductor integrated optic devices.

UNIT V **9**

OPTICALSIGNALPROCESSING

AnalogandDiscretesystems–NoiseandStochasticprocesses–Filters–PowerSpectraestimation–Ambiguityfunction,Wignerdistributionfunctionandtriplecorrelations

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. Heinz,Phd.Willebrand,"FreeSpaceOptics",Sams,FirstEdi.–2001
2. MorrisKatzman,"LaserSatelliteCommunication",PrenticeHallInc.,NewYork,1991.
3. HiroshiNishihara,"OpticalIntegratedCircuits",McGrawHill,NewYork,1992.
4. PankajK.Das,"OpticalSignalProcessing",NarosaPub.House,1993.
5. RajivRamaswami,KumarSivarajanandGalenSasaki"OpticalNetworks:APractical Perspective",MorganKaufmann,3rdEdition,2009.

SUBCODE	SUB NAME	L	T	P	C
YWC205A	WIRELESS NETWORKS	3	0	1	4

UNIT I **9**

PHYSICAL AND WIRELESS MAC LAYER ALTERNATIVES

Wired transmission techniques: design of wireless modems, power efficiency, out of band radiation, applied wireless transmission techniques, short distance base band transmission, VWB pulse transmission, broad Modems for higher speeds, diversity and smart receiving techniques, random access for data oriented networks, integration of voice and data traffic..

UNIT II **9**

WIRELESS NETWORK PLANNING AND OPERATION

Wireless networks topologies, cellular topology, cell fundamentals signal to interference ratio calculation, capacity expansion techniques, cell splitting, use of directional antennas for cell sectoring, micro cell method, overload cells, channels allocation techniques and capacity expansion FCA, channel borrowing techniques, DCA, mobility management, radio resources and power management securities in wireless networks.

UNIT III **9**

WIRELESS WAN

Mechanism to support a mobile environment, communication in the infrastructure, IS-95 CDMA forward channel, IS – 95 CDMA reverse channel, pallert and frame formats in IS – 95, IMT – 2000; forward channel in W-CDMA and CDMA 2000, reverse channels in W-CDMA and CDMA-2000, GPRS and higher data rates, short messaging service in GPRS mobile application protocols.

UNIT IV **9**

WIRELESS LAN

Historical overviews of the LAN industry, evolution of the WLAN industry, wireless home networking, IEEE 802.11. The PHY Layer, MAC Layer, wireless ATM, HYPER LAN, HYPER LAN – 2.

UNIT V	**9**

WPAN AND GEOLOCATION SYSTEMS

IEEE 802.15 WPAN, Home RF, Bluetooth, interface between Bluetooth and 802.11, wireless geolocation technologies for wireless geolocation, geolocation standards for E.911 service.

	LECTURE	**PRACTICAL**	**TOTAL**
	45	**30**	**75**

REFERENCES

1. Kaveh Pahlavan, Prashant Krishnamoorthy, Principles of Wireless Networks, - A united approach - Pearson Education, 2002.
2. Jochen Schiller, Mobile Communications, Person Education – 2003, 2nd Edn.
3. X.Wang and H.V.Poor, Wireless Communication Systems, Pearson education, 2004.
4. M.Mallick, Mobile and Wireless design essentials, Wiley Publishing Inc. 2003.
5. P.Nicopolitidis, M.S.Obaidat, G.I. papadimitria, A.S. Pomportsis, Wireless Networks, John Wiley & Sons, 2003.

SUBCODE	**SUB NAME**	**L**	**T**	**P**	**C**
YWC205B	**RFMEMS**	**3**	**0**	**0**	**3**

UNIT I	**9**

WIRELESSSYSTEMS

Introduction,spheresofwirelessactivities,thehomeandoffice,thegroundfixed/mobileplatform,thespaceplatform,wirelessstandards,systemsandarchitectures,conceptualwirelesssystems,wirelesstransceiverwirelessappliancesenableubiquitousconnectivity.

UNIT II	**9**

ELEMENTSOFRFCIRCUITDESIGN

Physical aspects of RF circuit design, skineffect,transmissionlinesonthinsubstrates,self-sonancefrequency,qualityfactorpackaging,practicalaspectsofRFcircuitdesign,DCbiasing,impedance mismatcheffectsinRFMEMS.

UNIT III	**9**

RFMEMS

RFMEMS, enabled circuit elements and models ,RF/microwave substrate properties, micromachined,enhancedelements,capacitors,inductors,varactors,MEMswitch,shuntMEMswitch,lowvoltagehingedMEMswitchapproaches,push-pull series switch, folded-beam springs suspension series witch ,resonators-transmission line plana resonators, cavity resonators, micro mechanical resonators, film bulk acoustics wave resonators, MEMS modeling –mechanical modeling, electro magnetic modeling.

UNIT IV	**9**

NOVELRFMEMS Novel RFMEMS ,enabled circuits, reconfigurable circuits ,theresonant MEMS switch, capacitors, inductors, tunableCPWresonator,MSmicro-switcharrays,reconfigurablecircuits,double,studtuner,Nth- tubtuner, filters, resonatortuning system, massively parallelswitchableRFfrontends,truedelaydigitalphaseshifters,reconfigurableantennas,tunabledipole antennas,tunablemicrostrippatch-arrayantenna.

UNIT V	**9**

RFMEMS BASED CIRCUITDESIGN

Phase shifters, fundamentals, X-band RFMEMS phase shifterf or phased array applications, Ka-and RFMEMS phase shifter for radar systems applications, Film bulkacousticwavefilters,FBARfilterfundamentals,FBARfilterforPCSapplications,RFMEMSfilters, AKa-bandmillimeterwaveMicromachinedtunablefilter,aHigh-Q8MHzMEMresonatorsfilter,RFMEMSOscillators-fundamentals,a14GHzMEMOscillator,aKa-Bandmicromachinedcavityoscillator,a2.4GHzMEMSbasedvoltagecontrolledoscillator,designofPLL.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. HectorJ.De,LosSantos,"RFMEMSCircuitDesignforWirelessCommunications",ArtechHouse,2002.
2. VijayK.Varadan,K.J.Vinoy,K.A.Jose,"RFMEMSandtheirApplications",JohnWileyandSons,Ltd.,2002.
3. GabrielM.Rebeiz,"RFMEMSTheory,Design&Technology",WileyInterscience,2002.

SUBCODE	**SUB NAME**	**L**	**T**	**P**	**C**
YWC 205C	**ANTENNASYSTEMS FOR WIRELESS APPLICATIONS**	**3**	**0**	**0**	**3**

UNIT I	**9**

HANDSET ANTENNAS

Introduction-Performance requirements-Electrically small Antennas-classes of Handset Antennas-The quest for Efficiency and Extended Bandwidth-Practical design-starting points for Design and optimization-RF performance of typical handsets

UNIT II	**9**

RFID TAG ANTENNAS

RFID fundamentals, Design considerations for RFID Tag Antennas, Effect of Environment on RFID Tag Antennas

UNIT III	**9**

LAPTOP ANTENNA DESIGN AND EVALUATION

Laptop related Antenna Issues-Antenna Design Methodology-PC Card Antenna Performance and Evaluation-Link Budget model-Dualband examples-Antennas for wireless wide Area Network Applications-Ultra wide band Antennas

UNIT IV	**9**

ANTENNA ISSUES IN MICROWAVE THERMAL THERAPIES

Microwave thermal therapies-Interstitial Microwave Hyperthermia-clinical trials

UNIT V **9**

ANTENNAS FOR WEARABLE DEVICES AND UWB APPLICATIONS

Antenna design requirements for wireless Body Area Network/PAN-modelling and characterization of wearable Antennas-WBAN Radio channel characterization and effect of Wearable Antennas-case study-UWB wireless systems-challenges in UWB Antenna Design-state of the art solutions-case study.

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LECTURE	TUTORIAL	TOTAL
45	0	45

REFERENCES:

1. Zhi Ning Chen "Antennas for Portable devices" Wiley,2007.
2. ConstatineA.Balanis "Modern Antenna Handbook"Wiley august 2008
3. Nemai Chandra Karmakar "Handbook of Smart Antennas for RFID Systems"Wiley
4. Mehmet R.Yuce,JamilY.Khan "Wireless body Area Networks:Technology,Implementation and Applications"CRC Press.

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SUBCODE	SUB NAME	L	T	P	C
YWC205D	DETECTIONANDESTIMATIONTHEORY	3	1	0	4

UNIT I **8**

BACKGROUNDANDSTATISTICALDECISIONTHEORY:

Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter restimationindiscrete-timedomain.Bayesian,minimax,andNeyman-Pearsondecisionrules,likelihoodratio,receiveroperatingcharacteristics,compositehypothesistesting,locallyoptimumtests,detectorcomparisontechniques,asymptoticrelativeefficiency.

UNIT II **12**

DETECTIONOFDETERMINISTICSIGNALSANDRANDOMSIGNALS:

Matched filterde tectorandits performance; generalizedmatched filter;detection of sinusoid wit unknown amplitude, phase, frequency and arrivaltime, linearmodel. Estimator- correlator, linear mode general ussiandetection,detectionofGaussianrandomsignalwithunknownparameters,weaksignaldetection

UNIT III **9**

NONPARAMETRICDETECTION:

Detectionin the absence of complete statistical description of observations, signdetector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.

UNIT IV **8**

ESTIMATIONOFSIGNALPARAMETERS:
Minimum varianceunbiase destimation, Fisher information matrix, Cramer-Raobound, sufficientstatistics, minimum statistics, completestatistics; linearmodels; best linearunbiase destimation; maximum like lihoo destimation, in variance principle; estimation efficiency; Bayesianestimation:philosophy, nuisanceparameters, riskfunctions, minimummean squareerrorestimation, maximum posterioriestimation.

UNIT V	**7**

SIGNALESTIMATIONINDISCRETE-TIME: Linear Bayesianestimation,Weinerfiltering, Kalman filtering.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. H.L.VanTrees,"Detection,EstimationandModulationTheory:PartI,II,andIII",JohnWiley,NY,1968.
2. H.V.Poor,"AnIntroductiontoSignalDetectionandEstimation",Springer,2/e,1998.
3. S.M.Kay,"FundamentalsofStatisticalSignalProcessing:EstimationTheory",Prentice
4. HallPTR,1993.
5. S.M.Kay,"FundamentalsofStatisticalSignalProcessing:DetectionTheory",PrenticeHallPTR,1998.
6. http://nptel.iitm.ac.in/courses.php?disciplineId=117
7. R.G.Gallager,“PrinciplesofDigitalCommunication”,CambridgeUniversityPress,2008.
8. Lapidoth,“AFoundationinDigitalCommunication”,Cambridge,2009.
9. WeeksMichael,“DigitalSignalProcessingUsingMATLABandWavelets”,FirewallMedia,2011.

SUBCODE	**SUB NAME**	**L**	**T**	**P**	**C**
YWC206A	**WIRELESS NETWORK SECURITY**	**3**	**1**	**0**	**4**

UNIT I	**9**

WIRELESS INFORMATION WARFARE

Protecting privacy and means of communication, taxonomies of wireless communication based on network architecture mobility, model for cost effective risk management, cryptographic attacks, key management, securing wireless LANS, Electromagnetic capture threats, wireless threat analysis, securing wireless LAN countermeasures.

UNIT -II	**9**

WIRELESS LAN TRANSMISSION MEDIA
WAP security architecture, BLUETOOTH, wireless access to internet. **Cryptographic Security:** Classical crypt analysis, digital cryptography**,** DES modern cipher breaking, non-keyed message digest, public key cryptography, Diffie – Hellman and Elliptic curve cryptography, comparison of public key crypto systems.

UNIT –III	**9**

NETWORK SECURITY COMPONENTS Network security model, network intrusion protection and detection, Host based security, virtual private networking, event correlation, wireless security components, secure configuration , secure authentication, encryption, wireless device placement.

UNIT –IV	**9**

INTEGRATING WIRELESS ACCESS INTO THE NETWORK SECURITY PROCESS

Logging wireless events, policy issues, accessing wireless network security, change control and device administration, wireless security models, Cisco implementation with LEAP,, WLAN authentication and key management with radius, wireless access with IP security, secure wireless public access, secure wireless point to point connectivity.

UNIT –V	**9**

HARDWARE PERSPECTIVE FOR END TO END SECURITY IN WIRELESS APPLICATION

Taxonomy of communication systems, protocol sensitive communication security , evolution towards wireless, hardware and software avenues, encryptor structures in wireless- interception and vulnerability of wireless systems, communication ESMs and interception receivers, SAW technology.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

REFERENCE BOOKS

1. Randall K. Nichols, Panos C. Lekkas, "Wireless Security Models, Threats and solutions". McGrawHill, 2005.
2. Brian Carter, Russel Shumway, "Wireless Security End to End", CISSPl, 2005.
3. Merrit Maxim, David Pollino, "Wireless Security", RSA Press, 2005.
4. Cyrus Peikari, Seth Fogie, , "Maximum Wireless Security ", SAMS, 2005.

SUBCODE	**SUB NAME**	**L**	**T**	**P**	**C**
YWC206B	**ADHOCNETWORKS**	**3**	**0**	**0**	**3**

UNIT I	**9**

WIRELESSLAN,PAN,WANANDMAN

Introduction to adhoc networks–definition, characteristics features, applications. Characteristics of wireless channel, Fundamentals ofWLANs,IEEE802.11standard,HIPERLANStandard,First-,Second-,andthird- generation cellula rsystems, WLL, Wireless ATM, IEEE802.16 standard ,HIPER ACCESS, AdHoc Wireless Internet.

UNIT II	**9**

MAC, ROUTING AND MULTICAST ROUTING PROTOCOLS

MAC Protocols: Design issues, goals and classification, Contention–based protocolswithreservationandschedulingmechanisms,Protocolsusingdirectionalantennas.Routingprotocols :Designissuesandclassification,Table-driven,On-demandand Hybrid routing protocols,Routing protocolswithefficientfloodinmechanisms,Hierarchicalandpower-aware routing protocols .Multicast Routing Protocols: Design issues and operation, Architecture reference model,classification,Tree-basedandMesh-basedprotocols,Energy-efficientmulticasting.

UNIT III	**9**

TRANSPORT LAYER AND SECURITY PROTOCOLS

Transport layer Protocol: Design issues, goals and classification, TCP aver AdHoc wireless Networks,Security,Securityrequirements,Issuesandchallengesinsecurityprovisioning,Network security attacks, Security routing. Quality of Service: Issues and challengesinprovidingQoS,ClassificationofQoSsolutions,MAClayersolutions,Networklayersolutions,QoSframeworks. HIPERMAN WIRELESS SECURITY - WEP/WPA(ENCRYPTION AND DECRYPTION)

UNIT IV	9

ENERGYMANAGEMENTANDWIRELESSSENSORNETWORKS

Need,classificationofbatterymanagementschemes,Transmissionpowermanagementschemes,Systempower managementschemes.WirelessSensorNetworks:Architecture,Datadissemination,Dategathering,MACprotocols,locationdiscovery,Qualityofasensornetwork.

UNIT V	9

PERFORMANCEANALYSIS

ABR beaconing, Performance parameters, Route-discovery time, End-to-end delay performance, Communicationthroughputperformance,Packetlossperformance,Routereconfiguration/repairtime,TCP/IP basedapplications.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES:

1. C.SivaRamMurthyandB.S.Manoj,AdHocWirelessNetworks:Architecturesandprotocols,PrenticeHallPTR,2004
2. C.-K.Toh,AdHocMobileWirelessNetworks:ProtocolsandSystems,PrenticeHallPTR,2001
3. MohammadIlyas,TheHandbookofAdHocWirelessNetworks,CRCpress,2002CharlesE.Perkins,AdHocNetworking,Addison–Wesley,2000
4. StefanoBasagni,MarcoConti,SilviaGiordanoandIvanStojmenovic,MobileAdHocNetworking,Wiley–IEEEpress,2004

SUBCODE	SUB NAME	L	T	P	C
YWC206C	HIGHPERFORMANCECOMPUTINGNETWORKS	3	0	0	3

UNITI		9

BASICSOFNETWORKS

Telephone,computer,Cable television and Wireless network,networking principles,DigitalizationService and layered architecture,traffic characterization and QOS, networks services network elementsand network mechanisms.

UNITII	9

PACKETSWITCHEDNETWORKS

OSI and IP models Ethernet(IEEE802.3);tokenring(IEEE802.5),FDDI,DQDB,framerelay,SMDS,InternetworkingwithSMDS.

UNIT –III	9

INTERNETANDTCP/IPNETWORKS

Overview,internet protocol,TCP and VDP,Performance of TCP/IP networks circuits switched networks SONET DWDM,Fiber to home,DSL,Intelligent networks,CATV.

UNIT –IV	9

ATMANDWIRELESSNETWORKS

Main features addressing,signaling and routingATM header structure adaptation layer,managementa nd control,BISDN,Inter working with ATM,Wireless channel,link level design channel access Networkdesignandwirelessnetworks.

UNIT –IV	9

OPTICALNETWORKSANDSWITCHING

Opticallinks–WDMsystems,cross-connectsopticalLAN'sopticalpathsandnetworksTDSandSDSmodularswitchdesigns-Packetswitching,shared,inputandoutputbuffers.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES:

1. JeanwarlandandPravinVaraiya,"HighPerformanceCommunicationNetworks",2ndEdition,HarcourtandMorganKanffman,London,2000
2.LeonGracia,Widjaja,"Communicationnetworks",TataMcGrawHill,NewDelhi,20003.LumitKasera,PankajSethi,"ATMNetworks",TataMcGrawHill,NewDelhi,2000
4.Behrouz.a.Forouzan,"DataCommunicationandNetworking",TataMcGrawHill,NewDelhi,2004.
5.ItamarElhananyandMounirHamdi,"High-performancePacketSwitchingArchitectures",SpringerPublications,2011.
6.J.F.Kurose&K.W.Ross,"ComputerNetworking-Atopdownapproachfeaturingtheinternet",Pearsoneducation,fifthedition.
7.NaderF.Mir,ComputerandCommunicationNetworks,firstedition,2006.
8.Walrand.J.Varatya,Highperformancecommunicationnetwork,MarganKanffmanHarcourtAsiaPvt.Ltd.2ndEdition,2000.
9. LEOM-GarCIA,WIDJAJA,"Communicationnetworks",TMHseventhreprint2002.10.Aunuragkumar,D.MAnjunath,Joykuri,"CommunicationNetworking",Morgan

COURSE CODE	COURSE NAME	L	T	P	C
YEC206D	INTERNET OF THINGS	3	0	0	3

UNIT I INTRODUCTION AND ENABLING TECHNOLOGIES IN IOT	9

IoT, Machine to Machine, Web of Things, Definition- Major components if IoT devices-Control Units-Sensors-Communication Modules-Power Sources Vision- Characteristics - Layered Architecture- Landscape-- IoT Functional View-IoT related Internet Technology-cloud computing-Networks and Communications related to IoT-Processes related to IoT-Data Management related to IoT-Security Privacy and Trust-Devices level energy issues-Standards related to IoT

UNIT II RESOURCE MANAGEMENT IN THE INTERNET OF THINGS	9

Clustering - Software Agents - Data Synchronization - Clustering Principles in an Internet of Things Architecture - The Role of Context - Design Guidelines -Software Agents for Object – Data Synchronization- Types of Network Architectures - Fundamental Concepts of Agility and Autonomy-Enabling Autonomy and Agility by the Internet of Things-Technical Requirements for Satisfying the New Demands in Production - The Evolution from the RFID-based EPC Network to an Agent based Internet of Things- Agents for the Behaviour of Objects

UNIT IIITHE ARCHITECTURE, PLATFORMS, SERVICES	9

The Layering concepts , IoT Communication Pattern, IoT protocol Architecture, The 6LoWPAN, Platforms - IBM watson-Intel Platform- Carriot Platform- Webnms-device WISE

UNIT IV SCALABLE INTEGRATION FRAMEWORK	9

Introduction- IPV6 Potential- IoT6- IPV6 for IoT- Adapting IPV6 to IoT requirement- IoT6 architecture - DigCovery- IoT6 Integration with cloud and EPICS- Enabling Heterogeneous Integration- IoT6 Smart Office use case- Scalability perceptive.

UNIT VIOT APPLICATIONS				9
Smart Environments and Smart Space creation - Connected Devices illustration-Industrial IoT-IERC application Domains-Smart Environment Monitoring- Smart Energy - Smart building- Smart Transport and mobility-IoT Smart X applications				
	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
HOURS	**45**	**0**	**0**	**45**
REFERENCES				
Ovidiu Vermesan, Peter Friess, "Internet of Things- From Research and Innovation to market Deployment", River Publishers, 2014. ArshdeepBahga, Vijay Madisetti Internet of Things: A Hands-On Approach Hardcover – Madisetti Publishers, 2014 Samuel Greengard, "The Internet of Things", MIT Press, 2015. http://postscapes.com/internet-of-things-resources/				

SUBCODE	SUB NAME	L	T	P	C
YWC207A	SOFTCOMPUTING	3	0	0	3
UNIT I					**10**
FUZZYSETTHEORY Introduction to Neuro–Fuzzy and Soft Computing–Fuzzy Sets–Basic Definition and Terminology–Set-theoretic Operations– Member Function Formulation and Parameterization–Fuzzy Rules and Fuzzy Reasoning–Extension Principle and Fuzzy Relations–Fuzzy If-Then Rules–Fuzzy Reasoning–Fuzzy Inference Systems–Mamdani Fuzzy Models–Sugeno Fuzzy Models–Tsukamoto Fuzzy Models–Input Space Partitioning and Fuzzy Modeling."					
UNIT II					**8**
OPTIMIZATION Derivative-based Optimization – Descent Methods – The Method of Steepest Descent – Classical Newton's Method – Step Size Determination – Derivative – free Optimization – Genetic Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search."					
UNIT III					**10**
NEURALNETWORKS Supervised Learning Neural Networks–Perceptrons-Adaline–Backpropagation Mutilayer Perceptrons–Radial Basis Function Networks–Unsupervised Learning Neural Networks–Competitive Learning Networks–Kohonen Self-Organizing Networks–Learning Vector Quantization–Hebbian Learning."					
UNIT IV					**9**
NEUROFUZZYMODELING AdaptiveNeuro–FuzzyInferenceSystems–Architecture–HybridLearningAlgorithm–LearningMethodsthatCross–fertilizeANFISandRBFN–CoactiveNeuroFuzzyModeling–FrameworkNeuronFunctionsforAdaptiveNetworks–NeuroFuzzySpectrum.					
UNIT V					**8**

APPLICATIONSOFCOMPUTATIONALINTELLIGENCE

Printed Character Recognition–Inverse Kinematics Problems–Automobile Fuel Efficiency Prediction–Soft Computing for Color Recipe Prediction".

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. TimothyJ.Ross,"FuzzyLogicwithEngineeringApplications",McGraw-Hill,1997.
2. DavisE.Goldberg,"GeneticAlgorithms:Search,OptimizationandMachine Learning",AddisonWesley,N.Y.,1989.
3. S.RajasekaranandG.A.V.Pai,"NeuralNetworks,FuzzyLogicandGeneticAlgorithms",PHI,2003.
4. R.Eberhart,P.SimpsonandR.Dobbins,"ComputationalIntelligence-PCTools",APProfessional,Boston,1996.
5. Jyh-ShingRogerJang,Chuen-TsaiSun,EijiMizutani,"Neuro-FuzzyandSoftComputing",Prentice-HallofIndia,2003.
6. GeorgeJ.KlirandBoYuan,"FuzzySetsandFuzzyLogic-TheoryandApplications",PrenticeHall,1995.
7. JamesA.FreemanandDavidM.Skapura,"NeuralNetworksAlgorithms,Applications,andProgrammingTechniques",PearsonEdn.,2003.
8. MitchellMelanie,"AnIntroductiontoGeneticAlgorithm",PrenticeHall,1998.
9. DavidE.Goldberg,"GeneticAlgorithmsinSearch,OptimizationandMachine Learning",AddisonWesley,1997.
10. S.N.Sivanandam,S.SumathiandS.N.Deepa,"IntroductiontoFuzzyLogicusingMATLAB",Springer,2007.
11. J.S.R.Jang,C.T.SunandE.Mizutani,"Neuro-FuzzyandSoftComputing",PHI,2004,PearsonEducation2004.

SUBCODE	SUB NAME	L	T	P	C
YWC207B	MULTIMEDIACOMPRESSIONTECHNIQUES	3	0	0	3

UNIT I — 9

INTRODUCTIONSpecial features of Multimedia – Graphics and Image Data Representations – Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications – Need for Compression – Taxonomy of compression techniques – Overview of source coding, source models, scalar and vector quantization theory – Evaluation techniques – Error analysis and methodologies"

UNIT II — 9

TEXTCOMPRESSION

Compaction techniques – Huffman Arithmetic coding – Shannon-Fano coding algorithms. coding – Adaptive Huffman Coding – Dictionary techniques – LZW family"

UNIT III — 9

AUDIOCOMPRESSION

Audio compression techniques - μ-Law and A-Law companding. Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – Application to audio coding – MPEG audio, progressive encoding for audio – Silence compression, speech compression techniques – Formant and CELP Vocoders"

UNIT IV — 9

IMAGECOMPRESSION

Predictive techniques – DM, PCM, and DPCM: Optimal Predictors and Optimal Quantization – contour based compression – Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards - JBIG, JBIG2 standards"

UNIT V | **9**

VIDEOCOMPRESSION

Video compression techniques and standards – MPEG Video Coding: MPEG – 1 and 2 – MPEG Video Coding II: MPEG – 4 and 7 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – PLV performance – DVI real time compression – Packet Video"

LECTURE	TUTORIAL	TOTAL
45	0	60

REFERENCES

1. KhalidSayood:IntroductiontoDataCompression,MorganKauffmanHarcourtIndia,2nd
2. Edition,2000.
3. DavidSalomon:DataCompression–
   TheCompleteReference,SpringerVerlagNewYorkInc.,2nd Edition,2001.
4. YunQ.Shi,HuifangSun:ImageandVideoCompressionforMultimediaEngineering-
5. Fundamentals,Algorithms&Standards,CRCpress,2003.
6. PeterSymes:DigitalVideoCompression,McGrawHillPub.,2004.5.MarkNelson:
7. Datacompression,BPBPublishers,NewDelhi,1998.
8. MarkS.Drew,Ze-NianLi:FundamentalsofMultimedia,PHI,1Edition,2009
9. Watkinson,J:CompressioninVideoandAudio,Focalpress,London.1995.
10. JanVozer:VideoCompressionforMultimedia,APProfes,NewYork,1995
11. AndyBeach,“RealWorldVideoCompression”,PearsonEducation,2010.
12. IrinaBocharova,“CompressionforMultimedia”,CambridgeUniversityPress,2010.
13. ArjunaMarzuki,AhmadIsmatBinAbdulRahimandMouradLoulou,“Advancesin
14. MonolithicMicrowaveIntegratedCircuits:ModelingandDesignTechnologies”,(PremierReferencesource),2011.

SUBCODE	SUB NAME	L	T	P	C
YWC207C	SOFTWAREDEFINEDRADIO	3	0	0	3

UNITISOFTWAREBASEDRADIO **9**

Software defined radio and Software Radio Concepts – Realization of Software Based Radio - Front end Technology: Radio Frequency Translation and Software Defined Radio Requirements and Specifications - Receiver Design Considerations - Transmitter Design Considerations - Candidate Architectures for SDR – Radio frequency front end Implementations for Multimode SDRS: Evolution of RF Front Ends – Super heterodyne Architecture - The AS2/6 Product Family – Dual Band, Six Mode – Alternative RF Front End Architectures."

UNITII DATACONVERSIONINSOFTWAREDEFINEDRADIOS: **9**

The Importance of Data Converters in Software Defined Radios - Converter Architectures – Converter Performance Impact on SDR - Superconductor Microelectronics: A Digital RF Technology for Software Radios: Introduction - Rapid Single Flux Quantum Digital Logic – Cryogenic Aspects - Superconductor SDR for Commercial Applications & Military Applications – The Digital Front End: Bridge Between RF and Baseband Processing: The digital frontend - Digital up and down conversions - Channel Filtering - Sample Rate Conversion."

UNITIII BASEBANDTECHNOLOGY: **9**

Baseband Processing for SDR – The Role of Baseband Architectures – Baseband Component Technologies - Design Tools and Methodologies - System design and maintenance – Parameterization - A Technique for SDR Implementation – Definitions - Adaptability – Parameterization of Standards – Signal Processing Issues – Adaptive Computing IC Technology for 3G Software – Software defined Radio – A Solution for Mobile Devices – The Mobile Application Space and the need for Processing Power - SDRB as eband processing – Hardware with Software Programmability – The Computational Power Efficiency Required by 3G Algorithms – Example Case Studies."

UNITIV SOFTWARETECHNOLOGY

Software Engineering for Software Radios - Overview of Vanu Systems – The Importance of software in software Radio – Software Portability - Commodity PC hardware - Signal Processing' software - Control – Software - Performance - Future Directions – Software Download for Mobile Terminals – Downloading Technologies for SDR – Standards for downloading - Seamless Upgrading 'on the FLY' security of download – software Architectures for Download - Future Applications of SDR Downloading."

UNITVRECONFIGURATIONANDWAVEFORMDESCRIPTION **9**

Protocols and Network Aspects of SDR - Protocol stacks: SAPS vs. Configurability - Approaches to protocol stack reconfiguration – Reconfiguration Management and control – Network support for software radios Conclusions – The Waveform Description Language: The specification problem – WDL overview – FM3TR example – Refinement to an implication – WDL details – A practical WDL support environment".

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. WalterTuttlebee,"SoftwareDefinedRadio:EnablingTechnologies",WileyPublications,2002.
2. PaulBurns,"SoftwareDefinedRadiofor3G",ArtechHouse,2002
3. MarkusDillinger,"SoftwareDefinedRadio:Architectures,SystemsandFunctions", 2003.

SUBCODE	SUB NAME	L	T	P	C
YWC207D	FUNDAMENTALS OF 5G MOBILE AND WIRELESS TECHNOLOGY	3	0	0	3

UNIT I **9**

INTRODUCTION

Rationale of 5G: high data volume, twenty-five billion connected devices and wide requirements - 10 pillars of 5G-Requirements and key performance indicators 5G system concept Concept overview Extreme mobile broadband Massive machine-type communication Ultra-reliable machine-type communication - Dynamic radio access network 3- Lean system control plane - Localized contents and traffic flows -Spectrum toolbox -The 5G architecture -High-level requirements for the 5G architecture

UNIT II **9**

MACHINE-TYPE COMMUNICATIONS

Introduction - Use cases and categorization of MTC - MTC requirements -Fundamental techniques for MTC - Data and control for short packets -Non-orthogonal access protocols - Massive MTC -Design principles -Technology components - Summary of mMTC features - Ultra-reliable low-latency MTC - Design principles - Technology components

UNIT III	9

SMALL CELLS FOR 5G MOBILE NETWORKS

Introduction- What are Small Cells? - WiFi and Femtocells as Candidate Small-Cell Technologies - WiFi and Femto Performance – Indoors vs Outdoors -Capacity Limits and Achievable Gains with Densification - Gains with Multi-Antenna Techniques -Gains with Small Cells - Mobile Data Demand - Approach and Methodology - Demand vs Capacity - Small-Cell Challenges

UNIT IV	9

THE 5G RADIO-ACCESS TECHNOLOGIES

Access design principles for multi-user communications-Orthogonal multiple-access systems- Spread spectrum multiple-access systems -Capacity limits of multiple-access methods - Multi-carrier with filtering: a new waveform - Filter-bank based multi-carrier - Universal filtered OFDM - Non-orthogonal schemes for efficient multiple access - Non-orthogonal multiple access (NOMA) -Sparse code multiple access (SCMA) - Interleave division multiple access (IDMA) - Radio access for dense deployments - OFDM numerology for small-cell deployments - Small-cell sub-frame structure - Radio access for V2X communication -Medium access control for nodes on the move - Radio access for massive machine-type communication - The massive access problem -Extending access reservation 198-Direct random access

UNIT V	9

SECURITY FOR 5G COMMUNICATIONS

Overview of a Potential 5G Communications

System Architecture -Security Issues and Challenges in 5G CommunicationsSystems - User Equipment - Access Networks -Mobile Operator's Core Network - External IP Networks

SON Evolution for 5G Mobile Networks -SON in UMTS and LTE -The Need for SON in 5G - Evolution towards Small-Cell Dominant HetNets -Towards a New SON Architecture for 5G -

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. Jonathan Rodriguez" Fundamentals of 5G Mobile Networks", John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom
2. AfifOsseiran, Jose F . Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology" Cambridge University Press, 2016

SUBCODE	SUB NAME	L	T	P	C
YWC302A	QUALITYOFSERVICEINWIRELESSCOMMUNICATION	3	0	0	3

UNIT I	9

QOSFORPACKETNETWORKS-ANINTRODUCTION

QoS of real-time services - delay - frame delay - packetization delay - interleaving delay - error correction coding delay - jitter buffer delay - packet queuing delay - propagation delay - effect of delay - end-to-end delay objectives - delay variation or "jitter" - source of delay variation - packet loss probability - subjective testing — mean opinion score (mos) - the "emodel" — codec performance - blocking probability - "trunked channel" systems — offered traffic - load - units of traffic load - trunk utilization factor"

UNIT II	9

QOSINCELLULARSYSTEMS-PARTI

QoS Definition - Need for QoS Differentiation - QoS Standardization - Data Services Classification IP-Based QoS Motivation of IP QoS Mechanisms QoS Paradigm sip - QoS Management in UMTS Networks Traffic Handling Mechanisms . Motivation for QoS in Cellular systems - Service

Experience - Radio Network Performance - Network Capacity - Network Design - Application Design - Service - Enhancing Technology"

UNIT III **9**

QOSINCELLULARSYSTEMS-PARTII

QoS Architecture in 3GPP and 3GPP 2 End-to-End QoS Introduction Evolution of QoS in 3GPP Releases IP Multimedia Subsystem (IMS) - 3GPP versus 3GPP2 in QoS End-User Performance Analysis - Characterization of End-User Performance - Data Link Effects - Transport and Application Layer Effects - Impact of Network Dimensioning in the Service Performance".

UNIT IV **9**

QUALITYOFSERVICEINADHOCNETWORKS

Challenges behind QOS Provisioning in Ad hoc networks - Routing in mobile ad hoc networks - Routing with quality of service constraints - Quality of service routing in ad hoc networks"

UNIT V **9**

QOSINWIRELESSSENSORNETWORKS

WSN challenges - Difficulties of QOS provisioning in WSN - QOS Performance metrics in WSN - Mechanisms to Achieve QOS in WSN – Resource Constraints - Platform Heterogeneity - Dynamic Network Topology - Mixed Traffic - Power, bandwidth, memory size constraints - Application-specific QoS, Network QoS, QoS Aware Communication Protocols - QoS-Aware Power Management"

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. KunI.Park,Ph.D."QosInPacketNetworks"2005SpringerscienceBoston
2. AmitabhMishra"SecurityAndQualityOfServiceInAdHocWireless Networks"CambridgeUniversityPress2008
3. G.GómezandR.Sánchez"End-to-EndQualityofServiceoverCellularNetworks"2005JohnWiley&SonsLtd
4. Hwee-XianTan"Qualityofserviceinwirelesssensornetworks".

SUBCODE	SUB NAME	L	T	P	C
YWC302B	TELECOM NETWORK PLANING AND MANEGEMENT	3	0	0	3

UNIT I **9**

OVERVIEW OF NETWORK PLANNING

Evolution of the Telecom context -Requirements to the planners- Typical network planning tasks-Network planning processes-Overall plans per network layer and technology- Solution mapping per scenario-Relation among technical, business and operational plans-Planning issues and trends when reaching NGN

UNIT II **9**

SERVICE DEFINITION AND FORECASTING AND TRAFFIC CHARACTERIZATION

Customer segments - Services definition and characterization. Categories - Services mapping to customer segment - Service forecasting per segment - Service bundling - Service security Traffic units for service characterization - Reference periods for dimensioning - Traffic aggregation process - Origin/destination of the traffic flows in Local, Metropolitan, Regional, National, Continental and Intercontinental networks - Traffic models."

UNIT III **9**

ECONOMICAL MODELLING AND BUSINESS PLANS

Business planning - Economic modelling for planning- Economic concepts and terms- Economic modelling for services- Cycle life amortization versus modernization -

UNIT IV **9**

NETWORK DESIGN, DIMENSIONING AND OPTIMIZATION

Core Network -Access Network -Basic optimisation methods - Specific Issues of Radio Network Planning-Special issues for rural network

UNIT V **9**

DATA GATHERING

Geographical information for the studied area -Demand of services in relative penetration per customer category -Demand of traffic, usually expressed as traffic matrices-Information for the existing network and infrastructure-Telecommunication equipment characteristics and capabilities-QOS requirements-Economical and Operational data

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. ITU Telecom Network Planning Reference Manual - Draft version 4.1 January 2007
2. Anandalingam, G., Raghavan, S. (Eds.), "Telecommunications Network Design and Management" Springer US, 2003.
3. Thomas G. Robertazzi, "Planning Telecommunication Networks",John Wiley & Sons, Inc.,1998

SUBCODE	SUB NAME	L	T	P	C
YWC302C	REGULATION AND POLICY IN THE TELECOMMUNICATIONS INDUSTRY	3	0	0	3

UNIT I **9**

THE BIG PICTURE: INTRODUCTION TO TELECOMMUNICATIONS REGULATION - Introduction - Technology in Context -. Why Regulate?-Regulatory Organizations- International Frameworks- Looking Ahead - **A LEVEL PLAYING FIELD: REGULATING FOR EFFECTIVE COMPETITION-** Competitive Markets -Sector Regulation and Competition Law -Competition Analysis - Control of Mergers and Acquisitions-Regulating Prices-

UNIT II **9**

GROWING THE MARKET: LICENSING AND AUTHORIZING SERVICES-Introduction- The Trend Towards General Authorization - Licensing Objectives and Types- Competing for Licenses.- Authorization Principles and Procedures-Special Authorization-Situations- Licensing for Convergence - Global Standards Making and Compliance-

GOING MOBILE: MANAGING THE SPECTRUM Introduction - Changing Demands for Spectrum-Planning and Technical Standards -Mechanisms for Assigning and Pricing Spectrum.- Monitoring Spectrum- Flexibility in Spectrum

UNIT III **9**

FROM CAPACITY TO CONNECTIVITY: NETWORK ACCESS AND INTERCONNECTION Introduction-Access and Interconnection -Forms of Interconnection-Setting Interconnection rices-Cross-border Interconnection-New Paradigms and New Challenges- Dispute Resolution-

UNIT IV **9**

FROM AVAILABILITY TO USE: UNIVERSAL ACCESS AND SERVICE -Trends and Approaches-Policy Rationale-Types of Universal Service Regimes-Reforming Universal Access - Strategies for Developing Economies -Digital Literacy and e-Inclusion -		
UNIT V		**9**
A DIGITAL FUTURE: REGULATORY CHALLENGES IN A BRAVE NEW WORLD - Convergence, Ubiquity, and Web 2.0 - Regulating Digital Content- Balancing Intellectual Property Rights-. Neutrality of Access- Protecting Privacy- Cybersecurity Concerns - Green ICT-Regulation in a Global Era		
LECTURE	**TUTORIAL**	**TOTAL**
45	**0**	**45**
REFERENCES		
1. Colin Blackman and Lara Srivastava,"Telecommunications Regulation Handbook, Tenth Anniversary Edition, The International Bank for Reconstruction and Development / The World Bank, InfoDev, and The International Telecommunication Union, 2011		

4. Curriculum andSyllabusofthe programme after revision–M.Tech

SEMESTER I

	CODE NO.	COURSE TITLE	L	T	P	C	H
PCC	YWC101	Fundamentals of wireless communication	3	0	0	3	3
PCC	YWC102	Advanced Digital Communication	3	1	0	4	4
PCC	YWC103	**Advanced Technologies In Wireless Networks**	3	0	0	3	3
PEC	YWC104*	Elective I	3	0	0	3	3
PEC	YWC105*	Elective–II	3	0	0	3	3
PCC-L	YWC106	Digital Communication Lab	0	0	2	2	4
AICTE Mandatory Course	YRM107	Research Methodology and IPR	2	0	0	2	2
AICTE - Audit	YEGOE1	English for Research Paper Writing	2	0	0	0	2
PCC-L	YWC 109	Wireless Networks Lab	0	0	2	2	4

Total Hours:23 **Total Credits: 22**

SEMESTER II

	CODE NO.	COURSE TITLE	L	T	P	C	H
PCC	YWC201	MultiCarrierCommunication	3	0	0	3	3
PCC	YWC202	MicrowavePassive and Active Systems	3	0	0	3	3
PCC	YWC203	AdvancedRadiationSystems	3	0	0	3	3

PEC	YWC204*	Elective–III	3	0	0	3	3
PEC	YWC205*	Elective IV	3	0	0	3	3
PCC-L	YWC206	Radio Frequency Systems lab	0	0	2	2	4
Proj	YWC207	MiniProject	0	0	2	2	4
AICTE - Audit	YPSOE1	Constitution of India	2	0	0	0	2

Total Hours: 21 **Total Credits: 19**

SEMESTER III

	CODE NO.	COURSE TITLE	L	T	P	C	H
Proj	YWC301	Dissertation Phase – I	0	0	10	10	20
PEC	YWC302	Elective -V	0	0	0	3	3
OEC	Open Elective	1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects	3	0	0	3	3

Total Hours: 26 **Total Credits: 16**

SEMESTER IV

	CODE NO.	COURSE TITLE	L	T	P	C	H
Proj	YWC401	Dissertation Phase – II	0	0	16	16	32

Total Hours: 32 **Total Credits: 16**

Overall Credits:73

Legend

PCC – Professional Core Course
PEC- Professional Elective Course
OEC – Open Elective Course
PCC-L – Professional Core Course - Lab

Table 3 Distribution of credits and course types

S.No	Course Type	Symbol	Credits
1	Professional Core Course	PCC	19
2	Professional Elective Course	PEC	15
3	Open Elective Course	OEC	3
4	Professional Core Course - Lab	PCC-L	6
5	Project	Proj	28
5	AICTE Course - Audit	ACIET –Audit	0
6	AICTE Course - Mandatory	ACIET – Mandatory	2
Total			**73**

LIST OF ELECTIVES

Sl.No	CodeNo	CourseTitle	L	T	P	C
		ELECTIVE-I				
1	YWC104A	**Modern Radar communication**	3	0	0	3
2	YWC104B	Mobile Satellite Communication	3	0	0	3
3	YWC104C	AdvancedDigitalSignalProcessing	3	0	0	3
4	YWC104D	Free space optics	3	0	0	3
		ELECTIVE-II				
1	YWC105A	Mathematics for Communication Systems	3	0	0	3
2	YWC105B	RF MEMS	3	0	0	3
3	YWC105C	Antenna Systems for Wireless Applications	3	0	0	3
4	YWC105D	Detection and Estimation Theory	3	0	0	3
		ELECTIVE-III				
1	YWC204A	Wireless Network Security	3	0	0	3
2	YWC204B	**MIMO Communication**	3	0	0	3
3	YWC 204C	High Performance Wireless Networks	3	0	0	3
4	YWC204D	Internet of Things	3	0	0	3
		ELECTIVE-IV				
1	YWC205A	Soft Computing	3	0	0	3
2	YWC205B	**Millimeter Wave Wireless Communications**	3	0	0	3
3	YWC 205C	Software Defined Radio	3	0	0	3
4	YWC205D	Fundamentals of 5G Mobile and Wireless Technology	3	0	0	3
		ELECTIVE-V				
1	YWC302A	Quality of Service in Wireless Communication	3	0	0	3
2	YWC302B	Telecom Network Planning and Management	3	0	0	3
3	YWC 302C	Regulation and Policy in the Telecommunications Industry	3	0	0	3

SEMESTER-I

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YWC101			**FUNDAMENTALS OF WIRELESS COMMUNICATION**	**3**	**0**	**3**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**		**3**	**0**	**0**	**3**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Classify various wireless communication application and infer mathematical concepts in the modelling of transmission of radio waves.	Cognitive	Understanding
CO2	Explain the statistical modelling of channels and compare various parameters associated with channel models	Cognitive	Understanding
CO3	Outline and compare capacities of various channel models encountered in wireless communication	Cognitive	Understanding
CO4	Classify various diversity schemes	Cognitive	Understanding
CO5	Explain and compare various multiuser systems	Cognitive	Understanding

UNIT I	**9**
INTRODUCTION AND RADIO WAVE PROPAGATION	
History of Wireless Communications - Wireless Vision - Technical Issues - Current Wireless Systems - Cellular Telephone Systems - Cordless Phones- Wireless LANs - Wide Area Wireless Data Services- Broadband Wireless Access -Paging Systems - Satellite Networks Low-Cost Low-Power Radios: Bluetooth and Zigbee -Ultrawideband Radios- The Wireless Spectrum - Methods for Spectrum Allocation -Spectrum Allocations for Existing System. Path Loss and Shadowing Radio Wave Propagation -Transmit and Receive Signal Models -Free-Space Path Loss Ray Tracing -Two-Ray Model Ten-Ray Model (Dielectric Canyon) - General Ray Tracing Local Mean Received Power-Empirical Path Loss Models -The Okumura Model -Hata Model COST 231 -Extension to Hata Model Piecewise Linear (Multi-Slope) Model Indoor Attenuation Factors Simplified Path Loss Model - Shadow Fading -Combined Path Loss and Shadowing . Outage Probability under Path Loss and Shadowing.	
UNIT II	**9**
STATISTICAL MULTIPATH CHANNELS	
Models Time-Varying Channel Impulse Response -Narrowband Fading -Models Autocorrelation, Cross Correlation, and Power Spectral Density -Envelope and Power Distributions Level -Crossing Rate and Average Fade Duration- Finite State Markov Channels -Wideband Fading Models Power Delay Profile Coherence Bandwidth -Doppler Power Spectrum and Channel Coherence Time Transforms for Autocorrelation and Scattering Functions -Discrete-Time Model Space-Time Channel Models	
UNIT III	**9**
CAPACITY OF WIRELESS CHANNELS	
Capacity in AWGN Capacity of Flat-Fading Channels Channel and System Model Channel Distribution Information (CDI) Known Channel Side Information at Receiver Channel Side Information at Transmitter and Receiver Capacity with Receiver Diversity Capacity Comparisons - Capacity of Frequency-Selective Fading Channels - Time-Invariant Channels Time-Varying Channels - (Broadcast) Channel Capacity - Channel Model Capacity in AWGN -Common Data Capacity in Fading - Capacity with Multiple Antennas Uplink (Multiple Access)- Channel Capacity Capacity in AWGN - Capacity in Fading - Capacity with Multiple Antennas -Uplink/Downlink Duality Multiuser Diversity -MIMO Multiuser Systems	
UNIT IV	**9**
POINT TO POINT COMMUNICATION, DETECTION, DIVERSITY	
Non-coherent detection, Coherent detection From BPSK to QPSK: exploiting the degrees of freedom Diversity, Time diversity Repetition coding,- Time diversity code design criterion, Time diversity in GSM. Antenna diversity- Receive diversity Transmit diversity, space-time codes MIMO, MIMO	

schemes Frequency diversity-Basic concept -Single-carrier with ISI equalization -Direct-sequence spread-spectrum, Orthogonal frequency division multiplexing ,Communication over frequency-selective channels. Impact of channel uncertainty -Non-coherent detection for DS spread-spectrum, Channel estimation, other diversity scenarios

UNIT V	**9**
MULTIUSER SYSTEMS	

Multiuser Channels: The Uplink and Downlink - Multiple Access - Frequency-Division Multiple Access (FDMA) -Time-Division Multiple Access (TDMA) - Code-Division Multiple Access (CDMA) - Space-Division Hybrid Techniques -Random Access - Pure ALOHA Slotted ALOHA - Carrier Sense Multiple Access -Scheduling -Power Control - Downlink

LECTURE	**TUTORIAL**	**TOTAL**
45	**0**	**45**

REFERENCES

Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005

David Tse and Pramod Viswanath, Fundamentals ofWirelessCommunication, Cambridge University Press, 2005.

T.S.Rappaport "Wireless Communication" Pearson Education, 2002

Lee W.C.Y., "Mobile Communications Engineering: Theory and Applications", Second Edition, McGraw-Hill, New York, 1998.

Schiller, "Mobile Communications", Pearson Education Asia Ltd., 2000

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3	1	1	1	1
CO2	3	3	3	3		1	1
CO3	3	3	3	3	2	1	1
CO4	3	3	3	1		1	1
CO5	3	3	3	1	2	1	1
	15	15	15	9	5	5	5
Scaled Values	3	3	3	2	1	1	1

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YWC102			**ADVANCEDDIGITALCOMMUNICATION**	**3**	**1**	**0**	**4**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**		**3**	**1**	**0**	**4**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Define and outline PSD of various modulated waveforms.	Cognitive	Understanding

CO2	Explain and compare optimum detection in coherent communication systems.	Cognitive	Understanding
CO3	Explain and compare optimum detection in non-coherent communication systems.	Cognitive	Understanding
CO4	Illustrate the effects of CFO and CTO in communication systems and apply suitable solution to rectify them.	Cognitive	Understanding
CO5	Demonstrate the application of error control coding in detection and correction of errors.	Cognitive	Understanding

UNIT I **12**

DIGITAL MODULATION SCHEMES

Representation of Digitally Modulated Signals - Memoryless Modulation Methods -Pulse Amplitude Modulation (PAM) / -Phase Modulation /- Quadrature Amplitude-Modulation / -Multidimensional Signaling-Signaling Schemes with Memory -Continuous-Phase Frequency-Shift Keying-(CPFSK) / - Continuous-Phase Modulation (CPM)- Power Spectrum of Digitally Modulated Signals -Power Spectral Density of a Digitally Modulated Signal-with Memory / - Power Spectral Density of Linearly-Modulated Signals / - Power Spectral Density of Digitally Modulated Signals with Finite Memory -Power Spectral Density of Modulation Schemes with a Markov Structure - Power Spectral Densities of CPFSK and CPM Signals

UNIT II **12**

OPTIMUM RECEIVERS FOR AWGN CHANNELS - I

Waveform and Vector Channel Models -Optimal Detection for a General Vector Channel - Waveform and Vector AWGN Channels -Optimal Detection for the Vector AWGN Channel / -Implementation of the Optimal Receiver for AWGN Channels / A Union Bound on the Probability of Error of Maximum Likelihood Detection -Optimal Detection and Error Probability for Band-Limited Signaling - - Optimal Detection and Error Probability for ASK or PAM Signaling /- Optimal Detection and Error Probability for PSK Signaling / - Optimal Detection and Error Probability for QAM Signaling / - Demodulation and Detection - Optimal Detection and Error Probability for Power-Limited Signaling -Optimal Detection and Error Probability for Orthogonal Signaling / - Optimal Detection and Error Probability for Biorthogonal Signaling / - Optimal Detection and Error Probability for Simplex Signaling

UNIT III **12**

OPTIMUM RECEIVERS FOR AWGN CHANNELS – II

Optimal Detection in Presence of Uncertainty: Noncoherent Detection -Noncoherent Detection of Carrier Modulated Signals / Optimal Noncoherent Detection of FSK Modulated Signals / Error Probability of Orthogonal Signaling with Noncoherent Detection / Probability of Error for Envelope Detection of Correlated Binary Signals / Differential PSK (DPSK)- A Comparison of Digital Signaling Methods - Bandwidth and Dimensionality -Lattices and Constellations Based onLattices - An Introduction to Lattices / Signal Constellations from Lattices -Detection of Signaling Schemes

with Memory - The Maximum Likelihood Sequence Detector - Optimum Receiver for CPM Signals - Optimum Demodulation and Detection of CPM /- -Performance of CPM Signals / - Suboptimum Demodulation and Detection of CPM Signals - Performance Analysis for Wireline and Radio Communication Systems -Regenerative Repeaters / Link Budget Analysis in Radio Communication Systems

UNIT IV **12**

CARRIER AND SYMBOL SYNCHRONIZATION

Signal Parameter Estimation - The Likelihood Function / - Carrier Recovery andSymbol Synchronization in Signal Demodulation- Carrier Phase Estimation -- Maximum-Likelihood Carrier Phase Estimation /-The Phase-Locked Loop / -Effect of AdditiveNoise on the Phase Estimate / - Decision-Directed Loops / Non-Decision-Directed Loops- Symbol Timing Estimation -Maximum-Likelihood Timing Estimation /-Non-Decision-Directed Timing Estimation- Joint Estimation of Carrier Phase and Symbol Timing -Performance Characteristics of ML Estimators

UNIT V **12**

ERROR CONTROL

Coded waveforms for fading channels. - Viterbi decoding of convolutional codes and lower bounds-soft and hard decision decoding of binary block codes-low-density parity-check (LDPC), Low Complexity Parity Check (LCPC), cyclic redundancy check (CRC), Polar Codes,

	LECTURE	PRACTICAL	TOTAL
	45	15	60

REFERENCES

1. M.K.Simon, S.M.Hinedi and W.C.Lindsey, Digital communication techniques; Signalling and detection, Prentice Hall India, New Delhi. 1995.
2. S Simon Haykin, Digital communications, John Wiley and sons, 2007
3. Bernard Sklar,"Digital Communications Fundamentals and Applications", 2nd
4. Edition, Prentice Hall PTR, Upper Sadle River, New Jersey,2002.
5. B.P.Lathi Modern digital and analog communication systems, 3rd Edition, Oxford
6. University press 1998.
7. Haykins, “Communication Systems”, 5th ed., John Wiley, 2008. [Unit-I, III, V].
8. M. K. Simon and M. S. Alouini,” Digital Communication over Fading Channels”,Wiley-Interscience, 2nd Edition 2005.
9. R. G. Gallager, “Principles of Digital Communication”, Cambridge University Press, 2008.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	1	1
CO2	3	3	3	1		1	1
CO3	3	3	3	1	2	1	1
CO4	3	3	3	1		1	1
CO5	3	3	3	3	2	1	1
	15	15	15	7	5	5	5
Scaled values	3	3	3	2	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC103			ADVANCED TECHNOLOGIES IN WIRELESS NETWORKS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25					

After completion of the course, a student will be able to:

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Explain the architecture, functioning, protocols and capabilities of wireless communication networks.	Cognitive	Understanding
CO2	Demonstrate their understanding on the functioning of Internet Protocols and Wireless security and standards.	Cognitive	Understanding
CO3	Explain the architecture, functioning and protocols of wireless Sensor networks.	Cognitive	Understanding
CO4	Compare different Wideband Wireless technologies used for wireless communication systems.	Cognitive	Understanding
CO5	Demonstrate an ability explain wireless networks standards using related tools	Cognitive	Understanding

UNIT I **9**

WIRELESS AREA NETWORKS

WPAN: System model - protocol stack of IEEE 802.15; Bluetooth: Network architecture -operation - specification and application models; Radio Frequency Identification (RFID): Types and specifications; ZIGBEE and WBAN: Standard and architecture; WLAN: Network architecture - protocol stack of IEEE 802.11 - physical layer and MAC layer mechanism; WiMAX: BWA - issues and challenges of WiMAX - network architecture - protocol stack of IEEE 802.16 - differences between IEEE 802.11 and IEEE 802.16

UNIT II **9**

WIRELESS INTERNET

IP for wireless domain - mobile IP - IPv6 advancements - mobility management functions - location management - registration and handoffs; TCP in wireless domain: TCP over wireless - types - mobile transaction - impact of mobility; Wireless security and standards.

UNIT III **9**

WIRELESS SENSOR NETWORK

Issues - design challenges - characteristics and architecture of wireless sensor network - classification - MAC protocols - routing schemes - security - enabling technologies for sensor network.

UNIT IV **9**

WIDEBAND WIRELESS TECHNOLOGIES

UWB Radio Communication: Fundamentals of UWB - major issues - operation of UWB systems -

comparisons with other technologies - advantages and disadvantages; LTE: System architecture - frame structure - LTE FDD vs TDD comparison; LTE advanced: Network architecture - frame structure and its characteristics; 5G networks: Technical challenges- architecture.

UNIT V	**9**

INSTRUCTIONAL ACTIVITIES

Simulation of minimum of five wireless networks standards using related tools

	LECTURE	**PRACTICAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. Siva Ram Murthy C and Manoj B S, "Ad-hoc Wireless Networks-Architecture and Protocols", 2nd Edition, Pearson education, 2007.

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3	1	1	3	1
CO2	3	3	3	1		3	1
CO3	3	3	3	1	2	3	1
CO4	3	3	3	1		3	1
CO5	3	3	3	1	2	3	1
	15	15	15	5	5	15	5
Scaled values	3	3	3	2	1	3	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YWC106			**DIGITAL COMMUNICATION LAB**	**0**	**0**	**2**	**2**
C	**P**	**A**		**L**	**T**	**P**	**H**
1.5	**0.25**	**0.25**					

LIST OF EXPERIMENTS

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Demonstrate the performance of various digital modulation techniques under AWGN noise	Cognitive	Understanding
CO2	Demonstrate the performance of various digital modulation techniques under AWGN noise and fading	Cognitive	Understanding
CO3	Show fading channels and performance of coded modulation schemes under Rayleigh fading	Cognitive	Understanding
CO4	Show the multicarrier systems in Matlab	Cognitive	Understanding
CO5	Demonstrate the effects of CFO, CTO and fading and solutions for the same	Cognitive	Understanding

11. PSD of digitally modulated waveforms
12. Demonstrate the theoretical and simulated BER for M-ary PSK MATLAB.

13. Demonstration of theoretical and simulated BER for M- QAM in AWGN usingMATLAB
14. Rayleigh fading channel simulation.
15. BER for BPSK/QPSK/QAM under Rayleigh channel
16. Carrier frequency and Timing Offset demonstration
17. Performance of coded digital modulated systems under Rayleigh fading
18. Demonstration of different equalizers
19. BER performance of BPSK using convolutional code under AWGN channel
20. Simulation of OFDM IN MATLAB

REFERENCES:

http://www.vlab.co.in/
http://203.110.240.139/
http://iitg.vlab.co.in/?sub=59&brch =163
http://solve.nitk.ac.in/

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	1	1
CO2	3	3	3	1	1	1	1
CO3	3	3	3	1	1	1	1
CO4	3	3	3	1	1	1	1
CO5	3	3	3	1	1	1	1
	15	15	15	5	5	5	5
Scaled values	3	3	3	1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YRM107			**RESEARCH METHODOLOGY AND IPR**	**2**	**0**	**0**	**2**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**		**2**	**0**	**0**	**2**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Identify andformulate a research problem, collect data, identify research gap for the identified problem	Cognitive	Applying
CO2	Consolidate literature survey and provide inference on own words	Cognitive	Understanding
CO3	Describe Patents, Designs, Trade and Copyright	Cognitive	Understanding
CO4	Appraise, discuss and categorize Patent Rights	Cognitive	Evaluating
CO5	Identify and describe new developments in IPR	Cognitive	Applying

UNIT I **6**

Meaning of research problem, Sources of research problem, Criteria-Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II **6**

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT IV **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V **6**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

	LECTURE	TUTORIAL	TOTAL
	30	**0**	**30**

REFERENCES

10. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
11. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
12. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
13. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
14. Mayall, "Industrial Design", McGraw Hill, 1992.
15. Niebel, "Product Design", McGraw Hill, 1974.
16. Asimov, "Introduction to Design", Prentice Hall, 1962.
17. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
18. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				1	3	3	3
CO2				1	3	3	3
CO3				1	3	3	3
CO4				1	3	3	3
CO5				3	3	3	3
				7	15	15	15

Scaled values				2	3	3	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YEGOE1			**ENGLISH FOR RESEARCH PAPER WRITING**	**2**	**0**	**0**	**0**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**		**2**	**0**	**0**	**0**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Recall the basic writing methods in proper context	Cognitive	Remembering
CO2	Explain the methodology of writing a paper	Cognitive	Understanding
CO3	Adapt the important reviews for classification	Cognitive	Creating
CO4	Demonstrate the key writing skills	Cognitive	Understanding
CO5	Classify the results and findings in the conclusion	Cognitive	Understanding

UNIT I **6**

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and vagueness

UNIT II **6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III **6**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV **6**

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT V **6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

LECTURE	**TUTORIAL**	**TOTAL**
30	**0**	**30**

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			3	1	3	2	2
CO2			3	1	2	3	3
CO3			3	1	2	3	3
CO4			3	1	3	3	3
CO5			3	3	2	3	3
			15	7	12	14	14
Scaled values			3	2	3	3	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSENAME**	**L**	**T**	**P**	**C**
YWC109			**WIRELESS NETWORKS LAB**	**0**	**0**	**2**	**2**
C	**P**	**A**		**L**	**T**	**P**	**H**
1.5	**0.25**	**0.25**		**0**	**0**	**2**	**2**
			LIST OF EXPERIMENTS				

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Simulate different routing protocols.	Cognitive	Analysis
CO2	Evaluate the MAC algorithm and energy models.	Cognitive	Evaluate
CO3	Compare security algorithms.	Cognitive	Analysis
CO4	Simulate and compare PAN and GSM networks.	Cognitive	Analysis
CO5	Measure the performance parameters of wireless networks.	Cognitive	Evaluate

1. Analysis of wireless network with wireshark, TCL scripts and Xgraph.

   Comparison of DSDV, DSR and AODV Routing protocols.
2. Implementation of MAC algorithm for wireless network.
3. Program to implement energy models for wireless nodes.
4. Implementation of symmetric key encryption using Ns2.
5. Implementation of Gray hole and wormhole attack in Ns2.
6. Program to calculate packet delivery ratio, packet loss, throughput, end to end delay and routing overhead for Wireless Networks.
7. Implementation of congestion control algorithms.
8. Simulate a wireless Personal Area Networks.
9. Measurement on the effect of RTS/CTS on a wireless link.
10. Performance comparison of GSM and CDMA networks

REFERENCES:

1. Advanced Network Technologies Virtual Lab @ www.virtual-labs.ac.in/cse28/
2. www.winlab.rutgers.edu/zhibinwu/pdf/tr_ns802_11.pdf

3. www.ittc.ku.edu/jpgs/courses/... / lecture-lab-intro2ns3-print.pdf
4. www.isi.edu/nsnam/ns/

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	1	1
CO2	3	3	3	1	1	1	1
CO3	3	3	3	1	1	1	1
CO4	3	3	3	1	1	1	1
CO5	3	3	3	1	1	1	1
Scaled values	15	15	15	5	5	5	5

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

SEMESTER-II

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YWC201			**MULTICARRIERCOMMUNICATION**	**3**	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**		**3**	**0**	**0**	**3**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Explain the fundamentals of OFDM and model the same.	Cognitive	Understanding
CO2	Outline the system imperfections and produce solutions in MC communications.	Cognitive	Understanding
CO3	Analyze the effects of various noise in OFDM performance.	Cognitive	Analyzing
CO4	Explain and describe MC CDMA	Cognitive	Understanding
CO5	Discuss various applications of MC communications	Cognitive	Create

UNIT I **9**

FUNDAMENTALS OF OFDM/OFDMA SYSTEMS

Mobile channel modeling- Parameters of wireless channels, Categorization of fadingchannels. Conventional methods for channel fading mitigation-Time-selective fading, Frequency-selective fading. OFDM systems- System architecture, Discrete-time model of an OFDM system, Spectral efficiency, Strengths and drawbacks of OFDM. OFDM-based multiple access schemes.

UNIT II **9**

SYSTEM IMPERFECTIONS

Time and frequency synchronizations-Sensitivity to timing and frequency errors, Synchronizations for downlink transmission, Synchronizations for uplink transmissions. Peak-to-Average Power Ratio (PAPR)-definitions, Statistical properties of PAPR, PAPR reduction techniques. Channel estimation and equalization techniques.

UNIT III **9**

OFDM PERFORMANCE

OFDM System Performance over AWGN Channels-Clipping Amplification, BER Performance Using Clipping Amplifiers, Signal Spectrum with Clipping Amplifier. Analogue- to-Digital Conversion, Phase Noise -Effects of phase noise, White Phase Noise Model, coloured phase noise, OFDM transmission over wideband channel-channel model, Effects of Time Dispersive Channels on OFDM, system performance over dispersive channel.

UNIT IV	**9**

MC CDMA

OFDM versus MC-CDMA, CDMA- MC-CDMA, MC-DS-CDMA, MT- CDMA,MC- MC-CDMA System. Basic spreading sequences, MC-CDMA System Performance in Synchronous Environment, Advanced peak factor reduction techniques.

UNIT V	**9**

APPLICATIONS OF OFDM AND MC-CDMA

Digital Broadcasting- Digital Audio Broadcasting, Terrestrial Digital Video Broadcasting, Terrestrial Integrated Services Digital Broadcasting, GHz-Band Wireless LANs- IEEE 802.11g , IEEE 802.11h , IEEE 802.16a.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

8. Man-On Pun Michele Morelli C-C Jay Kuo,"Multi-Carrier Techniques For Broadband Wireless Communications A Signal Processing Perspective" 2007 by Imperial College Press
9. Hara, Shinsuke. Multicarrier techniques for 4G mobile communications Artech House Universal personal communications series 2003
10. OFDM and MC-CDMA A Primer L. Hanzo, T. Keller 2006 John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
11. Liu, Hui, OFDM-based broadband wireless networks : design and optimization 2005 by John Wiley & Sons
12. Lie Liang Yang, "Multicarrier Communications", John Wiley & Sons Ltd, 2009
13. Andreas F. Molisch, "Wireless Communications", Wiley IEEE, 2011.
14. James B. Y. Tsui, "Special Design Topics in Digital Wideband Receivers", Artech House Radar Library, 2009.

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3			1	1
CO2	3	3	3			1	1
CO3	3	3	3		2	1	1
CO4	3	3	3		2	1	1
CO5	3	3	3		2	1	1
	15	15	15		6	5	5
Scaled values	3	3	3		2	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
				3	0	0	3
YWC202			MICROWAVE PASSIVE AND ACTIVE SYSTEMS				
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to .

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Compare the various transmission lines and impedance matching techniques	Cognitive	Understanding
CO2	Explain the operation of passive microwave devices and their S-parameters	Cognitive	Understanding
CO3	Illustrate the performance of microwave integrated passive circuits and filters.	Cognitive	Understanding
CO4	Demonstrate the various microwave systems and its standards	Cognitive	Understanding
CO5	Explain the various active microwave circuits and its characteristics	Cognitive	Understanding

UNIT I **9**

MICROWAVE CIRCUITS:

S parameters reciprocal networks, Lossless networks, **Planar transmission Lines:** Micro strip, Slot line, Strip and coplanar lines. **Impedance matching:** Matching with lumped elements, Stub matching- Single and double stub using Smith chart solutions, Quarter wave transformer, tapered lines- Exponential taper, triangular taper.

UNIT –II **9**

PASSIVE CIRCUIT DESIGN wave guide based Directional coupler, E & H plane Tee junction, hybrid T, isolator, circulator, slotted line section, Frequency meter, Attenuator, microwave Antenna

UNIT III **9**

MICROWAVE INTEGRATED PASSIVE CIRCUITS

Power divider coupler Wilkinson power divider90 degree Hybrid Coupler,180 degree coupler, Filter design: Periodic structures, Insertion loss method, maximally flat low pass filter, stepped impedance low pass filter, filter transformation, filter implementation.

UNIT –IV **9**

MICROWAVE SYSTEMS RF transceiver, Microwave standards, Satellite link, Cellular Communication system, Radar systems

UNIT-V **9**

ACTIVE MICROWAVE CIRCUIT DESIGN

Characteristics of microwave diodes and transistors. Linear and nonlinear behaviour and models- Amplifier design; gain and stability, design for noise figure- Noise in microwave circuits; dynamic

range and noise sources, equivalent noise temperature, system noise figure considerations

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

5. David M. Pozar," Microwave Engineering," John Wiley & Sons, 1998.
6. David M. Pozar," Microwave & RF Design of Wireless Systems," John Wiley & Sons, 1998.
7. R.E.Collin," Foundations of Microwave Engineering," Tata McGraw Hill, 1995.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3		2	1	1
CO2	3	3	3			1	1
CO3	3	3	3		2	1	1
CO4	3	3	3			1	1
CO5	3	3	3		2	1	1
	15	15	15		6	5	5
Scaled values	3	3	3		2	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC203			ADVANCED RADIATION SYSTEMS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to .

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Outline the radiation characteristics of monopole and dipole antennas.	Cognitive	Understanding
CO2	Classify one dimensional and two dimensional antenna arrays.	Cognitive	Understanding
CO3	Compare the characteristics of different types of aperture antennas.	Cognitive	Understanding
CO4	Illustrate the performance of Microstrip Antennas.	Cognitive	Understanding
CO5	Summarize the operation of modern antennas for various applications.	Cognitive	Understanding

UNIT I **9**

ANTENNA FUNDAMENTA

roduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas – Maxwell's equations - Antenna fundamental parameters - Radiation integrals - Radiation from surface and line current distributions – dipole, monopole, loop antenna; Mobile phone antenna-base station, hand set antenna; Image; Induction ,reciprocity theorem, Balance to unbalance transformer.

UNIT II **9**

ANTENNA ARRAYS	
view of One Dimensional and Two dimensional Arrays, General structure of phased array, linear array theory, variation of gain as a function of pointing direction, effects of phase quantization, frequency scanned arrays, analog beamforming matrices-Active modules, digital beam forming, MEMS technology in phased arrays-Retrodirective and self-phased arrays.	
UNIT III	**9**
RADIATION FROM APERTURES	
ld equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane; Babinets principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration.	

UNIT IV	**9**
MICROSTRIP ANTENNA	
Radiation Mechanism and Excitation techniques : Microstrip dipole; Patch, Rectangular patch, Circular patch, and Ring antenna – radiation analysis from cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Reconfiguration Mechanisms; Computer Aided Design of Microstrip Antennas, Microstrip Reflectarray Antennas.	
UNIT V	**9**
MODERN ANTENNAS	
A – Vivaldi Antennas - UWB Antennas - Antennas in Medicine – Leaky Wave Antennas –Plasma Antennas – Wearable Antennas – RFID Antennas - Automotive antennas, Reconfigurable antennas - Meta materials	

LECTURE	**TUTORIAL**	**TOTAL**
45	**0**	**45**

REFERENCES

1. Balanis.A, ―Antenna Theory Analysis and Design, 3rd Edition, John Wiley and Sons, New York, 1982.
2. Frank B. Gross, ―Frontiers in Antennas, Mc Graw Hill, 2011.
3. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, ―Modern 9 Antennas, II Edition, Springer Publications, 2007.
4. Krauss.J.D, ―Antennas, II edition, John Wiley and sons, New York, 1997.
5. I.J. Bahl and P. Bhartia, Microstrip Antennas, Artech House,Inc.,1980
6. W.L.Stutzman and G.A.Thiele, ―Antenna Theory and Design, 2nd edition, John Wiley& Sons Inc.,1998.
7. Jim R. James,P.S.Hall ,"Handbook of Microstrip Antennas" IEE Electromagnetic wave series 28, Volume 2,1989

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	1	1
CO2	3	3	3	0		1	1
CO3	3	3	3	1	2	1	1

CO4	3	3	3	1		1	1
CO5	3	3	3	1	2	1	1
	15	15	15	4	5	5	5
Scaled values	3	3	3	1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
				0	**0**	**2**	**2**
YWC206			**RADIO FREQUENCY SYSTEMS LABORATORY**				
C	**P**	**A**		**L**	**T**	**P**	**H**
1.5	**0.25**	**0.25**		**0**	**0**	**2**	**2**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Buildmonopole and dipole antennas.	Cognitive	Applying
CO2	Develop the antenna arrays	Cognitive	Applying
CO3	Evaluate the effective height of antennas.	Cognitive	Evaluating
CO4	Experiment the performance of IFA and UWB antennas	Cognitive	Applying
CO5	Construct wearable antennas	Cognitive	Applying

LIST OF EXPERIMENTS:

1. Simulation of half wave dipole antenna.
2. Simulation of quarter wave, full wave antenna and comparison of their parameters.
3. Simulation of monopole antenna with and without ground plane.
4. Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.
5. Simulation of a half wave dipole antenna array.
6. Simulation of IFA antenna.
7. Simulation of UWB antenna.
8. Simulation of Wearable antenna.

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3		1	1	1
CO2	3	3	3			1	1
CO3	3	3	3		2	1	1
CO4	3	3	3			1	1
CO5	3	3	3		2	1	1
	15	15	15		5	5	5

Scaled values	3	3	3		1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YPSOE1			**CONSTITUTION OF INDIA**	**2**	**0**	**0**	**0**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**					

UNIT I	**6**
HISTORY AND PHIOLOSOPHY	
History of Making of the Indian Constitution: History-Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble-Salient Features	
UNIT II	**6**
CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES:	
Fundamental Rights -Right to Equality-Right to Freedom-Right against Exploitation-Right to Freedom of Religion-Cultural and Educational Rights-Right to Constitutional Remedies-Directive Principles of State Policy-Fundamental Duties.	
UNIT III	**6**
ORGANS OF GOVERNANCE:	
Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive-President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications-Powers and Functions	
UNIT IV	**6**
LOCAL ADMINISTRATION	
District's Administration head: Role and Importance, -Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	
UNIT V:	**6**
ELECTION COMMISSION	
Election Commission: Role and Functioning. -Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	

	LECTURE	**TUTORIAL**	**TOTAL**
	30	**0**	**30**

REFERENCES

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				3		1	1
CO2				3		1	1
CO3				3		1	1
CO4				3		1	1
CO5				3		1	1
				15		5	5
Scaled values				3		1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YWC207			**MINI PROJECT**	0	0	2	2
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**0.5**	**0.5**		0	0	2	2

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Define and discuss an existing problem in wireless communication and summarize the solutions.	Cognitive	Understanding
CO2	Discover various tools and mathematical/engineering methods behind the solutions	Cognitive	Remembering Applying
CO3	Present the problem, objectives, literature and analyze various solutions.	Cognitive	Analyzing
CO4	Solve the problem using existing method by proper tools and produce the results.	Cognitive	Understanding
CO5	Conclude, compare, report and present the solution proposed and the results obtained.	Cognitive	Analyzing

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3				1	1
CO2			3	3		1	1
CO3		3			3	1	1
CO4	3	3	3			1	1
CO5					3	1	1
	6	9	6	3	6	5	5
Scaled values	2	2	2	1	2	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC401			DISSERTATION PHASE – I	0	0	10	10
C	**P**	**A**		**L**	**T**	**P**	**H**
1	0.5	0.5		0	0	10	10

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Identify problems and contemporary tools to solve them efficiently.	Cognitive	Applying
CO2	Survey recent solutions proposed and outline the objectives and methods.	Cognitive	Analyzing
CO3	Explain the project ideas, findings and demonstrate the same	Cognitive	Understanding

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	3	3			3	
CO2	1	3					
CO3	1	2	3	3	3	1	1
	3	8	6	3	3	4	1
Scaled values	1	2	2	1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC401			DISSERTATION PHASE – II	0	0	16	16
C	**P**	**A**		**L**	**T**	**P**	**H**
1	0.5	0.5		0	0	16	16

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Identify, Estimate, Track and cost the human and physical resources required, and make plans to obtain the necessary resources	Cognitive	Applying
CO2	Conclude, compare, report and present the solution proposed and the results obtained.	Cognitive	Analyzing
CO3	Extend the findings and develop a research article without any plagiarism and present	Cognitive	Understanding

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				3	3	3	
CO2	1	1	1	3	3	3	1
CO3	1	1	1	3	3	3	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

ELECTIVES

COURSE CODE			COURSE NAME	L	T	P	C
YWC104A			MODERN RADAR COMMUNICATION	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Explain various principles associated with radar communication	Cognitive	Understanding
CO2	Apply matched filter and discuss various situation where matched filter can be used	Cognitive	Applying
CO3	Examinevarious Ambiguity Functions	Cognitive	Analyzing
CO4	Outline FMCW radar and demonstrate various applications.	Cognitive	Understanding
CO5	AnalyzeMoving Target Indicator (MTI) and Pulse Doppler Radars	Cognitive	Analyzing

UNIT I **9**

INTRODUCTION

Pulsed and Continuous Wave (CW) Radars, -. Range,-Range Resolution, - Doppler Frequency, - Coherence, -Decibel Arithmetic,- The Radar Range Equation, - Low PRF Radar Equation, - High PRF Radar Equation, -Surveillance Radar Equation, -Radar Equation with Jamming, - Self-Screening Jammers (SSJ), - Burn-Through Range, -Stand-Off Jammers (SOJ), - Range Reduction Factor, - Bistatic Radar Equation, - Radar Losses, -Transmit and Receive Losses, - Antenna Pattern Loss and Scan Loss, -Atmospheric Loss, - Collapsing Loss, - Processing Loss, -Noise Figure, - Continuous Wave (CW) Radars, - CW Radar Equation, - Frequency Modulation, - Linear Frequency Modulated CW Radar, - Multiple Frequency CW Radar

UNIT II **9**

THE MATCHED FILTER RADAR RECEIVER

The Matched Filter SNR, -White Noise Case, - The Replica, -General Formula for the Output of the Matched Filter, -Stationary Target Case, - Moving Target Case, -Waveform Resolution and Ambiguity, - Range Resolution, - Doppler Resolution, -Range and Doppler Uncertainty, -Range Uncertainty, - Doppler Uncertainty, -Range-Doppler Coupling, -Range Error Estimate, -Doppler Error Estimate, - Range-Doppler Coupling in LFM Signals, - Target Parameter Estimation, - What

Is an Estimator?, - Amplitude Estimation, -Phase Estimation,

UNIT III | **9**

AMBIGUITY FUNCTION

Examples of the Ambiguity Function, -Single Pulse Ambiguity Function, - LFM Ambiguity Function, - Coherent Pulse Train Ambiguity Function, - Pulse Train Ambiguity Function with LFM, - Stepped Frequency Waveforms, -Nonlinear FM, 1-The Concept of Stationary Phase, - Frequency Modulated Waveform Spectrum Shaping, - Ambiguity Diagram Contours, 1- Interpretation of Range-Doppler Coupling in LFM Signals, Ambiguity Function - Discrete Coded Waveforms

UNIT IV | **9**

FCW AND FREQUENCY MODULATED RADAR: Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar, Illustrative Problems.FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Multiple Frequency CW Radar.

UNIT V | **9**

MOVING TARGET INDICATOR (MTI) AND PULSE DOPPLER RADARS

Clutter Power Spectrum Density, Concept of a Moving Target Indicator (MTI), - Single Delay Line Canceler, -Double Delay Line Canceler, -Delay Lines with Feedback (Recursive Filters), - PRF Staggering, - MTI Improvement Factor, -Two-Pulse MTI Case, - The General Case, -Subclutter Visibility (SCV), - Delay Line Cancelers with Optimal Weights, - Pulse Doppler Radars, -Pulse Doppler Radar Signal Processing, - Resolving Range Ambiguities, - Resolving Doppler Ambiguities, -Phase Noise

LECTURE	PRACTICAL	TOTAL
45	0	45

REFERENCES

Bassem R. Mahafza, "Radar Systems Analysis and Design Using MATLAB, CRC Press, Boca Raton, FL, United States, 2000

Sullivan, “Radar foundations for imaging and advanced concepts”, 2004

Richards, Sheer and Holm (eds), “Principles of modern radar, basic principles”, 2010

. C. Toomay and Paul J. Hannen, “Radar Principles for the Non-Specialist”, by J. C. Toomay, Paul Hannen, SciTech Publishing

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		2	2	1	1
CO2	3	3		1	2	1	1
CO3	3	3			2	1	1
CO4	3	3		2	2	1	1
CO5	3	3		1	2	1	1
	15	15		6	10	5	5
Scaled values	3	3		2	2	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC104B			MOBILE SATELLITE COMMUNICATION	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Outline the orbital mechanism pointing out the coverage of the satellite.	Cognitive	Understanding
CO2	Explain the radio link and summarize the multiple access in satellite communications.	Cognitive	Understanding
CO3	Explain the satellite subsystems and links	Cognitive	Evaluating
CO4	Appraise and explain various planning in implementing a satellite communication	Cognitive	Understanding
CO5	Explain various satellite system and services	Cognitive	Understanding

UNIT I **9**

INTRODUCTION TO SATELLITE COMMUNICATION:

Satellite Orbits – Satellite Constellations –Orbital Mechanics – Equation of orbit –Orbital Elements – Look angle determination – orbital perturbation – Satellite coverage – Space environment – Eclipse – Sun Transit outage – Limitsofvisibility–subsatellitepoint-launchingproceduresandLaunchVehicles.

UNIT II **9**

RADIO LINK AND SATELLITE ACCESS: Spectrum issues – Propagation characteristics and frequency considerations – Radio link analysis – Modulation – codingand multiple access schemes and comparison of multiple access schemes.

UNITIII **9**

SPACECRAFT TECHNOLOGY: Satellite subsystems – Satellite for MSS, Intersatellite links– Emerging Technologies – Launching Satellite constellation- Gateways – Mobile Terminals – Environmental issues.

UNIT IV **9**

SYSTEM ARCHITECTURE: System planning – Service Distribution model – Investment Routes – Regulatory issues – Traffic Forecast – Air interface –system development – network considerations and network management – Licensingissues.

UNIT V **9**

SATELLITE SYSTEM & SERVICES: Representative MSS system – Distress and Safety Systems- navigation systems – Direct Satellite broadcast – Direct TV Broadcast system – Very Small Aperture Terminal systems- Terrestrial Cellular system – Future Trends –Broadband systems – ATM over Satellite – Role of Satellite in FeatureNetworks.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. M.Richharia, "Mobile Satellite Communications-Principles & Trends", Pearson Education,2003
2. T.PrattandBostian, "Satellite Communications", John Wiley,2001.
3. W.L.Prichand and A.Sciulli, "Satellite Communication systems Engineering", Prentice Hall,1986
4. T.Ha, "Digital Satellite Communication SystemsEngineering", McGraw Hill, 1998
5. Gerard Maral, Michel Bousquet and Zhili ,"Satellite Communications Systems: Systems, Techniques and Technology", Wiley,2010.
6. Anil K. Maini and Varsha Agrawal "Satellite Technology: Principles and Applications", Wiley,2010.
7. Bruce R. Elbert "Introduction to Satellite Communication (Artech House Space Applications)",2008.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		2	2	1	1
CO2	3	3		1		1	1
CO3	3	3			1	1	1
CO4	3	3		2		1	1
CO5	3	3		1	3	1	1
	15	15		6	6	5	5
Scaled values	3	3		2	2	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC104A			ADVANCE DIGITAL SIGNAL PROCESSING	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Explain Multirate digital signal processing principles and its applications.	Cognitive	Understanding
CO2	Estimate the various spectral components present in the received signal using different spectral estimation methods such as Parametric and Nonparametric.	Cognitive	Evaluating
CO3	Design and implement an optimum adaptive filter using LMS and RLS algorithms.	Cognitive	Creating
CO4	Explain the concepts and mathematical representations	Cognitive	Understanding

	of Wavelet transforms.		
CO5	Design adaptive filters	Cognitive	Creating

UNIT I **9**

FUNDAMENTALS OF SIGNAL PROCESSING

Introduction: Basic Elements Of Digital Signal Processing System- advantages of digital over analog signal processing; Classification of signals: Deterministic vs Random signals - Multi channel and Multi-dimensional signals; Down Sampling-decimation-up sampling- interpolation

UNIT II **9**

POWER SPECTRUM ESTIMATION

Estimation of spectra using the DFT from finite duration signals - non– parametric methods for power spectrum estimation: Welch- Bartlett methods; Parametric methods for power spectrum estimation: Yule-Walker method- Burg method for the ARM parameters- sequential estimation methods.

UNIT III **9**

ADAPTIVE SIGNAL PROCESSING

FIR adaptive filters- steepest descent adaptive filter - LMS algorithm - convergence of LMS algorithms; Applications: Noise cancellation - channel equalization; Adaptive recursive filters - recursive least square estimation.

UNIT IV **9**

WAVELET TRANSFORM

Introduction: Continuous Wavelet Transform - basic properties of wavelet transforms - Discrete Wavelet Transform: Haar scaling functions and function spaces- nested spaces - Haar wavelet function - orthogonality of $\varphi(t)$ and $\psi(t)$ - normalization of Haar bases at different scales; Daubechies wavelets - support of wavelet system.

UNIT V **9**

INSTRUCTIONAL ACTIVITIES

EEG/ECG signal analysis for the real time environment; Echo cancellation using adaptive filters; Voice recognition and speech-to-text conversion using related tools.

	LECTURE	**PRACTICAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. Proakis J G and Manolkis D G, “Digital Signal Processing: Principles, Algorithms and Applications”, 4th Edition, Prentice Hall of India, 2007.
2. Monson H H, “Statistical Digital Signal Processing and Modeling”, Wiley, 2002.
3. Cristi R, “Modern Digital Signal Processing”, Thomson Brooks/ Cole, 2004.
4. Lokenath D and Firdous A S, “Wavelet Transforms and Their Applications”, 2nd Edition, Birkhauser, Springer, 2014.
5. Raghuveer R M, and Ajit S B, “Wavelet Transforms: Introduction to Theory and Applications”, Pearson Education, New Delhi, 1998.
6. Insight into Wavelets- from Theory to Practice”, K.P Soman, Ramachandran, Resmi- PHI Third Edition-2010.

Hyperlinks:

7. www.ece.umd.edu/class/enee630.F2012.html
8. 2.http://ar.book.org/s/?q=DSP+PROAKIS&yearFrom=&yearTo=&language=&extension=&t=0

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3		2	2	1	1
CO2		3		1		1	1
CO3		3			3	1	1
CO4		3		2		1	1
CO5		3		1	3	1	1
		15		6	8	5	5
Scaled values		3		2	2	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC104D			FREE SPACE OPTICS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Outline and describe fundamentals related to Free Space Optics	Cognitive	Understanding
CO2	Explain FSO networks	Cognitive	Understanding
CO3	Discuss long distance FSO communication.	Cognitive	Creating
CO4	Illustrate and give Examples of FSO devices and components	Cognitive	Understanding
CO5	Discuss the optical signal processing techniques	Cognitive	Creating

UNIT I **9**

FUNDAMENTALS

Fundamentals of FSO Technology : Introduction – Maxwell's Equations – Electromagnetic wave propagation in free space - alternate bandwidth technologies – Fiber Vs FSO- Fiber Access – Overview of FSO Optical Transmitters – Receivers – Subsystems – Pointing, Acquisition and Tracking – Line of sightanalysis.

UNIT II **9**

FSO NETWORKS

The Role of FSO in the network – factors affecting FSO – line of sight (LOS) –Selecting transmission wave integration of FSO in Optical networks – installation of FSO systems – moving towards edge – and

residentialareas.

UNITIII	**9**

LONG DISTANCE FSO COMMUNICATION

The FSO model – Applications – System descriptions and design – Introduction to Laser Satellite Communications – Characteristics, Modulation Techniques and Radiation effects – Laser Sources.

UNIT IV	**9**

PLANE EM WAVES IN ISOTROPIC MEDIA OPTICAL COMPONENTS FOR FSO

Optical waveguides – Optical Filters, Couplers, Amplifiers, Switches, Antennas, Interconnecting Equipment, etc – Optical integrated circuits – semiconductor integrated optic devices.

UNIT V	**9**

OPTICAL SIGNAL PROCESSING

Analog and Discrete systems – Noise and Stochastic processes – Filters – Power spectraestimation– Ambiguityfunction,Wignerdistributionfunctionandtriplecorrelations

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. Heinz, Phd. Willebrand, “Free Space Optics”, Sams, First Edi. –2001
2. Morris Katzman, “Laser Satellite Communication”, Prentice Hall Inc., New York,1991.
3. Hiroshi Nishihara, “Optical Integrated Circuits”, McGraw Hill, New York, 1992.
4. Pankaj K. Das, “Optical Signal Processing”, Narosa Pub. House, 1993.
5. Rajiv Ramaswami, Kumar Sivarajan and Galen Sasaki “Optical Networks: A Practical Perspective”, Morgan Kaufmann, 3rd Edition, 2009.

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3		2		1	1
CO2	3	3		2		1	1
CO3	3	3				1	1
CO4	3	3		1		1	1
CO5	3	3		2		1	1
	15	15		7		5	5
Scaled values	3	3		1		1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC105A			MATHEMATICS FOR COMMUNICATION SYSTEMS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Apply Gram Schmidt orthonormalization process to construct an orthonormal set of vectors from the given linearly independent set of vectors	Cognitive	Applying
CO2	Construct a QR decomposition for a given set of vectors	Cognitive	Applying
CO3	Analyze the relationship between the continuous and discrete distributions	Cognitive	Analyzing
CO4	Identify the given process is stationery or not	Cognitive	Applying
CO5	Identify average waiting time and queue length of a given single or multi server queue models	Cognitive	Analyzing

UNIT I **9**

VECTOR SPACES

Vector Spaces, Subspaces, Linearly Independence and dependence, Dimension and Bases, Rank – Nullilty dimension theorem, Inner product spaces, Orthogonality and Gram-Schmidt orthogonalization process, Diagonalization

UNIT II **9**

ALGEBRA

Sets-Relations and functions- Definitions; Groups-Definition and elementary properties-subgroups-abelian groups-Lagranges theorem-properties; Field-Finite fields-elementary properties-subfields-statements, properties. **Matrix Theory –** Some important matrix factorizations–The Cholesky decomposition–QR factorization–Least squares method–Singular value decomposition.

UNIT III **9**

RANDOM VARIABLES AND THEIR DISTRIBUTIONS

Random variables - Probability function – Moments – Moment Generation Function, Characteristic Function, Binomial Distribution, Negative Binomial Distribution, Hypergeometric distribution, Multinomial, Poisson Distributions and Relationship between various Discrete-Type distributions

Normal, Log - Normal, Multivariate Normal, Gamma, Exponential, Chi-square, Weibull, Rayleigh distributions. Relationship between continuous distributions.

UNIT IV **9**

STOCHASTIC PROCESSES

Introduction- Classification of stochastic process, Stationary process (SSS and WSS) Stationary process, Ergodic Process, Independent increment Process, Markov Process, Counting Process, Narrow- Band Process, Normal Process, Wiener-Levy Process, Poisson, Bernoulli, Shot noise Process, Autocorrelation Function.

UNIT V	**9**

QUEUEING MODELS

Poisson Process – Markovian queues – Single and Multi-server Models – Little's Formula – Machine Interference Model – Steady State analysis – Self Service queue.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

7. Grewal B.S., "Numerical methods in Engineering and Science", 40th edition, Khanna Publishers, 2007. [unit I]
8. Moon, T.K., Sterling, W.C., "Mathematical methods and algorithms for signal processing", Pearson Education, 2000.
9. Richard Johnson, Miller & Freund, "Probability and Statistics for Engineers", 7th Edition, Prentice – Hall of India, Private Ltd., New Delhi (2007).[unit III &IV]
10. Michel K. Ochi , "Applied Probability and Stochastic Processes," John Wiley & Sons .ISSN – 0271-6356, 2008.
11. Kenneth Hoffman, "Linear Algebra", Prentice Hall of India Private Limited, New Delhi. [unit II]
12. Grewal,B.S, Higher Engineering Mathematics, 37th edition, Khanna Publishers,2003. [unit I]

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1		3	2			1	
CO2		3	2		2	1	
CO3		3	1	2		1	
CO4		3	2		1	1	
CO5		3	1	1		1	
		15	8	3	3	5	
Scaled values		3	2	1	1	1	

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC105B			RF MEMS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Outline wireless techniques, standards and transceivers architectures	Cognitive	Understanding
CO2	Appraise and illustrate physical aspects of RF systems in relation to MEMS	Cognitive	Evaluating
CO3	Explain RF MEMS technology and devices	Cognitive	Understanding
CO4	Explain MEMS modern devices	Cognitive	Understanding
CO5	Summarize the operation of RF MEMS based circuits	Cognitive	Understanding

UNIT I **9**

WIRELESS SYSTEMS

Introduction, spheres of wireless activities, the home and office, the ground fixed/mobile platform, the space platform, wireless standards, systems and architectures, conceptual wireless systems, wireless transceiver wireless appliances enable ubiquitous connectivity.

UNIT II **9**

ELEMENTS OF RF CIRCUIT DESIGN

Physical aspects of RF circuit design, skin effect, transmission lines on thin substrates, self - resonance frequency, quality factor packaging, practical aspects of RF circuit design, DC biasing, impedance mismatch effects in RFMEMS.

UNITIII **9**

RF MEMS

RF MEMS, enabled circuit elements and models, RF/microwave substrate properties, micro machined, enhanced elements, capacitors, inductors, varactors, MEM switch, shunt MEM switch, low voltage hinged MEM switch approaches, push-pull series switch, folded- beam springs suspension series switch, resonators- transmission line planar resonators, cavity resonators, micromechanical resonators, film bulk acoustics wave resonators, MEMS modeling- mechanical modeling, electromagneticmodeling.

UNIT IV **9**

NOVEL RF MEMS

Novel RF MEMS, enabled circuits, reconfigurable circuits, the resonant MEMS switch,capacitors,inductors, tunable CPW resonator, MEMS micro-switch arrays, reconfigurable circuits, double, stud tuner, Nth-stub tuner, filters, resonator tuningsystem, massively parallel switchable RF front ends, true delay digital phase shifters, reconfigurable antennas, tunable dipole antennas, tunable microstrip patch-array antenna.

UNIT V	9

RF MEMS BASED CIRCUIT DESIGN

Phase shifters, fundamentals, X-band RF MEMS phase shifter for phased array applications, Ka-band RF MEMS phase shifter for radar systems applications, Film bulk acoustic wave filters, FBAR filter fundamentals, FBAR filter for PCS applications, RF MEMS filters, A Ka-band millimeter wave Micro machined tunable filter, a High-Q 8 MHz MEM resonators filter, RF MEMS Oscillators- fundamentals, a 14GHz MEM Oscillator, a Ka-Band micro machined cavity oscillator, a 2.4 GHz MEMS based voltage controlled oscillator, design ofPLL.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. Hector J. De, Los Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House,2002.
2. Vijay K. Varadan, K.J. Vinoy, K.A. Jose, "RF MEMS and their Applications", John Wiley and Sons, Ltd.,2002.
3. GabrielM.Rebeiz,"RFMEMSTheory,Design&Technology",WileyInter science, 2002.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		3	1	1	1
CO2	3	3			1	1	1
CO3	3	3		3		1	1
CO4	3	3			1	1	1
CO5	3	3		1		1	1
	15	15		7	3	5	5
Scaled values	3	3		2	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	COURSE NAME	L	T	P	C
YWC 105C	ANTENNA SYSTEMS FOR WIRELESS APPLICATIONS	3	0	0	3

C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Classify the various handset antennas and its performance parameters.	Cognitive	Understanding
CO2	Explain the of RFID Tag antennas and mention its effects.	Cognitive	Understanding
CO3	Outline the Laptop antenna and evaluate its performance.	Cognitive	Understanding
CO4	Analyze the various issues in microwave thermal therapies.	Cognitive	Creating
CO5	Design and evaluate antennas for wearable devices and its UWB applications.	Cognitive	Creating, Evaluating

UNIT I **9**

HANDSET ANTENNAS

Introduction-Performance Requirements-Electrically small Antennas-classes of Handset Antennas-The quest for Efficiency and Extended Bandwidth-Practical design-starting points for Design and optimization-RF performance of typical handsets

UNIT II **9**

RFID TAG ANTENNAS

RFID fundamentals, Design considerations for RFID Tag Antennas, Effect of Environment on RFID Tag Antennas

UNITIII **9**

LAPTOP ANTENNA DESIGN AND EVALUATION

Laptop related Antenna Issues-Antenna Design Methodology-PC Card Antenna Performance and Evaluation-Link Budget model-Dual band examples-Antennas for wireless wide Area Network Applications-Ultra wide band Antennas

UNIT IV **9**

ANTENNA ISSUES IN MICROWAVE THERMAL THERAPIES

Microwave thermal therapies-Interstitial Microwave Hyperthermia-clinical trials

UNIT V **9**

ANTENNAS FOR WEARABLE DEVICES AND UWB APPLICATIONS

AntennadesignrequirementsforwirelessBodyAreaNetwork/PAN-modellingandcharacterizationof wearable Antennas-WBAN Radio channel characterization and effect of Wearable Antennas-case study-UWBwirelesssystems-challengesinUWBAntennaDesign-stateoftheartsolutions-casestudy.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES:

1. Zhi Ning Chen ,"Antennas for Portable devices" Wiley,2007.
2. ConstatineA.Balanis, "Modern Antenna Handbook "Wiley august2008
3. Nemai Chandra Karmakar, "Handbook of Smart Antennas for RFIDSystems", Wiley
4. Mehmet R.Yuce, Jamil Y.Khan, "Wireless body Area Networks: Technology, Implementation and Applications" CRCPress.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		3	1	1	1
CO2	3	3			1	1	1
CO3	3	3		3		1	1
CO4	3	3			1	1	1
CO5	3	3		1		1	1
	15	15		7	3	5	5
Scaled values	3	3		2	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC105D			DETECTION AND ESTIMATION THEORY	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Outline statistical decision theory used for signal detection and estimation.	Cognitive	Understanding
CO2	Examine the detection of deterministic and random signals using statistical models.	Cognitive	Analyzing
CO3	Explain the elements and structure of non-parametric detection.	Cognitive	Understanding
CO4	Examine the performance of signal parameters using optimal estimators.	Cognitive	Analyzing
CO5	Analyze signal estimation in discrete-time domain using filters.	Cognitive	Analyzing

UNIT I **8**

BACKGROUND AND STATISTICAL DECISION THEORY:

Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter estimation in discrete-time domain. Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.

UNIT II **12**

DETECTION OF DETERMINISTIC SIGNALS AND RANDOM SIGNALS:

Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model. Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

UNITIII **9**

NONPARAMETRIC DETECTION:

Detection in the absence of complete statistical description of observations, sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.

UNIT IV **8**

ESTIMATION OF SIGNAL PARAMETERS:

Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posterioriestimation.

UNIT V	7

SIGNAL ESTIMATION IN DISCRETE-TIME:

Linear Bayesian estimation, Weiner filtering, Kalman filtering.

LECTURE	TUTORIAL	TOTAL
45	0	45

REFERENCES

1. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, NY,1968.
2. H.V.Poor,"AnIntroductiontoSignalDetectionandEstimation",Springer,2/e,1998.
3. S.M.Kay,"FundamentalsofStatisticalSignalProcessing:EstimationTheory",Prentice
4. Hall PTR,1993.
5. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", Prentice Hall PTR,1998.
6. http://nptel.iitm.ac.in/courses.php?disciplineId=117
7. R.G.Gallager,"PrinciplesofDigitalCommunication",CambridgeUniversityPress,2008.
8. Lapidoth, "A Foundation in Digital Communication", Cambridge,2009.
9. Weeks Michael, "Digital Signal Processing Using MATLAB and Wavelets", Firewall Media, 2011.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	3		2	1	1	1
CO2	1	3			1	1	1
CO3	1	3				1	1
CO4	1	3		2	1	1	1
CO5	1	3				1	1
	15	15		4	3	5	5
Scaled values	3	3		1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	COURSE NAME	L	T	P	C
		3	0	0	3
YWC204A	WIRELESS NETWORK SECURITY				

C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Summarize why Network Security is essential in wireless communication	Cognitive	Understanding
CO2	Explain various types of Cryptographic Security	Cognitive	Understanding
CO3	Apply wireless security model to setup a secure wireless system	Cognitive	Applying
CO4	Analyze the integrity of the Wireless system using cryptographic algorithms	Cognitive	Analyzing
CO5	Apply security in point to point and end to end in wireless applications	Cognitive	Applying

UNIT I 9

WIRELESS INFORMATION WARFARE

Protecting privacy and means of communication, taxonomies of wireless communication based on network architecture mobility, model for cost effective risk management, cryptographic attacks, key management, securing wireless LANS, Electromagnetic capture threats, wireless threat analysis, securing wireless LAN countermeasures.

UNIT -II 9

WIRELESS LAN TRANSMISSION MEDIA

WAP security architecture, BLUETOOTH, wireless access to internet. **Cryptographic Security:** Classical crypt analysis, digital cryptography**,** DES modern cipher breaking, non-keyed message digest, public key cryptography, Diffie – Hellman and Elliptic curve cryptography, comparison of public key crypto systems.

UNIT –III 9

NETWORK SECURITY COMPONENTS

Network security model, network intrusion protection and detection, Host based security, virtual private networking, event correlation, wireless security components, secure configuration, secure authentication, encryption, wireless device placement.

UNIT –IV 9

INTEGRATING WIRELESS ACCESS INTO THE NETWORK SECURITY PROCESS

Logging wireless events, policy issues, accessing wireless network security, change control and device

administration, wireless security models, Cisco implementation with LEAP, WLAN authentication and key management with radius, wireless access with IP security, secure wireless public access, secure wireless point to point connectivity.		
UNIT –V		9
HARDWARE PERSPECTIVE FOR END-TO-END SECURITY IN WIRELESS APPLICATION Taxonomy of communication systems, protocol sensitive communication security, evolution towards wireless, hardware and software avenues, encryptor structures in wireless- interception and vulnerability of wireless systems, communication ESMs and interception receivers, SAW technology.		

LECTURE	**TUTORIAL**	**TOTAL**
45	**0**	**45**

REFERENCE BOOKS

5. Randall K. Nichols, Panos C. Lekkas, "Wireless Security Models, Threats and solutions". Mc Graw Hill, 2005.
6. Brian Carter, Russel Shumway, "Wireless Security End to End", CISSPl, 2005.
7. Merrit Maxim, David Pollino, "Wireless Security", RSA Press, 2005.
8. Cyrus Peikari, Seth Fogie, , "Maximum Wireless Security ", SAMS, 2005.

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	1	1		2		1	3
CO2	1	1				1	3
CO3	1	1				1	3
CO4	1	1		3			3
CO5	1	1		1		1	3
	5	5		6		4	15
Scaled values	1	1		2		1	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC204B			MIMO COMMUNICATION	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Explain the various Spatial Multiplexing and Channel Modelling Techniques	Cognitive	Understanding
CO2	Outline thevarious multiplexing architectures.	Cognitive	Understanding
CO3	Criticise on Diversity-Multiplexing Trade-off and explain universal space-time coding scheme.	Cognitive	Evaluating
CO4	Analyse and justify usage of space time codes in MIMO	Cognitive	Analyzing
CO5	Explain multiuser MIMO systems with examples.	Cognitive	Understanding

UNIT I **9**

SPATIAL MULTIPLEXING AND CHANNEL MODELLING

Multiplexing Capability of Deterministic MIMO Channels - Capacity via Singular Value Decomposition -Rank and Condition Number- Physical Modelling of MIMO Channels -Line-of-Sight SIMO channel - Line-of-Sight MISO Channel -Antenna arrays with only a line-of-sight path - Geographically separated antennas-Line-of-sight plus one reflected path - Modelling of MIMO Fading Channels - Basic Approach -MIMO Multipath Channel -Angular Domain Representation of Signals - Angular Domain Representation of MIMO Channels -Statistical Modeling in the Angular Domain -Degrees of Freedom and Diversity -Degrees of Freedom in Clustered Response Models - Dependency on Antenna Spacing - I.I.D. Rayleigh Fading Model

UNIT II **9**

CAPACITY AND MULTIPLEXING ARCHITECTURES

The V-BLAST Architecture -Fast Fading MIMO Channel - Capacity with CSI at Receiver - Performance Gains - Full CSI -Receiver Architectures - Linear Decorrelator -Successive Cancellation -Linear MMSE Receiver - Information Theoretic Optimality- Connections with CDMA Multiuser Detection and ISI Equalization- Slow Fading MIMO Channel - D-BLAST: An Outage-Optimal Architecture - Sub-optimality of V-BLAST -Coding Across Transmit Antennas: D-BLAST

UNIT III **9**

DIVERSITY-MULTIPLEXING TRADEOFF AND UNIVERSAL SPACE-TIME CODES

Diversity-Multiplexing Tradeoff -Formulation -Scalar Rayleigh Channel - Parallel Rayleigh Channel - MISO Rayleigh Channel -2 × 2 MIMO Rayleigh Channel -nt × nr MIMO i.i.d. Rayleigh Channel - Universal Code Design for Optimal Diversity-Multiplexing Tradeoff -QAM is Approximately

Universal for Scalar Channels - Universal Code Design for Parallel Channels -Universal Code Design for MISO Channels -Universal Code Design for MIMO Channels - Universal Codes in the Downlink

UNIT IV **9**

ANTENNA DIVERSITY AND SPACE-TIME CODING TECHNIQUES

Antenna Diversity -Receive Diversity -Transmit Diversity -Space-Time Coding (STC): Overview - System Model - Pairwise Error Probability -Space-Time Code Design -Space-Time Block Code (STBC) - Alamouti Space-Time Code-Generalization of Space-Time Block Coding -Decoding for Space-Time Block Codes -Space-Time Trellis Code

UNIT V **9**

MULTIUSER COMMUNICATION

Uplink with Multiple Receive Antennas Space-Division Multiple Access SDMA Capacity Region System Implications Slow Fading - Fast Fading -Multiuser Diversity Revisited - MIMO Uplink - SDMA with Multiple Transmit Antennas - System Implications - Fast Fading - Downlink with Multiple Transmit Antennas -Degrees of Freedom in the Downlink - Uplink-Downlink Duality and Transmit Beamforming -Precoding for Interference Known at Transmitter - Precoding for the downlink -Fast Fading - MIMO Downlink - Multiple Antennas in Cellular Networks: A System View - Inter-cell Interference Management -Uplink with Multiple Receive Antennas - MIMO Uplink - Downlink with Multiple Receive Antennas -Downlink with Multiple Transmit Antennas

	LECTURE	PRACTICAL	TOTAL
	45	0	45

REFERENCES

1. D. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge: Cambridge University Press, 2005.
2. Yong Soo Cho, Jaekwon Kim, Won Young Yang and Chung G. Kan, "MIMO-OFDM Wireless Communications with MATLAB®, 2010 John Wiley & Sons (Asia) Pte Ltd.
3. Duman, Tolga M., Coding for MIMO communication systems, Hoboken, NJ : J. Wiley & Sons, c2007.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1		2		1	3
CO2	1	1				1	3
CO3	1	1				1	3
CO4	1	1		3			3
CO5	1	1		1		1	3
	5	5		6		4	15
Scaled values	1	1		2		1	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC204C			HIGH PERFORMANCE WIRELESS NETWORKS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Identify the requirements of high-speed networks such as WLAN, WPAN and WATM-	Cognitive	Understanding
CO2	Classify the wireless LAN standards with its PHY and MAC functions-	Cognitive	Understanding
CO3	Explain the performance of WLAN-	Cognitive	Understanding
CO4	Apply WATM systems for Multimedia and Satellite applications	Cognitive	Applying
CO5	Compare the capabilities of ATM and WATM systems	Cognitive	Understanding

UNIT I **9**

WIRELESS LOCAL AREA NETWORK

Need for WLAN, Indoor Wireless Communication, Radio Spectrum, Path loss, Multiple Access, Multipath, fading. Classification of WLAN Radio LANs, DSSS, FHSS, Comparison of DSSS and FHSS, Infrared WLAN

UNIT II **9**

WLAN IMPLEMENTATION AND STANDARDS

WLAN Components, Architecture and Topologies, Deployment Considerations, WLAN enhancement techniques WLAN Standards IEEE 802.11 WLAN standard, Physical and MAC layer, Unresolved issues in 802.11, Current and commercial 802.11 Deployment, HIPERLAN, Bluetooth and WAP standards

UNIT III **9**

PERFORMANCE EVALUATION OF WLAN

Evaluation Techniques, Non 802.11 Wave point WLAN, Case studies- Motorola Altair plus WLAN

UNIT IV **9**

WIRELESS ATM NETWORKS

ATM Technology, Need for WATM, WATM for Wireless, Multimedia and Satellite Communication, WATM prototypes, Commercial WATM systems for Local loop

UNIT V **9**

WATM STANDARDS

ATM Forum, WATM Standard, BRAN standard, MMAC-PC standard

LECTURE	PRACTICAL	TOTAL
45	0	45

REFERENCES

1. Benny Bing, "High-speed Wireless ATM and LANs‖ Artech House Publishers, 2009.
2. William Stallings, —High Speed Networks and Internet‖, 2nd Edition, Pearson Education, 2002.
3. Kaveh Pahalavan and P. Krishnamurthy.‖ Principles of Wireless Networks- A Unified approach‖, Pearson Education,2009.
4. Larry L. Peterson and Bruce S. Davie, —Computer networks-A system Approach‖, Third Edition, Mc Graw Hill, 2010.
5. Mani Subramanian, —Network Management: principles and practice — Addision – Wesley Publisher 2007.
6. Peter T. Davis, Craig R. McGuffin, —Wireless Local Area Networks- Technologies, issues and strategies‖, McGraw Hill 2003.
7. David E. McDysan, Darren L. Spohn, Mc Dysan," ATM Theory and applications‖, McGraw Hill, 2004

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		2	1	1	1
CO2	3	3			1	1	1
CO3	3	3		1		1	1
CO4	3	3			1	1	1
CO5	3	3		2		1	1
	15	15		5	3	5	5
Scaled values	3	3		1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YWC204D			**INTERNET OF THINGS**	**3**	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**		**3**	**0**	**0**	**3**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Outline and explain the technologies behind IoT.	Cognitive	Understanding
CO2	Explain resource management in IoT	Cognitive	Understanding
CO3	Explain various architecture, platform and services of IoT	Cognitive	Analyzing
CO4	Examine adaptation of IPV6 to IoT and discuss IoT6	Cognitive	Analyzing
CO5	Discuss applications of IoT	Cognitive	Craeting

UNITI I **9**

INTRODUCTION AND ENABLING TECHNOLOGIES INIOT

IoT, Machine to Machine, Web of Things, Definition- Major components if IoT devices- Control Units-Sensors-Communication Modules-Power Sources Vision- Characteristics - Layered Architecture- Landscape-- IoT Functional View-IoT related Internet Technology- cloud computing-Networks and Communications related to IoT-Processes related to IoT-Data Management related to IoT-Security Privacy and Trust-Devices level energy issues- Standards related to IoT

UNITII	**9**

RESOURCE MANAGEMENT IN THE INTERNET OF THINGS

Clustering - Software Agents - Data Synchronization - Clustering Principles in an Internet of Things Architecture - The Role of Context - Design Guidelines -Software Agents for Object–DataSynchronization-TypesofNetworkArchitectures-FundamentalConceptsof Agility and Autonomy-Enabling Autonomy and Agility by the Internetof Things-Technical RequirementsforSatisfyingtheNewDemandsinProduction-TheEvolutionfromtheRFID-based EPC Network to an Agent based Internet of Things- Agents for the Behaviour of Objects

UNIT III	**9**

THE ARCHITECTURE, PLATFORMS, SERVICES

The Layering concepts , IoT Communication Pattern, IoT protocol Architecture, The 6LoWPAN, Platforms - IBM watson-Intel Platform- Carriot Platform- Webnms-device WISE

UNIT IV	**9**

SCALABLE INTEGRATION FRAMEWORK

Introduction- IPV6 Potential- IoT6- IPV6 for IoT- Adapting IPV6 to IoTrequirement- IoT6 architecture-DigCovery-IoT6IntegrationwithcloudandEPICS-EnablingHeterogeneous Integration-IoT6 Smart Office use case- Scalabilityperceptive.

UNIT V	**9**

IOT APPLICATIONS

Smart Environments and Smart Space creation - Connected Devices illustration-Industrial IoT-IERC application Domains-Smart Environment Monitoring- Smart Energy - Smart building-Smart Transport and mobility-IoT Smart X applications

	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
	45	**0**	**0**	**45**

REFERENCES

1. Ovidiu Vermesan, Peter Friess, "Internet of Things- From Research and Innovation to market Deployment", River Publishers,2014.
2. ArshdeepBahga, Vijay Madisetti Internet of Things: A Hands-On ApproachHardcover – Madisetti Publishers, 2014
3. Samuel Greengard, "The Internet of Things", MIT Press,2015.
4. http://postscapes.com/internet-of-things-resources/

CO Vs PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		1	3	1	1
CO2	3	3					1
CO3	3	3		2		1	1
CO4	3	3			1		1
CO5	3	3				1	1
	15	15		3	4	3	5
Scaled values	3	3		1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
YWC205A	**SOFT COMPUTING**	**3**	**0**	**0**	**3**

C	**P**	**A**	**L**	**T**	**P**	**H**
2.75	**0**	**0.25**	**3**	**0**	**0**	**3**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Outline the Soft Computing techniques and their roles in building an intelligent System-	Cognitive	Understanding
CO2	Apply Neural network in pattern Classification	Cognitive	Applying
CO3	Explain fuzzy logic to handle engineering problems	Cognitive	Understanding
CO4	Apply Genetic Algorithm to Optimization Problems	Cognitive	Applying
CO5	Explain the soft computing tools and hybrid systems	Cognitive	Understanding

UNIT I **10**

FUZZY SET THEORY

Introduction to Neuro–Fuzzy and Soft Computing–Fuzzy Sets–Basic Definition and Terminology–Set-theoretic Operations–ember Function Formulation and Parameterization–Fuzzy Rule sand Fuzzy Reasoning–Extension Principle and Fuzzy Relations–Fuzzy If-Then Rules–Fuzzy Reasoning–Fuzzy Inference Systems–

Mamdani Fuzzy Models–Sugeno Fuzzy Models–Tsukamoto Fuzzy Models–InputS pace Partitioning and Fuzzy Modeling.

UNIT II	**8**

OPTIMIZATION

Derivative-based Optimization–Descent Methods–The Method of Steepest Descent–Classical Newton's Method–Step Size Determination–Derivative-free Optimization–Genetic Algorithms–Simulated Annealing–Random Search–Downhill Simplex Search.

UNIT III	**10**

NEURAL NETWORKS

Supervised Learning Neural Networks–Perceptrons- Adaline–Back propagation MutilayerPerceptrons–Radial Basis Function Networks–UnsupervisedLearningNeuralNetworks–CompetitiveLearningNetworks–Kohonen Self-Organizing Networks–Learning Vector Quantization–Hebbian Learning.

UNIT IV	**9**

NEUROFUZZY MODELING

Adaptive Neuro-Fuzzy Inference Systems–Architecture–Hybrid Learning Algorithm–Learning Methods that Cross-fertilize ANFIS and RBFN–Coactive Neuro Fuzzy Modeling–Framework Neuron Function s for Adaptive Networks–Neuro Fuzzy Spectrum.

UNIT V	**8**

APPLICATIONS OF COMPUTATIONAL I NTELLIGENCE

Printed Character Recognition–Inverse Kinematics Problems–Automobile Fuel Efficiency Prediction–Soft Computing for Color Recipe Prediction.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

REFERENCE BOOKS

1. Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional, 2000.
2. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010.
3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
4. Fuzzy Logic for Embedded Systems Applications, Ahmed M. Ibrahim, Elesvier Press, 2004.
5. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India, 2007.
6. Soft Computing, D. K. Pratihar, Narosa, 2008.
7. Neuro-Fuzzy and soft Computing, J.-S. R. Jang, C.-T. Sun, and E. Mizutani, PHI Learning, 2009.
8. Neural Networks and Learning Machines, (3rd Edn.), Simon Haykin, PHI Learning, 2011.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			1	1	3	1	1
CO2			1				1
CO3			1	2		1	1
CO4			1		1		1
CO5			1			1	1
			5	3	4	3	5
Scaled values			3	1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC205B			MILLIMETER WAVE WIRELESS COMMUNICATIONS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Outline the Soft Computing techniques and their roles in building an intelligent System-	Cognitive	Understanding
CO2	Apply Neural network in pattern Classification	Cognitive	Applying
CO3	Explain fuzzy logic to handle engineering problems	Cognitive	Understanding
CO4	Apply Genetic Algorithm to Optimization Problems	Cognitive	Applying
CO5	Explain the soft computing tools and hybrid systems	Cognitive	Understanding

UNIT I **9**

INTRODUCTION AND RADIO WAVE PROPAGATION FOR MMWAVE

The Frontier: Millimeter Wave Wireless - A Preview of MmWave Implementation Challenges - Emerging Applications of MmWave Communications -Data Centers - Replacing Wired Interconnects on Chips - Information Showers -The Home and Office of the Future - Vehicular Applications - Cellular and Personal Mobile - Large-Scale Propagation Channel Effects - Log-Distance Path Loss Models - Atmospheric Effects - Weather Effects on MmWave Propagation -Diffraction - Reflection and Penetration - Scattering and Radar Cross Section Modeling - Influence of Surrounding Objects, Humans, and Foliage - Ray Tracing and Site-Specific Propagation Prediction - Small-Scale Channel Effects -Delay Spread Characteristics - Doppler Effects -Spatial Characterization of Multipath and Beam Combining - Beam-Combining Procedure - Beam-Combining Results -Angle Spread and Multipath Angle of Arrival - Antenna Polarization - Outdoor Channel Models - 3GPP-Style Outdoor Propagation Models - Vehicle-to-Vehicle Models-Indoor Channel Models - Ray-Tracing Models for

Indoor Channels -Rayleigh, Rician, and Multiwave Fading Models 1-IEEE 802.15.3c and IEEE 802.11ad Channel Models -IEEE 802.15.3c -IEEE 802.11ad	
UNIT II	**9**
ANTENNAS AND ARRAYS FOR MMWAVE APPLICATIONS - Introduction -Fundamentals of On-Chip and In-Package MmWave Antennas - Antenna Fundamentals - Fundamentals of Antenna Arrays -The On-Chip Antenna Environment - Complementary Metal Oxide Semiconductor Technology (CMOS) -In-Package Antennas - Antenna Topologies for MmWave Communications -Techniques to Improve Gain of On-Chip Antennas -Integrated Lens Antennas -Adaptive Antenna Arrays — Implementations for MmWave Communications - Beam Steering for MmWave Adaptive Antenna Arrays - Antenna Array Beamforming Algorithms - Specific Beamforming Algorithms — ESPRIT and MUSIC -Case Studies of Adaptive Arrays for MmWave Communications -Characterization of On-Chip Antenna Performance -Case Studies of MmWave On-Chip Antenna Characterization - Improving Probe Station Characterizations of On-Chip orIn-Package Antennas	
UNIT III	**9**
MMWAVE RF Basic Concepts for MmWave Transistors and Devices - S-Parameters, Z-Parameters, Y-Parameters, and ABCD-Parameters -Simulation, Layout, and CMOS Production of MmWave Circuits -Transistors and Transistor Models - More Advanced Models for MmWave Transistors - BSIM Model - MmWave Transistor Model Evolution — EKV Model -Introduction to Transmission Lines and Passives - Transmission Lines - Differential versus Single-Ended Transmission Lines - Inductors - Parasitic Inductances from Bond Wire Packaging - Transformers - Interconnects -Basic Transistor Configurations -Conjugate Matching -Miller Capacitance -Poles and Feedback - Frequency Tuning - Sensitivity and Link Budget Analysis for MmWave Radios	
UNIT IV	**9**
ANALOG DEVICES AND CIRCUITS FOR MMWAVE Important Metrics for Analog MmWave Devices 3-Non-Linear Intercept Points - Noise Figure and Noise Factor -Analog MmWave Components -Power Amplifiers - Low Noise Amplifiers -Mixers - Voltage-Controlled Oscillators (VCOs) -Phase-Locked Loops -Consumption Factor Theory - Numerical Example of Power-Efficiency Factor 3- Consumption Factor Definition -	
UNIT V	**9**
MMWAVE PHYSICAL LAYER DESIGN AND ALGORITHMS Practical Transceivers - Signal Clipping and Quantization - Power Amplifier Non-linearity -Phase Noise - High-Throughput PHYs - Modulation, Coding, and Equalization - A Practical Comparison of	

OFDM and SC-FDE - Synchronization and Channel Estimation -PHYs for Low Complexity, High Efficiency - Frequency Shift Keying (FSK) - On-Off, Amplitude Shift Keying (OOK, ASK) - Continuous Phase Modulation - Future PHY Considerations - Ultra-Low ADC Resolution - Spatial Multiplexing

	LECTURE	PRACTICAL	TOTAL
	45	0	45

REFERENCES

1. Theodore S. Rappaport, Robert W. Heath, Robert C. Daniels and James N. Murdock, "Millimeter Wave Wireless Communications", 1st edition, 2014, Pearson
2. Hemadeh, K. Satyanarayana, M. El-Hajjar and L. Hanzo, "Millimeter-Wave Communications: Physical Channel Models, Design Considerations, Antenna Constructions, and Link-Budget," in IEEE Communications Surveys & Tutorials, vol. 20, no. 2, pp. 870-913
3. Chong, Chia-Chin & Hamaguchi, Kiyoshi & Smulders, Peter & Yong, Su. (2007).
4. Millimeter-Wave Wireless Communication Systems: Theory and Applications. EURASIP J. Wireless Comm. and Networking. 2007. 10.1155/2007/72831.
5. Manuel García Sanchez (Ed.), "Millimeter-Wave (mmWave) Communications" 2020 MDPI Books, ISBN 978-3-03928-431-3 (PDF)

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		1	3		1
CO2	3	3		1			
CO3	3	3			3		1
CO4	3	3		1			
CO5	3	3			2		1
	15	15		3	8		3
Scaled values	3	3		1	2		1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC205C			SOFTWARE DEFINED RADIO	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Explain Software Defined Radio Requirements and Specifications and Illustrate SDR architectures	Cognitive	Understanding
CO2	Explain various data conversion techniques in SDR	Cognitive	Understanding
CO3	Summarize the baseband technologies in SDR and its application in wireless communications.	Cognitive	Understanding

CO4	Discuss software technologies in SDR and outline various Software Download techniques for Mobile Terminals	Cognitive	Evaluating
CO5	Outline reconfigurability in SDR and explain Waveform Description Language	Cognitive	Understanding

UNITI **9**

SOFTWARE BASED RADIO

Software defined radio and Software Radio Concepts – Realization of Software Based Radio - Front end Technology: Radio Frequency Translation and Software Defined Radio: Requirements and Specifications- Receiver Design Considerations- Transmitter Design Considerations- Candidate Architectures for SDR – Radio frequency front end Implementations for Multimode SDRS: Evolution of RF Front Ends – Superheterodyne Architecture- The AS 2/6 Product Family – Dual Band, Six Mode – Alternative RF Front End Architectures.

UNIT II **9**

DATA CONVERSION IN SOFTWARE DEFINED RADIOS:

The Importance of Data Converters in Software Defined Radios-Converter Architectures – Converter Performance Impact on SDR-Superconductor Microelectronics: A Digital RF Technology for Software Radios: Introduction-Rapid Single Flux Quantum Digital Logic – Cryogenic Aspects- Superconductor SDR for Commercial Applications & Military Applications – The Digital Front End: Bridge Between RF and Baseband Processing: The digital front end-Digital up and down conversions-Channel Filtering-Sample RateConversion.

UNIT III **9**

BASEBAND TECHNOLOGY:

Baseband Processing for SDR-The Role of Baseband Architectures – Base Band Component Technologies-Design Tools and Methodologies-System design and maintenance – Parameterization-A Technique for SDR Implementation – Definitions-Adaptability – Parameterization of Standards – Signal Processing Issues – Adaptive Computing IC Technology for 3G Software – Software defined Radio – A Solution for Mobile Devices – The Mobile Application Space and the need for Processing Power- SDR Baseband processing – Hardware with Software Programmability – The Computational Power Efficiency Requiredby 3 G Algorithms – Example Case Studies.

UNIT IV **9**

SOFTWARE TECHNOLOGY

Software Engineering for Software Radios-Overview of Vanu Systems – The Importance of software in software Radio – Software Portability-Commodity PC hardware- Signal Processing software-Control – Software-Performance-Future Directions – Software Download for Mobile Terminals – Downloading Technologies for SDR – Standards for downloading-Seamless Upgrading ‘on the FLY’ security of download –software Architectures for Download- Future Applications of SDRDownloading.

UNIT V **9**

RECONFIGURATION ANDWAVEFORMDESCRIPTION

Protocols and Network Aspects of SDR-Protocol stacks: SAPS vs. Reconfigurability- Approaches to protocol stack reconfiguration – Reconfiguration Management and control – Network support for software radios Conclusions – The Waveform Description Language: The specification problem – WDL overview – FM3TR example – Refinement to an implication – WDL details – A practical WDL supportenvironment.

LECTURE	TUTORIAL	TOTAL
45	0	45

REFERENCES

1. Walter Tuttlebee, "Software Defined Radio: Enabling Technologies", Wiley Publications, 2002.
2. Paul Burns, "Software Defined Radio for 3G", Artech House,2002
   Markus Dillinger, "Software Defined Radio: Architectures, Systems and Functions", 2003.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		1	1	1	1
CO2	3	3		1	2		1
CO3	3	3		1		1	1
CO4	3	3			2		1
CO5	3	3		2		1	1
	15	15		5	5	3	5
Scaled values	3	3		1	1	1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			SUBNAME	L	T	P	C
YWC205D			FUNDAMENTALSOF5GMOBILEAND WIRELESSTECHNOLOGY	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Outline the 5G networks and its architecture	Cognitive	Understanding
CO2	Examine the techniques for machine type communication in 5G networks	Cognitive	Analyzing
CO3	Explain the latest technology used in 5G communication	Cognitive	Understanding
CO4	Classify the various 5Gradio-accesstechnologies	Cognitive	Understanding
CO5	Explain the security principles in 5G communication	Cognitive	Understanding

UNITI	9

INTRODUCTION Rationale of 5G: high data volume, twenty-five billion connected devices and wide requirements-10pillarsof5G-Requirements and key performance indicators 5G system concept Concept overview Extreme mobile broadband Massive machine-type communication Ultra-reliable machine-type communication - Dynamic radio access network 3- Lean system control plane - Localized contentsandtrafficflows-Spectrumtoolbox-The5Garchitecture-High-level requirements for the 5G architecture	
UNITII	**9**
MACHINE-TYPECOMMUNICATIONS Introduction - Use cases and categorization of MTC - MTC requirements -Fundamental techniques for MTC - Data and control for short packets -Non-orthogonal access protocols - Massive MTC - Design principles -Technology components - Summary of mMTC features - Ultra-reliable low-latency MTC-Design principles-Technology components	
UNITIII	**9**
SMALLCELLS FOR5GMOBILENETWORKS Introduction- What are Small Cells? – Wi-Fi and Femtocells as Candidate Small-Cell Technologies - Wi-Fi and Femto Performance – Indoors vs Outdoors -Capacity Limits and Achievable Gains with Densification - Gains with Multi-Antenna Techniques -Gains with Small Cells - Mobile Data Demand-Approach and Methodology-Demand vs Capacity -Small-Cell Challenges.	
UNITIV	**9**
THE5GRADIO-ACCESSTECHNOLOGIES Access design principles for multi-user communications- Orthogonal multiple-access systems-Spread spectrum multiple-access systems-Capacity limits of multiple-access methods-Multi-carrier with filtering: a new waveform - Filter-bank based multi-carrier - Universal filtered OFDM - Non-orthogonalschemesforefficientmultipleaccess-Non-orthogonalmultipleaccess(NOMA)-Sparsecodemultipleaccess(SCMA)-Interleave division multiple access(IDMA)-Radio access for dense deployments - OFDM numerology for small-cell deployments - Small-cell sub-frame structure -Radio access for V2X communication-Medium access control for nodes on the move-Radio access for massive machine-type communication-The massive access problem-Extending access reservation 198-Directrandomaccess	
UNITV	**9**

SECURITYFOR5GCOMMUNICATIONS			
Overview of a Potential 5G Communications System Architecture -Security Issues and Challenges in 5G Communications-Systems - User Equipment - Access Networks -Mobile Operator's Core Network-External IP Networks SONEvolutionfor5GMobileNetworks -SON in UMT SandLTE-The Need for SON in 5G -Evolution towards Small-Cell Dominant Het Nets -Towards a New SON Architecture for 5G			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. Jonathan Rodriguez" Fundamentals of 5G Mobile Networks", John Wiley& Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO198SQ, United Kingdom
2. AfifOsseiran, Jose F. Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology "Cambridge University Press, 2016

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3		1	3	3	1
CO2	3	3				3	1
CO3	3	3		2		3	1
CO4	3	3			1	3	1
CO5	3	3				3	1
	15	15		3	4	15	5
Scaled values	3	3		1	1	3	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

SEMESTER-III

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YWC302A			**QUALITY OF SERVICE IN WIRELESS COMMUNICATION**	**3**	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.75	**0**	**0.25**		**3**	**0**	**0**	**3**

After completion of the course, a student will be able to

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Outlinethe QoS for Packet Networks	Cognitive	Understanding
CO2	Classify IP-based QoS motivation in QoS Mechanisms and Design the network capacity with the application and service enhancing technology.	Cognitive	Understanding
CO3	Predict the characterization f End-User Performance and compare 3GPP versus 3GPP2 in QoS End-User performances.	Cognitive	Creating

CO4	Explain the Challenges behind QOS Provisioning in Adhoc networks and Distinguish routing in mobile adhoc network.	Cognitive	Understanding
CO5	List out the application of specific QoS, Network QoS and Discuss difficulties of QOS provisioning in WSN .	Cognitive	Remembering

UNIT I **9**

QOS FOR PACKET NETWORKS -AN INTRODUCTION

Qos of real time services-delay-frame delay-packetization delay-interleaving delay-error correction coding delay-jitter buffer delay-packet queuing delay-propagation delay-effectof delay-end-to-end delay objectives-delay variation or "jitter"-sourceofdelayvariation-packetlossprobability-subjectivetesting—mean opinion score (mos)-the "emodel"—codec performance-blocking probability-"trunked channel" systems—offered traffic-oad-units of traffic load-trunk utilization factor

UNIT II **9**

QOS IN CELLULAR SYSTEMS-PARTI

QoS Definition-Need for QoS Differentiation-QoS Standardization-Data Services Classification IP-Based QoS Motivation of IP QoS Mechanisms QoS Paradigms IP-QoS Management in UMTS Networks Traffic Handling Mechanisms. Motivation for QoS in cellular systems-Service Experience-Radio Network Performance-Network Capacity-NetworkDesign-ApplicationDesign-Service-EnhancingTechnology

UNIT III **9**

QOS IN CELLULAR SYSTEMS- PARTII

QoS Architecture in 3GPP and 3GPP2 End-to-End QoS Introduction Evolution of QoS in 3GPP Releases IP Multimedia Subsystem(IMS)-3GPPversus 3GPP2in QoS End-User Performance Analysis-Characterization of End-User Performance-Data Link Effects-Transport and Application Layer Effects-Impact of Network Dimensioning in the Service Performance.

UNIT IV **9**

QUALITYOFSERVICE IN ADHOC NETWORKS

Challenges behind QOS Provisioning in Adhoc Networks-Routing in mobile adhoc networks-Routing with quality of serviceconstraints-Quality of service routing in adhoc networks

UNIT V **9**

QOSINWIRELESSSENSORNETWORKS

WSN challenges-Difficulties of QOS provisioning in WSN-QOS Performance metrics in WSN-Mechanisms to Achieve QOS in WSN- Resource Constraints- Platform Heterogeneity- Dynamic Network Topology- Mixed Traffic-Power, bandwidth, memorysize constraints-Application-specific

QoS, Network QoS, QoS Aware Communication Protocols-QoS-Aware Power Management

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. KunI.Park, ."Qos In Packet Networks" 2005, Springer science Boston
2. Amitabh Mishra" Security andQuality of Service In Ad Hoc Wireless Networks" Cambridge University Press 2008
3. G. GómezandR.Sánchez"End-to-End Quality of Service over Cellular Networks" 2005 John Wiley & Sons Ltd
4. Hwee-XianTan" Quality of service in wireless sensor networks".

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		2		3	3
CO2	3	3				3	3
CO3	3	3		3		3	3
CO4	3	3				3	3
CO5	3	3		2		3	3
	15	15		7		15	15
Scaled values	3	3		2		3	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	COURSE NAME	L	T	P	C
YWC302B	TELECOM NETWORK PLANNING AND MANAGEMENT	3	0	0	3

C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Explain the Overall plans per network layer and technology in network planning and solution mapping per scenario.	Cognitive	Understanding
CO2	Discuss the traffic models and explain the categories of Services mapping to customer segment.	Cognitive	Creating
CO3	Compare Cycle life amortization versus modernization and explain the economic concepts and terms in modelling.	Cognitive	Understanding
CO4	Compare the specific issues of radio network planning and rural network in network design	Cognitive	Understanding
CO5	Explaincore network and access network in network design.	Cognitive	Analyzing

UNIT I **9**

OVERVIEW OF NETWORK PLANNING

Evolution of the Telecom context -Requirements to the planners- Typical network planning tasks-Network planning processes-Overall plans per network layer and technology- Solution mapping per scenario-Relation among technical, business and operational plans-Planning issues and trends when reaching NGN.

UNIT II **9**

SERVICE DEFINITION AND FORECASTING AND TRAFFIC CHARACTERIZATION

Customer segments-Services definition and characterization. Categories-Services mapping to customer segment-Service forecasting per segment-Service bundling-Service security
Traffic units for service characterization-Reference periods for dimensioning-Traffic aggregation process-Origin/destination of the traffic flows in Local, Metropolitan, Regional, National,Continental and Intercontinental networks- Traffic models.

UNIT III **9**

ECONOMICAL MODELLING AND BUSINESS PLANS

Business planning - Economic modelling for planning- Economic concepts and terms- Economic modelling for services- Cycle life amortization versus modernization.

UNIT IV

NETWORK DESIGN, DIMENSIONING AND OPTIMIZATION

Core Network -Access Network -Basic optimisation methods - Specific Issues of Radio Network Planning-Special issues for rural network.

UNIT V

DATA GATHERING

Geographical information for the studied area -Demand of services in relative penetration per customer category -Demand of traffic, usually expressed as traffic matrices-Information for the existing network and infrastructure-Telecommunication equipment characteristics and capabilities-QOS requirements-Economical and Operational data
REFERENCES
4. ITU Telecom Network Planning Reference Manual - Draft version 4.1 January 2007 5. Anandalingam, G., Raghavan, S. (Eds.), "Telecommunications Network Design and Management" Springer US, 2003. 3.Thomas G. Robertazzi, "Planning Telecommunication Networks", John Wiley & Sons, Inc.,1998

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3		2		3	3
CO2	3	3				3	3
CO3	3	3		3		3	3
CO4	3	3				3	3
CO5	3	3		2		3	3
	15	15		7		15	15
Scaled values	3	3		2		3	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
YWC302C			REGULATION AND POLICY IN THE TELECOMMUNICATIONS INDUSTRY	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Explainneed for regulation in telecom and discuss effective competition in telecom.	Cognitive	Understanding
CO2	Explain the global authorization principles in licensing and demonstrate mechanismsfor assigning and pricing spectrum.	Cognitive	Understanding
CO3	Define access and interconnection in network and compare setting interconnection rices and cross-border interconnection.	Cognitive	Remembering
CO4	List out the types of universal and service regimes and Explain the digital literacy and e-inclusion .	Cognitive	Remembering
CO5	Illustrate the ubiquity and web 2.0 and Discuss green ICT-regulation in a global Era.	Cognitive	Understanding

UNIT I **9**

THE BIG PICTURE: INTRODUCTION TO TELECOMMUNICATIONS REGULATION Introduction - Technology in Context -. Why Regulate? -Regulatory Organizations- International Frameworks- Looking Ahead - **A LEVEL PLAYING FIELD: REGULATING FOREFFECTIVE COMPETITION**- Competitive Markets -Sector Regulation and Competition Law -Competition Analysis - Control of Mergers and Acquisitions-Regulating Prices-

UNIT II **9**

GROWING THE MARKET: LICENSING AND AUTHORIZING SERVICES-Introduction- The Trend Towards General Authorization - Licensing Objectives and Types- Competing for Licenses.-Authorization Principles and Procedures-Special Authorization-Situations- Licensing for Convergence - Global Standards Making and Compliance-

GOING MOBILE: MANAGING THE SPECTRUM Introduction - Changing Demands forSpectrum-Planning and Technical Standards -Mechanisms for Assigning and Pricing Spectrum.-Monitoring Spectrum- Flexibility in Spectrum

UNIT III **9**

FROM CAPACITY TO CONNECTIVITY: NETWORK ACCESS ANDINTERCONNECTION

Introduction-Access and Interconnection -Forms of Interconnection-Setting Interconnection ricesCross-border Interconnection-New Paradigms and New Challenges- Dispute Resolution-

UNIT IV **9**

FROM AVAILABILITY TO USE: UNIVERSAL ACCESS AND SERVICE -Trends and Approaches-Policy Rationale-Types of Universal Service Regimes-Reforming Universal Access Strategies for Developing Economies -

Digital Literacy and e-Inclusion -

UNIT V	9

A DIGITAL FUTURE: REGULATORY CHALLENGES IN A BRAVE NEW WORLD - Convergence, Ubiquity, and Web 2.0 - Regulating Digital Content- Balancing Intellectual Property Rights-. Neutrality of Access- Protecting Privacy- Cybersecurity Concerns - Green ICT-Regulation in a Global Era

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1.Colin Blackman and Lara Srivastava, "Telecommunications Regulation Handbook, Tenth Anniversary Edition, The International Bank for Reconstruction and Development / The World Bank, InfoDev, and The International Telecommunication Union, 2011

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3		2		3	3
CO2	3	3				3	3
CO3	3	3		3		3	3
CO4	3	3				3	3
CO5	3	3		2		3	3
	15	15		7		15	15
Scaled values	3	3		2		3	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

OPEN ELECTIVES

COURSE CODE			COURSE NAME	L	T	P	C
			BUSINESS ANALYTICS	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Demonstrate knowledge of data analytics.	Cognitive	Understanding
CO2	Demonstrate the ability of think critically in making decisions based on data and deep analytics.	Cognitive	Understanding
CO3	Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.	Cognitive	Understanding
CO4	Demonstrate the ability to translate data into clear, actionable insights.	Cognitive	Understanding

UNIT I **9**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II **9**

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression.Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology

UNIT III **9**

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT IV **9**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model,

Overbooking Model, Cash Budget Model.			
UNIT V			**9**
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey , "Business analytics Principles, Concepts, and Applications ", Pearson FT Press.
2. James Evans, " Business Analytics" , persons Education.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3	3	3		1	1
CO2		3	3	3		1	1
CO3		3	3	3		1	1
CO4		3	3	3		1	1
CO5		3	3	3		1	1
		15	15	15		5	5
Scaled values		3	3	3		1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
			INDUSTRIAL SAFETY	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Summarize the causes, effects and avoidance plans for accidents	Cognitive	Understanding
CO2	Appraise the importance of planning and describe methods for planning	Cognitive	Evaluating
CO3	Explain Wear and Corrosion and their prevention	Cognitive	Understanding
CO4	Analyse various faults and illustrate machine tool faults.	Cognitive	Analyzing
CO5	Explain Periodic and preventive maintenance	Cognitive	Understanding

UNIT I **9**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II **9**

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III **9**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV **9**

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V			9
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

REFERENCES

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

CO Vs PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1						3	3
CO2						3	3
CO3						3	3
CO4						3	3
CO5						3	3
						15	15
Scaled values						3	3

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE			COURSE NAME	L	T	P	C
			OPERATIONS RESEARCH	3	0	0	3
C	P	A		L	T	P	H
2.75	0	0.25		3	0	0	3

After completion of the course, a student will be able to

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Apply the dynamic programming to solve problems of discreet and continuous variables.	Cognitive	Understanding
CO2	Apply the concept of non-linear programming	Cognitive	Remembering Applying
CO3	Carry out sensitivity analysis	Cognitive	Analyzing
CO4	Model the real-world problem and simulate it.	Cognitive	Understanding

UNIT I **9**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II **9**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III **9**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV **9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V **9**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

LECTURE	TUTORIAL	TOTAL
45	0	45

REFERENCES

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		1		2		1	1
CO2		1		2		1	1
CO3		1		2		1	1
CO4		1		2		1	1
CO5		1		2		1	1
		5		10		5	5
Scaled values		1		2		1	1

1 – 5 →1, 6 – 10 → 2, 11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High