SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF

ELECTRONICS & COMMUNICATION ENGINEERING

CURRICULUM

DESIGNED FOR M.E COMMUNICATION SYSTEMS

REGULATION 2019

Applicable for students admitted from

2019-2020

Sri Krishna College of Engineering and Technology

An Autonomous Institution, Affiliated to Anna University

Coimbatore – 641 008

10th ACADEMIC COUNCIL MEETING

16thAugust, 2019

APPENDIX - IV

CURRICULUM AND SYLLABI

M.E. COMMUNICATION SYSTEMS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

To be a center of excellence for technological education, training & Research and to produce world class Engineers who can be placed in top core companies to serve the nation and the society.

MISSION

- **To provide intensive training in the fundamentals as well as the current trends in the field of Electronics and Communication Engineering.**
- **To continuously update the various facilities in the department and facilitate R&D and Consulting activities.**
- **To provide placement assistance to the students.**
- **To disseminate the knowledge by organizing seminars, Faculty Development Programs and Workshops.**

PROGRAMME OBJECTIVES (POs)

At the time of their graduation students of Electronics and Communication Engineering Programme should be in possession of the following Programme Outcomes

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and electronics and communication engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed based on the department mission

PEO I. Excel in professional career to provide engineering solution by demonstrating technical competence in electronics and communication engineering.

PEO II. Identify, analyze and formulate problems to offer appropriate design solutions that are technically superior, economically feasible, environmentally compatible and socially acceptable.

PEO III. Achieve progress in professional and research career through communication skills, team work and knowledge up-gradation through continuous education.

PROGRAMME SPECIFIC OUTCOMES (PSO)

On successful completion of Bachelor of Engineering in Electronics and Communication Engineering Program from Sri Krishna College of Engineering and Technology, the graduate will demonstrate:

PSO1: Potential to analyse, design, synthesize and provide technical solutions in the field of VLSI, Embedded Systems and Communication Networks.

PSO2: Emerge as ethical leaders, engage in lifelong learning and pursue entrepreneurship and contribute towards the field of Electronics and Communication Engineering.

Mapping of PO's to PEO's

Programme Educational Objectives	Programme Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
PEO 1	3	3	3	3	2	2	2	1	1	1	1	2
PEO 2	3	3	3	3	3	3	3	1	1	1	1	2
PEO 3	1	1	1	1	1	2	1	3	3	3	3	1

1	Reasonably agreed	2	Moderately agreed	3	Strongly agreed

Year	Sem	Course Title	Program Outcomes											
			1	2	3	4	5	6	7	8	9	10	11	12
I	I	Linear Algebra, Optimization Techniques And Numerical Methods	3	2		3			1				2	1
		Statistical Signal Processing	3	2	3	2	2	1	1				2	2
		Advanced Communication Networks	3	3	3	2	1	1	1				1	1
		Signal Processing Lab	3	3	3	2	3	1	1				2	2
		Audit Course 1						1	1	3	2	3	2	
	II	Antennas and Radiating Systems	3	2	3	2	2	2	1				2	2
		Algorithms for Network Routing	3	2	3	2	1	1	1				2	2
		Modern Digital Communication Techniques	3	3	3	2	1	1	1				1	1
		Antennas and Networking Lab	3	2	3	2	3	2	1				2	2
		Mini Project	3	2	3	2	3	1	1		3		2	2
		Audit Course II						1	1	3	2	3	2	
II	III	Open Elective						1	1	3	2	3	2	
		Dissertion Phase I	3	3	3	3	3	1	1		3		2	2
	IV	Dissertion Phase II	3	3	3	3	3	1	1		3		2	2
PROFESSIONAL ELECTIVE COURSES	Stream I	Pattern Recognition and Machine Learning	3	3	2	2	1	1	1				1	1
		Multimedia Compression Techniques	3	3	3	3	1	1	1				1	1
		Real Time Image and Video Processing	3	3	2	2		1	1				1	1
		Cooperative Communication and Cognitive Radio	3	3	3	3	1	1	1				1	1
		Energy Management for Wireless Communication	3	3	3	2	1	1	1				1	1
		MANET Protocols	3	3	3	2	1	1	1				1	1
		Wireless Security	3	3	3	2	1	1	1				1	1

		RF System Design	3	3	3	2	1	1	1				2	1
		Optical Wireless Communication	3	2	2	2	1	2	1				1	2
		Voice and Data Networks	3	3	2	2	1	1	1				1	1
	Stream II	Digital Control Engineering	3	2	3	2	1	1	1				2	2
		Human Machine Interface	3	3	2	2	1	1	1				2	1
		Smart Systems	3	3	2	2	1	1	1				2	1
		Secure Computing Systems	3	3	3	3	2	1	1				2	1
		Network Architecture and Security	3	3	2	2	1	1	1				2	1
		Optimization Techniques	3	3	2	2	1	1	1				2	1
		Internet of Everything	3	3	2	2	1	1	1				2	1
		Real Time Embedded Systems	3	3	3	2	1	1	1				2	2
		Research Methodology and IPR	3	3	2	2	1	1	1				2	1
		Computer Vision	3	3	2	2	1	1	1				2	1

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNLOGY

M.E Communication Systems
Regulations 2019

SEMESTER I							
S No.	**Course Code**	**Course**	**L/T/ P**	**Contact hrs/week**	**Credits**	**Ext/Int**	**Category**
THEORY							
1	19PB101	Linear Algebra, Optimization Techniques And Numerical Methods	3/0/0	3	3	50/50	PC
2	19PB102	Statistical Signal Processing	3/0/0	3	3	50/50	PC
3	19PB103	Advanced Communication Networks	3/0/0	3	3	50/50	PC
4		Elective – 1	3/0/0	3	3	50/50	PE
5		Elective – 2	3/0/0	3	3	50/50	PE
PRACTICAL							
6	19PB104	Signal Processing Lab	0/0/4	4	2	50/50	PC
AUDIT COURSE							
7		Audit Course 1	-				AC
			Total	**19**	**17**		

SEMESTER II							
S No.	**Course Code**	**Course**	**L/T/ P**	**Contact hrs/week**	**Credits**	**Ext/Int**	**Category**
THEORY							
1	19PB201	Antennas and Radiating Systems	3/0/0	3	3	50/50	PC
2	19PB202	Algorithms for Network Routing	3/0/0	3	3	50/50	PC
3	19PB203	Modern Digital Communication Techniques	3/0/0	3	3	50/50	PC
4		Elective – 3	3/0/0	3	3	50/50	PE
5		Elective – 4	3/0/0	3	3	50/50	PE
PRACTICAL							
6	19PB204	Antennas and Networking Lab	0/0/4	4	2	50/50	PC
PROJECT							
7	19PB205	Mini Project	0/0/4	4	2	50/50	PW
AUDIT COURSE							
8		Audit Course 2	-				AC
			Total	**23**	**19**		

SEMESTER III							
S No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1		Elective – 5	3/0/0	3	3	50/50	PE
2		Open Elective	3/0/0	3	3	50/50	OE
PRACTICAL							
1	19PB301	Dissertion Phase I	0/0/20	20	10		PW
			Total	**26**	**16**		

SEMESTER IV							
S No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
PRACTICAL							
1	19PB401	Dissertion Phase II	0/0/32	-	16		PW
			Total		**16**		

AUDIT COURSES (AC)

S.No.	Course Code	Course Title	Category
1	19AC001	English for Research Paper Writing	AC
2	19AC002	Disaster Management	AC
3	19AC003	Hindi/German for Technical Knowledge	AC
4	19AC004	Value Education	AC
5	19AC005	Constitution of India	AC
6	19AC006	Pedagogy Studies	AC
7	19AC007	Stress Management	AC
8	19AC008	Personality Development through Life Enlightenment Skills	AC

OPEN ELECTIVES(OE)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
1	19PF001	Business Analytics	3/0/0	3	3	OE
2	19PD001	Industrial Safety	3/0/0	3	3	OE
3	19PD002	Operation Research	3/0/0	3	3	OE
4	19PC001	Cost Management of Engineering Projects	3/0/0	3	3	OE
5	19PC002	Composite Materials	3/0/0	3	3	OE
6	19PE001	Waste to Energy	3/0/0	3	3	OE

PROFESSIONAL ELECTIVE COURSES

Stream I

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
1	19PB501	Pattern Recognition and Machine Learning	3/0/0	3	3	PE
2	19PB502	Multimedia Compression Techniques	3/0/0	3	3	PE
3	19PB503	Real Time Image and Video Processing	3/0/0	3	3	PE
4	19PB504	Cooperative Communication and Cognitive Radio	3/0/0	3	3	PE
5	19PB505	Energy Management for Wireless Communication	3/0/0	3	3	PE
6	19PB506	MANET Protocols	3/0/0	3	3	PE
7	19PB507	Wireless Security	3/0/0	3	3	PE
8	19PB508	RF System Design	3/0/0	3	3	PE
9	19PB509	Optical Wireless Communication	3/0/0	3	3	PE
10	19PB510	Voice and Data Networks	3/0/0	3	3	PE

Stream 2

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
1	19PB511	Digital Control Engineering	3/0/0	3	3	PE
2	19PB512	Human Machine Interface	3/0/0	3	3	PE
3	19PB513	Smart Systems	3/0/0	3	3	PE
4	19PB514	Secure Computing Systems	3/0/0	3	3	PE
5	19PB515	Network Architecture and Security	3/0/0	3	3	PE
6	19PB516	Optimization Techniques	3/0/0	3	3	PE
7	19PB517	Internet of Everything	3/0/0	3	3	PE
8	19PB518	Real Time Embedded Systems	3/0/0	3	3	PE
9	19PB519	Research Methodology and IPR	3/0/0	3	3	PE
10	19PF502	Computer Vision	3/0/0	3	3	PE

SCHEME OF CREDIT DISTRIBUTION – SUMMARY

S. No	Stream	Credits/Semester				Credits	AICTE
		I	II		IV		
1	Program Core	11	11	22	-	22	22
2	Program Electives	6	6	15	-	15	15
3	Project Work	-	-	26	16	26	26
4	Open Elective	-	-	3	-	3	3
5	Mini Project	-	2	2	-	2	2
Total		**17**	**19**	**16**	**68**	**68**	**68**

19PB101	LINEAR ALGEBRA, OPTIMIZATION TECHNIQUES AND NUMERICAL METHODS	3/0/0/3

Nature of Course	J (Problem analytical)

Course Objectives:

1	To acquire the knowledge of Vector spaces and Inner product spaces to handle problems that arise in Communication Engineering and Data Analysis.
2	To emphasize the applications of optimization techniques and Queueing models in multi task situations.
3	To solve problems on differential equations using Numerical techniques.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Apply the concept of Vector spaces and Inner product spaces in the field of Communication Engineering.	[AP]
C101.2	Apply techniques of Queueing models in social related problems	[AP]
C101.3	Apply the effective numerical methods for finding the solution of differential equations.	[AP]

Course Contents:

LINEAR ALGEBRA **15**

Vector spaces and Sub spaces – Null spaces and Column spaces – Linear transformations – Matrix of Linear Transformation - Linear Dependent and Independent set of vectors – Basis and Dimensions– Rank – Real Symmetric matrix – Characteristic equation – Eigen values and Eigen vectors of Real Symmetric Matrix.- Inner product Spaces – Properties – Cauchy-Schwarz inequality – Length and Orthogonality – Orthogonal sets – Orthogonal projections – Gram-Schmidt Orthogonalization Process (Excluding proof of theorems)

OPTIMIZATION TECHNIQUES **15**

Linear Programming Problem – Simplex Method –Big M Method - Two phase method – Transportation Problem – Maximization and Minimization types – Initial basic feasible solution by NWC, LCM and VAM methods –Assignment Problem – Hungarian Algorithm for optimum solution – Travelling Salesman problem - Single and multiple server Queueing models – Queues with finite waiting rooms – Little's Formula.

NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS **15**

Numerical solution of ODE –Euler method- Modified Euler method- RK method- Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank-Nicolson implicit scheme

Total Hours: 45

Text Books:

1.	David C Lay, "Linear Algebra and its Applications", 5th Edition, Pearson Education Asia,NewDelhi,2017
2.	Kanti Swarup, P.K.Gupta, Man Mohan, "Operations research", 19th edition, S.Chand, Delhi, 2017
3.	Jain, M.K., Iyengar, S.R.K., and Jain, R.K., "Numerical Methods for Scientific & Engineering computation", VI Edition, New Age International, 2017.

Reference Books:

1.	Veerajan. T., "Probability, Statistics and Random Process," Tata McGraw-Hill Publishing company Limited, 7th Edition, 2014.

2.	Rajasekaran S., "Numerical methods in Science and Engineering- A Practical Approach", 4nd edition, Wheeler Publishing, 2011
3.	Grewal, B.S. “Higher Engineering Mathematics”, 44th Edition, Khanna Publications, 2017
Web References:	
1.	http:// http://nptel.ac.in/courses/111104075/DOE
2.	http:// http://nptel.ac.in/courses/122104019/numerical-analysis
Online Resources:	
1.	https://www.mooc-list.com/course/numerical-methods-engineers-saylororg
2.	https://www.canvas.net/browse/usflorida/courses/numerical-methods
3.	http://nptel.ac.in/upcoming_courses.php

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C101.1	Remember	Quiz	**7**
C101.2	Understand	Assignment	**7**
C101.3	Apply	Presentation	**6**

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination [50]
	CIA1 [10]	CIA2 [10]	Term End Assessment [10]	
Remember	30	30	30	30
Understand	20	40	30	30
Apply	50	20	30	30
Analyse	0	0	0	0
Evaluate	0	10	10	10
Create	0	0	0	0

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB102	STATISTICAL SIGNAL PROCESSING	3/0/0/3
Nature of Course	J (Problem analytical)	
Pre requisites	Digital Signal Processing	
Course Objectives:		
1	To establish fundamental concepts on random signal processing in modern spectral estimation.	
2	To enable the students to understand the concepts of spectrum estimation	
3	To understand the concepts of the adaptive filters and its applications	
4	To explore the concepts of multirate signal processing by study of DFT, computation and design of Multi rate filters	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C102.1	Explore the importance of discrete random processing in DSP and its applications on statistical measures, prediction and estimation..	[U]
C102.2	Analyze and estimate the spectrum for parametric and non-parametric methods.	[AN]
C102.3	Understand the concept of linear prediction and estimation and various filter techniques	[AP]
C102.4	Design LMS and RLS adaptive filters for different applications like signal enhancement, channel equalization.	[AN]
C102.5	Understand the concepts of adaptive filter and its applications	[U]
C102.6	Acquire knowledge about concept of multi rate signal processing and sample rate conversion	[U]

Course Contents:

DISCRETE RANDOM SIGNAL PROCESSING AND SPECTRUM ESTIMATION 15

Discrete Random Processes- Ensemble averages, stationary processes, Autocorrelation and Auto covariance matrices. Parseval's Theorem, Wiener-Khintchine Relation- Spectral Factorization, Filtering random processes. Low Pass Filtering of White Noise. Parameter estimation- Bias and consistency. Estimation of spectra from finite duration signals,Non parametric methods- Correlation Method, Periodogram Estimator, Modified periodogram, Bartlett and Welch methods, Blackman –Tukey method. Parametric methods- AR, MA, ARMA model based spectral estimation. Parameter Estimation -Yule-Walker equations.

LINEAR ESTIMATION PREDICTION AND ADAPTIVE FILTERS 15

Linear prediction- Forward and backward predictions, Solutions of the Normal equations- Levinson- Durbin algorithms. Maximum likelihood criterion -Least mean squared error criterion -Wiener filter for filtering and prediction , FIR Wiener filter and Wiener IIR filters ,Discrete Kalman filter. **ADAPTIVE FILTERS-**FIR adaptive filters -adaptive filter based on steepest descent method-Widrow-Hoff LMS adaptive algorithm. Adaptive channel equalization-Adaptive echo cancellation-Adaptive noise cancellation- Adaptive recursive filters (IIR). RLS adaptive filters- exponentially weighted RLS-sliding window RLS.

MULTIRATE DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS 15

Mathematical description of change of sampling rate - Decimation by an integer factor D - Interpolation by an integer factor I. Application of Multirate DSP- Design of DFT Filter bank, Design of QMF, Subband coding of speech signals.

Total Hours:	**45**

Text Books:	
1	Monson H.Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons, Inc.,Singapore,Reprint 2008.
2	John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson,4th edition,2014..
3	Dimitris G.Manolakis et.al.,”Statistical and adaptive signal Processing”, McGraw Hill, Newyork,2009.
Reference Books:	
1	Shaila,D.Apte,”Advanced signal processing”Wiley India Pvt.Ltd.,2013
2	Simon Haykin, “Adaptive signal processing, next generation solutions”, John Wiley and Sons, Inc. ,2010
3	P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 1993.
Web References:	
1	http://www.engr.wisc.edu/ece/courses/ece732.html
2	http://www.courses.ece.illinois.edu/ECE551/
3	http://www.et.byu.edu/groups/ece777web/
4	http://www.ee.lamar.edu/gleb/adsp/Lecture%2007%20%20Adaptive%20filtering.pdf
Online Resources:	
1	http://www.users.abo.fi/htoivone/courses/sbappl/asp_chapter2.pdf
2	https://www.edx.org/course/discrete-time-signal-processing-mitx-6-341x-1

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C102.1,5, 6	Understand	Class Presentation/Power point presentation	6
C102.2,4	Analyse	Classroom or Online Quiz	4
C102.3	Apply	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB103	ADVANCED COMMUNICATION NETWORKS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Computer Networks

Course Objectives:

1	To gain an insight into advanced topics in wireless networks.
2	To learn the architectures of wireless networks.
3	To acquire the concepts and the protocols involved in SDN.
4	To introduce the students with the emerging technologies and their standards with applications for vehicular communication systems
5	To familiarize the students with traffic model and routing protocols of vehicular communication systems

Course Outcomes:
Upon completion of the course, students shall have ability to

C103.1	Understand the various technologies in wireless networks	[U]
C103.2	Gain knowledge about the architectures of wireless networks.	[U]
C103.3	Interpret the concepts of SDN.	[U]
C103.4	Identify and familiarize with SDN protocols.	[A]
C103.5	Understand the basic principles, standards, and system architecture of Vehicular Ad-hoc Networks.	[U]
C103.6	Analyze the traffic model and routing protocols of vehicular communication systems	[A]

Course Contents:

WIRELESS AREA NETWORKS **15**

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.

SOFTWARE DEFINED NETWORKS **15**

Evolution of Software Defined Networking (SDN),Fundamental Characteristics of SDN, SDN operation, SDN Controllers, SDN Applications, Open Flow Controller,Open Flow protocol, Use Cases of SDNs: Data Centers, WAN, Internet Exchange Points.

VEHICULAR AD-HOC NETWORKS **15**

Introduction: Basic principles and challenges, past and ongoing VANET activities, cooperative system architecture, VANET enabled active safety applications, Vehicular Mobility Modeling: Random models, flow and traffic models, behavioral models, trace and survey-based models, VANET Routing protocols: Opportunistic packet forwarding, topology-based routing, geographic routing, Standards and Regulations: General concepts, Protocol Stack for DSRC.

Total Hours: 45

Text Books:

1	Siva Ram Murthy C and Manoj B S, “Ad-hoc Wireless Networks-Architecture and Protocols”, 2nd Edition, Pearson education, 2007.
2	Paul Goransson, Chuck Black, Timothy Culver, “Software Defined Networks: A Comprehensive Approach”,2nd Edition, 2016.
3	H. Hartenstein and K. P. Laberteaux, VANET: Vehicular Applications and Inter-Networking Technologies, Wiley, 2010.

Reference Books:	
1	KavehPahlavan and Prashant Krishnamurthy, “Principle of Wireless Networks - A Unified Approach”, Prentice Hall of India, 2006.
2	Thomas D. Nadeau, Ken Gray, —SDN: Software Defined Networks, O’Reilly Media, 2013.
2	C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.
3	M. Emmelmann, B. Bochow and C. C. Kellum, Vehicular Networking: Automotive Applications and Beyond, Wiley, 2010.
4	James F. Kurose, Keith W. Ross, “Computer Networking: A Top-Down Approach”, 7th edition
Web References:	
1	https://nptel.ac.in/courses/106105080/pdf/M5L7.pdf
2	https://nptel.ac.in/courses/126104006/LectureNotes/Week-5_4G%20Mobile%20Wireless%20WiMAX.pdf
3	https://nptel.ac.in/courses/106105183/44
4	http://textofvideo.nptel.ac.in/106105160/lec1.pdf
Online Resources:	
1	https://www.cse.iitb.ac.in/~sri/talks/Course-on-wireless-05.pdf
2	https://subjects.ee.unsw.edu.au/tele4642/wk5_sdn_basics.pdf
3	https://courses.engr.illinois.edu/ece438/fa2017/.../ECE438_FA17_4_Network.ppx
4	https://www.cs.odu.edu/~mweigle/courses/cs795-s08/papers/harri-mar07.pdf

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C103.1	Understand	Quiz	3
C103.2	Understand	Class Presentation	3
C103.3	Understand	Class Presentation	3
C103.4	Analyze	Group Assignment	4
C103.5	Understand	Technical presentation	4
C103.6	Analyze	Problem solving	3

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	40	30	30	30
Understand	40	40	40	40
Apply	-	-	-	-
Analyze	20	30	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB104	SIGNAL PROCESSING LAB	0/0/4/2

Nature of Course	: M (Practical application)
Pre-requisites	: Digital Signal Processing
Co requisites	Statistical Signal Processing

Course Objectives:

1.	To understand the underlying concepts in signal processing
2.	To enable the students to understand the concepts of spectrum estimation
3	To understand the concepts of the adaptive filters and its applications
4.	To enable the students to understand the concept of multi rate signal processing and its applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C104.1	Explore the importance of discrete random processing in DSP and its applications on statistical measures, prediction and estimation.	[AP]
C104.2	Design LMS and RLS adaptive filters for different applications like signal enhancement, channel equalization.	[AN]
C104.3	Analyse the performance of estimated power spectrum using various techniques	[AN]
C104.4	Construct the filter structure for sampling rate conversion	[AP]
C104.5	Evaluate the properties of various types of filters through design and simulation using software.	[E]

Course Contents:

Sl.No	List of Experiments using MATLAB	CO Mapping	RBT
1.	Power spectral estimation using Barlett method	C104.1	[AP]
2.	Power spectral estimation using Welch method	C104.1	[AP]
3.	Power spectral estimation of Parametric methods	C104.1	[AP]
4.	Implement Levinson Durbin algorithm for calculating LPC coefficients and reflection coefficients.	C104.4	[AN]
5.	Design of Channel equalizers (LMS, RLS)	C104.2	[AN]
6.	Implementation of Decimation and interpolation for achieving sampling rate conversion.	C104.3	[AP]
7.	Examine the effect of anti imaging filter and anti aliasing filter in multirate signal processing	C104.3	[AN]
		Total Hours:	**30**

Reference Books:

1	Monson H.Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons, Inc.,Singapore,Reprint 2008.
2	John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson,4th

	edition,2014..
3	Dimitris G.Manolakis et.al.," Statistical and adaptive signal Processing", McGraw Hill, Newyork,2009.
4	Shaila,D.Apte,"Advanced signal processing" Wiley India Pvt.Ltd.,2013
5	Simon Haykin, "Adaptive signal processing, next generation solutions", John Wiley and Sons, Inc. ,2010
Web References:	
1	http://www.engr.wisc.edu/ece/courses/ece732.html
2	http://www.courses.ece.illinois.edu/ECE551/
Online Resources:	
1	http://www.users.abo.fi/htoivone/courses/sbappl/asp_chapter2.pdf
2	https://www.edx.org/course/discrete-time-signal-processing-mitx-6-341x-1

Assessment Methods & Levels (based on Bloom's Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	20	20
Evaluate	10	10
Create	10	10

19PB201	ANTENNAS AND RADIATING SYSTEMS	3/0/0/3

Nature of Course	G (Theory Analytical)
Pre requisites	Antenna and Wave Propagation

Course Objectives:

1	To understand and analyze the behaviour of antenna with help of its performance parameters.
2	To understand and analyze the performance of array antennas for various applications.
3	To understand and analyze the performance of aperture antennas.
4	To understand and design a micros trip patch antennas for wireless applications.
5	To understand and analyze the performance of modern antennas.

Course Outcomes:

Upon completion of the course, students shall have ability to

C201.1	Analyze radiation fields of alternating current element and half wave dipole antennas.	[R]
C201.2	Design and analyze antenna arrays for the given specification.	[A]
C201.3	Compare different types of aperture antennas.	[U]
C201.4	Analyze various types of microwave antennas.	[A]
C201.5	Design, operate and analyze the characteristics of various antennas.	[AP]

Course Contents:

ANTENNA FUNDAMENTALS **15**

Review of Antenna Types and Antenna parameters- Retarded vector potentials – Heuristic approach and Maxwell's equation approach. The Lorentz gauge condition. Vector potential in phasor form. Radiation from alternating current element and Half wave dipole.

ANTENNA ARRAYS AND APERTURE ANTENNAS **15**

Linear array. Phased array, MEMS technology in phased arrays, Dolph- Tchebycheff arrays. Circular array. Antenna Synthesis- Line source and Discretization of continuous sources. Schelkunoff polynomial method. Fourier Transform method. Comparison of analog beamforming and digital beam forming. Smart Antennas.Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane; Babinets principle, Slot antenna;

MICROSTRIP AND MODERN ANTENNAS **15**

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;PIFA – Vivaldi Antennas - UWB Antennas - Leaky Wave Antennas – Plasma Antennas – Wearable Antennas- Reconfigurable antennas - Meta materials

Total Hours:	**45**

Text Books:

1	Balanis, C.A, "Antenna Theory",ThirdEdition,Wiley and Sons,2005.
2	E.C. Jordan & K.G. Balmain, "Electromagnetic waves and Radiating systems", Second Edition,Prentice Hall of India, 2011.
3	S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, "Modern Antennas", Second Edition, Springer Publications, 2007.
4	Jim R.,James,P.S.Hall ,"Handbook of Microstrip Antennas" IEE Electromagnetic wave series 28, Volume 2,1989.

Reference Books:	
1	Krauss, J.D, “Radio Astronomy”, McGraw-Hill 1966
2	Kraus, J.D. and Fleisch, D.A. “Electromagnetics with Applications”, Fifth Edition .New York, McGraw-Hill, 1999.
3	Fran K. B. Gross, “Frontiers in Antennas”, Mc Graw Hill, 2011.
4	I.J. Bahl and P. Bhartia,” Microstrip Antennas”, Artech House,Inc.,1980.
5	W.L.Stutzman and G.A.Thiele, “Antenna Theory and Design”, Second Edition, John Wiley &Sons Inc.,1998.
Web References:	
1	http://www.antenna-theory.com
2	https://www.tutorialspoint.com/antenna_theory
3	http://www.amanogawa.com/archive/antennaA.html
4	www.jackwinters.com/cwc.ppt
Online Resources:	
1	http://nptel.ac.in/courses/108101092/
2	http://nptel.ac.in/courses/117107035/
3	https://nptel.ac.in/courses/117104099/
4	https://nptel.ac.in/courses/117105136/

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C201.1	Remember	Quiz	4
C201.2	Analyse	Group Assignment & Tutorial	4
C201.3	Understand	Class Presentation	4
C201.4	Analyse	Group Assignment & Tutorial	4
C201.5	Apply	Group Assignment	4

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	30	20	20	20
Understand	20	20	20	20
Apply	20	20	20	20
Analyse	30	40	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB202	ALGORITHMS FOR NETWORK ROUTING	3/0/0/3

Nature of Course	G (Theory Analytical)
Pre requisites	Computer Networks

Course Objectives:

1	To learn about routing algorithms in Circuit switching network & Packet switching networks
2	To understand routing algorithms in Routing in High speed and mobile networks.
3	To learn routing algorithms in Mobile Ad-hoc networks.

Course Outcomes:

Upon completion of the course, students shall have ability to

C202.1	Understand various circuit and packet switching network for routing.	[U]
C202.2	Familiarize the concept of routing in optical and ATM networks.	[U]
C202.3	Analyse various routing algorithms for Mobile Networks	[A]

Course Contents:

CIRCUIT & PACKET SWITCHING NETWORKS **15**

AT & T's Dynamic Routing Network, Routing in Telephone Network-Dynamic Non Hierarchical Routing- Trunk Status Map Routing-Real Time Network Routing, Dynamic Alternative Routing-Distributed Adaptive Dynamic Routing-Optimized Dynamic Routing-Distance vector Routing, Link State Routing, Inter domain Routing-Classless Inter domain routing (CIDR), Interior Gateway routing protocols (IGRP) - Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Exterior Gateway Routing Protocol (EGRP) - Border Gateway Protocol (BGP), Apple Talk Routing and SNA Routing

HIGH SPEED NETWORKS **15**

Routing in optical networks-The optical layer, Node Designs, Network design and operation, Optical layer cost tradeoffs, Routing and wavelength assignment, Architectural variations, Routing in ATM networks- ATM address structure, ATM Routing, PNNI protocol, PNNI signaling protocol, Routing in the PLANET network and Deflection Routing.

MOBILE NETWORKS AND MOBILE AD-HOC NETWORKS (MANET) **15**

Routing in Cellular Mobile Radio Communication networks-Mobile Network Architecture, Mobility management in cellular systems, Connectionless Data service for cellular systems, Mobility and Routing in Cellular Digital Packet Data (CDPD) network, Packet Radio Routing-DARPA packet radio network, Internet based mobile ad-hoc networking, communication strategies, routing algorithms – Table-driven routing - Destination Sequenced Distance Vector (DSDV), Source initiated on-demand routing- Dynamic Source Routing (DSR), Ad-hoc On- demand Distance Vector (AODV), Hierarchical based routing- Cluster head Gateway Switch Routing (CGSR) and Temporally-Ordered Routing Algorithm (TORA), Introduction to Vehicular Adhoc Network (VANET) and Body Area Network.

Total Hours:	**45**

Text Books:

1	M. Steen Strub, "Routing in Communication networks", Prentice Hall International, NewYork, 1995.
2	William Stallings, "ISDN and Broadband ISDN with Frame Relay and ATM",

	PHI, New Delhi, 2004.
3	Behrouz A Forouzan, “Data Communications and Networking”, TMH, 3rd edition,2007.
Reference Books:	
1	C.Siva Ram Murthy and B.S.Manoj, 'Ad hoc Wireless Networks Architectures and protocols", 2nd edition, Pearson Education. 2007.
2	Mohammad llyas, "The handbook of adhoc wireless networks", CRC press, 2002
3	PallapaVenkataram and SunilkumarS.Manvi, “Communication protocol Engineering”, PHI, 2012.
Web References:	
1	http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/
2	http://www.cs.jhu.edu/~goodrich/cgc/pubs/routing.pdf
3	http://www.sparrow.ece.cmu.edu/group/ad-hoc-net.html
4	https://nptel.ac.in/courses/106105160/9
Online Resources:	
1	http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/
2	http://www.moment.cs.ucsb.edu
3	https://nptel.ac.in/courses/106106091/32

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C202.1	Understand	Classroom or Online Quiz	4
C202.2	Understand	Class Presentation/Power point presentation	6
C202.3	Apply	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	40	30	10	20
Understand	60	50	30	30
Apply	-	20	60	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB203	MODERN DIGITAL COMMUNICATION TECHNIQUES	3/0/0/3

Nature of Course	G (Theory Analytical)
Pre requisites	Digital communication

Course Objectives:

1	To understand the basics of signal-space analysis and digital transmission.
2	To deliberate the concepts of coherent and non-coherent receivers and its impact on different channel characteristics.
3	To understand the different Equalizers
4	To implement the different block coded and convolutional coded digital communication systems.
5	To apply the basics of Multicarrier and Multiuser Communications in OFDM applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C203.1	Develop the ability to understand the concepts of signal space analysis for coherent and non- coherent receivers and different Equalization techniques.	[U]
C203.2	Apply the knowledge on different block codes and convolution codes.	[AP]
C203.3	Comprehend the generation of OFDM signals and the techniques of multiuser detection.	[AP]

Course Contents:

COHERENT AND NON-COHERENT COMMUNICATION **15**

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier Synchronization- Bit synchronization. Equalization Techniques: Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

BLOCK AND CONVOLUTIONAL CODED DIGITAL COMMUNICATION **15**

Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon‟s channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes. Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

MULTICARRIER AND MULTIUSER COMMUNICATIONS **15**

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

Total Hours: **45**

Text Books:

1	Bernard Sklar, “Digital Communications”, second edition, Pearson Education, 2012.
2	M.K.Simon, S.M.Hinedi and W.C.Lindsey, “Digital communication techniques; Signal Design and Detection”, Prentice Hall of India, New Delhi, 2013.
3	Simon Haykin, “Digital communications”, John Wiley and sons, 2014.
Reference Books:	
1	John G. Proakis, “Digital Communication”, Fifth Edition, Mc Graw Hill Publication, 2014.
2	Stephen G. Wilson, “Digital Modulation and Coding”, First Indian Reprint, Pearson Education, 2010.
3	Theodore S.Rappaport, „Wireless Communications”, 2nd edition, Pearson Education, 2013.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc19_ee06
2	https://nptel.ac.in/courses/117105144/
3	https://www.cambridge.org/9780521876131
4	https://ece.illinois.edu/academics/courses/profile/ece562
Online Resources:	
1	https://wiki.metakgp.org/w/EC60603:_Modern_Digital_Communication_Techniques
2	http://technav.ieee.org/tag/2758/digital-communication
3	http://www.utas.edu.au/__data/assets/pdf_file/0008/385559/KNE432-unit-outline.pdf
4	https://trove.nla.gov.au/work/28921994

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C203.1	Understand	Group Assignment & Tutorial	5
C203.2	Apply	Class Presentation/Power point presentation	10
C203.3	Apply	Online Quiz	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	-	10	10	10
Understand	80	30	20	40
Apply	20	60	70	50
Analyse	-		-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB204	ANTENNAS AND NETWORKING LAB	0/0/4/2

Nature of Course	M(Practical Application)
Pre requisites	Antennas and Radiating Systems, Advanced Communication Networks

Course Objectives:

1	To learn the design procedureand to measure the characteristics of Microwave Tees.
2	To learn the design procedure and to measure the characteristics of aperture and Patch Antenna.
3	To learn the operation of wide area networks and their convergence method.
4	To acquire the knowledge in communication between vehicles

Course Outcomes:
Upon completion of the course, students shall have ability to

C204.1	Acquainted the operational detail of various Microwave Tees.	[A]
C204.2	Acquired the knowledge of Aperture and Patch antenna.	[A]
C204.3	Analyze the performance of different wide area networks.	[A]
C204.4	Analyze the performance of convergence networks.	[A]
C204.5	Build and verify the circuits of MANET and VANET.	[A]

Course Contents:

S.No	List of Experiments	CO Mapping	BT
1	Design and Simulation of E-Plane / H-Plane Tee in HFSS	CO1	[A]
2	Design and Simulation of Magic Tee in HFSS	CO1	[A]
3	Design and Simulation of Microstrip patch antenna in HFSS	CO2	[A]
4	Design and Simulation of Ridged Horn Antenna in HFSS	CO2	[A]
5	Design and Simulation of Reflector Antenna in HFSS	CO2	[A]
Simulation using NS/MATLAB			
6	Simulation and Performance analysis of WiMAX network in mesh mode and multihop relay mode	CO3	[A]
7	Simulation and Performance analysis of WiFi network	CO3	[A]
8	Performance analysis of convergence networks (WiMAX and LTE networks)	CO4	[A]
9	Simulation and Evaluation of Mobile Ad hoc Networks	CO5	[A]
10	Vehicle to Vehicle Communication Vehicle to infrastructure communication Infrastructure to vehicle communication	CO5	[A]
	Total Hours:	**30**	

Reference Books:

1	Annapurna Das and Sisir K Das, —Microwave Engineering, Tata Mc Graw Hill Inc., 2007.
2	D.M.Pozar, —Microwave Engineering.John Wiley & sons, Inc., 2008.
3	Gerd Keiser, Optical Fiber Communications, 4th Ed, McGrawHill, 2010.

4	Samuel Y Liao, —Microwave Devices & Circuits-ǁ, Prentice Hall of India, 2008.
5	Amnon Yariv, Pochi Yeh, Photonics: Optical Electronics in modern communications, 6th Ed, Oxford.
6	Siva Ram Murthy C and Manoj B S, “Ad-hoc Wireless Networks-Architecture and Protocols”, 2nd Edition, Pearson education, 2007
7	H. Hartenstein and K. P. Laberteaux, VANET: Vehicular Applications and Inter-Networking Technologies, Wiley, 2010
Web References:	
1	www.antennatheory.com
2	www.microwave101.com
3	http://www.ansys.com
4	http://ns3-code.com/ns2-wimax-example-code/
5	https://slogix.in/ns2-sample-source-code-for-vehicular-ad-hoc-network

Assessment Methods & Levels (based on Blooms Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	**Rubric based Continuous Assessment [60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	40	40
Evaluate	-	-

19PB501	PATTERN RECOGNITION AND MACHINE LEARNING	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	-

Course Objectives:

1	To develop the skill to use linear equations to represent approximation methods
2	To gain knowledge about various probabilistic models for classification
3	To familiarize with the classification models
4	To gain knowledge about the application of machine learning
5	To explore various clustering methods in pattern recognition

Course Outcomes:

Upon completion of the course, students shall have ability to

C501.1	Recall the various approximation methods.	[R]
C501.2	Express the methods for function approximation in linear equation	[U]
C501.3	Analyse the knowledge of parameter estimation for classification	[A]
C501.4	Apply the knowledge of classification in neural networks	[AP]
C501.5	Explore the various dimensionality reduction techniques	[U]
C501.6	Understand the various clustering techniques	[U]

Course Contents:

METHODS FOR FUNCTION APPROXIMATION **15**

Linear models for regression, Parameter estimation methods - Maximum likelihood method and Maximum a posteriori method; Regularization, Ridge regression, Lasso, Bias-Variance decomposition, Bayesian linear regression.

PROBABILISTIC MODELS FOR CLASSIFICATION **15**

Bayesian decision theory, Bayes classifier, Minimum error-rate classification, Normal (Gaussian) density – Discriminant functions, Decision surfaces, Maximum-Likelihood estimation, Maximum a posteriori estimation; Gaussian mixture models -- Expectation-Maximization method for parameter estimation; Naive Bayes classifier, Non-parametric techniques for density estimation -- Parzen-window method, K-nearest neighbors method.

DISCRIMINATIVE LEARNING BASED MODELS FOR CLASSIFICATION **15**

Logistic regression, Perceptron, Multilayer feed forward neural network – Gradient descent method, Error back propagation method. Dimensionality Reduction Techniques: Principal component analysis, Fisher discriminant analysis, Multiple discriminant analysis. Non-Metric Methods for Classification: Decision trees, CART. Ensemble Methods for Classification: Bagging, Boosting, Gradient boosting Pattern Clustering: Criterion functions for clustering, Techniques for clustering -- K-means clustering, Hierarchical clustering, Density based clusterinsg and Spectral clustering; Cluster validation.

Total Hours: **45**

Text Books:

1	C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006
2	R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001

Reference Books:	
1	S. Theodoridis and K. Koutroumbas, Pattern Recognition, Academic Press, 2009
2	E. Alpaydin, Introduction to Machine Learning, Prentice-Hall of India, 2010
3	G. James, D. Witten, T. Hastie and R. Tibshirani, Introduction to Statistical Learning, Springer, 2013.
Web References:	
1	https://nptel.ac.in/courses/117105101/
2	https://www.coursera.org/.../machine-learning/welcome-to-machine-learning-zcAuT
3	https://www.edx.org/course/machine-learning-columbiax-csmm-102x-0
Online Resources:	
1	https://ocw.mit.edu/resources/res-9-003-brains-minds-and-machines-summer-course-summer-2015/tutorials/tutorial-3.-machine-learning/
2	https://www.toptal.com/machine-learning/machine-learning-theory-an-introductory-primer
3	http://videolectures.net/christopher_bishop/

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C501.1	Remember	Online Quiz	5
C501.2	Understand	Power point presentation	5
C501.3	Analyse	Group Assignment	5
C501.4	Apply	Group Assignment	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	30	30	30	30
Understand	30	30	30	30
Apply	20	20	20	20
Analyse	20	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB502	MULTIMEDIA COMPRESSION TECHNIQUES	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	-

Course Objectives:

1	Implement basic compression algorithms with MATLAB and its equivalent open source environments.
2	Design and implement some basic compression standards
3	Critically analyze different approaches of compression algorithms in multimedia related projects.

Course Outcomes:

Upon completion of the course, students shall have ability to

C502.1	Recall the basic representation and concepts related to multimedia	[R]
C502.2	Express and relate the various compression methods using appropriate algorithm	[U]
C502.3	Apply and compare the techniques available for multimedia compression	[AP]

Course Contents:

INTRODUCTION TO MULTIMEDIA COMPRESSION **15**

Introduction to multimedia, Graphics, Image and Video representations, Fundamental concepts of video, digital audio. Storage requirements of multimedia applications, Need for compression, Taxonomy of compression Algorithms, Elements of Information Theory, Error Free Compression, Lossy Compression.

TEXT AND IMAGE COMPRESSION **15**

Text Compression: Huffman coding, Adaptive Huffman coding, Arithmetic coding, Shannon - Fanon coding, Dictionary techniques, LZW family algorithms. Image Compression: Fundamentals, Compression Standards, JPEG Standard, Sub band coding, Wavelet Based compression, Implementation using Filters, EZW, SPIHT coders, JPEG 2000 standards, JBIG and JBIG2 standards.

AUDIO AND VIDEO COMPRESSION **15**

Audio Compression: Audio compression Techniques, µ-law & A-Law companding, Frequency domain and filtering, Basic sub band coding, Application to speech coding, G.722, MPEG audio, progressive encoding, Silence compression, Speech compression, Formant and CELP vocoders. Video Compression: Video compression techniques and Standards, MPEG 1, MPEG 2 video coding, MPEG 3 and MPEG 4, Motion estimation and compensation techniques, H.261 Standard, DVI technology, DVI real time compression, Current Trends in Compression standards.

Total Hours:	**45**

Text Books:

1	Fred Halshall “Multimedia Communication – Applications, Networks, Protocols and Standards”, Pearson Education, 2007.
2	Tay Vaughan, “Multideai: Making it Work”, 7th Edition, TMH 2008 98.
3	Kurose and W.Ross” Computer Networking “a Top down Approach, Pearson

	Education 2005.
Reference Books:	
1	David Solomon, “Data Compression – The Complete Reference”, Fourth Edition, Springer Verlog, New York, 2006.
2	Darrel Hankerson, Greg A Harris, Peter D Johnson, „Introduction to Information Theory and Data Compression‟ Second Edition, Chapman and Hall ,CRC press, 2003
3	Khalid Sayood: Introduction to Data Compression”, Morgan Kauffman Harcourt India, Third Edition, 2010.
4	Mark S. Drew, Ze-Nian Li, “Fundamentals of Multimedia”, PHI, 2009
5	Peter Symes : Digital Video Compression, McGraw Hill Pub., 2004.
Web References:	
1	https://nptel.ac.in/courses/117105083/
2	https://nptel.ac.in/courses/106105082/38
Online Resources:	
1	https://www.coursera.org/learn/digital
2	https://freevideolectures.com/course/2652/cse-40373-multimedia-systems
3	http://users.cs.cf.ac.uk/Dave.Marshall/Multimedia/PDF/

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C502.1	Remember	Technical Quiz	5
C502.2	Understand	Class Presentation / Team presentation	5
C502.3	Apply	Group Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA,I [10 marks]	CIA,II [10 marks]	CIA,III [10 marks]	
Remember	25	25	25	25
Understand	25	25	25	25
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB503	REAL TIME IMAGE AND VIDEO PROCESSING	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Digital Image Processing

Course Objectives:

1	To understand the fundamentals of Image processing and Image Transforms
2	To study theconcept of Segmentation and Compression Technique for Image Processing
3	To understand thebasic steps of Video Processing in real time Process
4	To realize the importance of2-D and 3-D MotionEstimation for Video Processing

Course Outcomes:

Upon completion of the course, students shall have ability to

C503.1	Understand theimportance of Image Transform and fundamentals of Filtering of Images	[U]
C503.2	Recall the Segmentation, Compression Standards and technologies involved with Image Processing	[R]
C503.3	Apply the knowledge about 3-D motion Estimation and Applications of video Processing	[AP]

Course Contents:

IMAGE TRANSFORMS AND IMAGE PROCESSING TECHNIQUES **15**

Basic relationship between pixels Image Transforms: 2–D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms - Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, region based segmentation

IMAGECOMPRESSION **15**

Image compression fundamentals–coding Redundancy, spatial and temporalredundancy. Compression models : Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding, wavelet coding, JPEG standards

VIDEO PROCESSING AND 3-D MOTIONESTIMATION **15**

Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations, Optical flow, general methodologies, pixel based motion estimation, Blockmatching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

Total Hours:	**45**

Text Books:

1	Gonzaleze and Woods ,"Digital Image Processing ", 3rd edition , Pearson ,2018
2	Yao wang, JoemOstarmann and Ya – quin Zhang, "Video processing and

	communication “,1st edition , PHI, 2017
3	M. Tekalp ,”Digital video Processing”, 2nd Edition Prentice Hall International,2016
Reference Books:	
1	Relf, Christopher G.,"Image acquisition and processing with LabVIEW", CRC press,2017
2	Anerozdemi R, "Inverse Synthetic Aperture Radar Imaging with MATLAB Algorithms", John Wiley & Sons, 2017
3	Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons,2016
Web References:	
1	http://ptgmedia.pearsoncmg.com/images/9780133991000/samplepages/9780133991000.pdf
2	http://read.pudn.com/downloads161/ebook/734037/0849334926.pdf
3	https://www.researchgate.net/profile/A_Tekalp/publication/200132428_Digital_Video_Processing/links/0c96051c469546bb98000000/Digital-Video-Processing.pdf
Online Resources:	
1	https://www.coursera.org/learn/digital
2	https://www.edjio.com/digital-signal-processing/video-processing
3	https://nptel.ac.in/courses/117105079/

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C503.1	Understand	Online Quiz	4
C503.2	Remember	Power point presentation	6
C503.3	Apply	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Understand	40	40	20	20
Remember	60	60	30	30
Apply	-	-	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB504	COOPERATIVE COMMUNICATION AND COGNITIVE RADIO	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Wireless Communication Networks

Course Objectives:

1	To understand the protocols and networks of cooperative communication
2	To explain the principles and architectures of SDR and Cognitive Radio
3	To familiarize the recent trends and challenges faced by Cognitive Radio

Course Outcomes:

Upon completion of the course, students shall have ability to

C504.1	To list the protocols and describe the networks used in cooperative communication	[R]
C504.2	To describe the terminologies and architectures of SDR and Cognitive Radio	[U]
C504.3	To interpret Cognitive radio concepts in current scenario	[AP]

Course Contents:

COOPERATIVE COMMUNICATIONS **15**

Cooperation protocols - Hierarchical cooperation; Cooperative Communications with single relay; Multi-node cooperative communications; Distributed space–time coding (DSTC) - Distributed space–frequency coding (DSFC); Relay selection -Energy efficiency in cooperative sensor networks; Cognitive multiple access via cooperation; Content-aware cooperative multiple access; Distributed cooperative routing; Source–channel coding with cooperation

INTRODUCTION TO SOFTWARE DEFINED RADIO AND COGNITIVE RADIO **15**

Characteristics and Benefits of Software Radio; Dynamic Spectrum Access; Digital dividend; Types of Cognitive Radio; Spectrum policies and Regulations; Information theoretic perspective on Cognitive Radio networks. Cognitive Radio Tasks- Spectrum sensing and its methods, Cooperative Spectrum sensing, Spectrum sharing, spectrum mobility, spectrum management, spectrum trading.

RECENT TRENDS AND CHALLENGES IN COGNITIVE RADIO **15**

OFDM based Cognitive Radio; Security issues in cognitive radio; Game theory in Cognitive radio; applications of cognitive radio; IEEE 802.22 WRAN standard

Total Hours:	**45**

Text Books:

1	Rayliu K J, SadekA K, Weifeng Su andAndres Kwasinski, “Cooperative Communications and Networking”, Cambridge University Press, 2009.
2	Jeffrey H Reed, “Software Radio: A Modern Approach to Radio Engineering”, PEA Publication, 2002.
3	Bruce A Fette, “Cognitive Radio Technology”, Elsevier publication, BURLINGTON, 2009.
4	Joseph Mitola III, “Cognitive Radio Architecture: The Engineering Foundations of Radio XML”, Wiley Interscience Publication, NEW JERSEY, 2006.

Reference Books:

1	Alexander M. Wyglinski, Maziar Nekovee, Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles and Practice” 2010 Elsevier Inc.
2	Walter Tuttlebee, “Software Defined Radio” Copyright 2002 John Wiley & Sons,

	Ltd
3	Kwang-Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks”, John Wiley & Sons, 2009.
Web References:	
1	https://ieeexplore.ieee.org/document/6189409
2	https://www.researchgate.net/publication/220537186_Cooperative_Communications_in_Wireless_Networks
3	http://work911.com/communication/coop.htm
Online Resources:	
1	https://nptel.ac.in/courses/108107107/3
2	https://onlinecourses.nptel.ac.in/noc18_ec01/preview
3	https://nptel.ac.in/courses/108104112/16

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C504.1	Remember	Online Quiz	5
C504.2	Understand	Seminar	5
C504.3	Apply	Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	50	-	-	30
Understand	50	80	40	50
Apply	-	20	60	20
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB505	ENERGY MANAGEMENT FOR WIRELESS COMMUNICATION	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Wireless Communication	
Course Objectives:		
1	To enable the student to understand the evolving paradigm of green communication and the enabling technologies for its implementation.	
2	To enable the student to understand the necessities and requirements in designing green communication.	
3	To explore the student to understand the application of Energy Conservation.	
4	To expose the student to the evolving energy harvesting strategies for green communication and their associated challenges.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C505.1	Learn about green communication, energy management and modulation.	[U]
C505.2	Understand the mechanism for minimizing energy consumption of wireless networks without compromising QoS.	[U]
C505.3	Analyze the design issues in EM Energy Harvesting Systems.	[A]
C505.4	Understand new energy harvesting algorithms and tools for that.	[U]
C505.5	Comprehend the energy efficient harvesting and management on wireless sensor networks.	[U]

Course Contents:

GREEN COMMUNICATION ENERGY MANAGEMENT AND CONSERVATION 15

Energy Management for Location –Based Services on mobile Devices, Energy Efficient Supply of Mobile Devices, Green Radio network-PHY and MAC layer optimization for energy-harvesting wireless networks-Green modulation and coding schemes in energy –constrained wireless networks.QoE-Based Energy Conservation for VoIP Applications in WLAN, Minimum Energy Multi-criteria Relay Selection in Mobile Ad Hoc Networks; Energy optimization Techniques for Wireless Sensor Networks.

ENERGY HARVESTING SYSTEMS AND ITS TECHNIQUES 15

Design Issues in EM Energy Harvesting Systems, Energy Scavenging for magnetically Coupled Communication Devices-Case study- Mixed –Signal, Low-power Techniques in Energy Harvesting Systems, Toward Modelling Support for Low-power and Harvesting Wireless Sensors for Realistic Simulation of Intelligent Energy.

ENERGY HARVESTING AND MANAGEMENT ON WSN 15

Energy Consumption Profile for Energy Harvested WSNs, Radio Frequency Energy harvesting and Management for Wireless Sensor Networks.

Total Hours:	**45**

Text Books:

1	H.Venkataraman, Gabriel-miroMuntean,"Green Mobile Devices and Networks: Energy optimization and Scavenging Techniques", - CRC Press, 2015.
2	Vijay K. Bhargava,Gerhard P.Fettweis and EkramHossian, "Green Radio

	Communication Networks", Cambridge University press, 2015.
3	Jinsong Wu, SundeepRangan, Honggang Zhang, "Green Communication: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.
Reference Books:	
1	Mohammad S. Obaidat, AlaganAnpalagan and Isaac Woungang, "Handbook of Green Information and Communication Systems", ELSEVIER, 2019.
2	F.RichardYu,Xi Zhang ,Victor C.M.leung ,"Green Communication and Networking", - CRC Press, 2015.
3	BhuvanUnhelkar ,"Green IT Strategies and Applications: Using Environmental Intelligence", CRC Press, 2011.
Web References:	
1	https://nptel.ac.in/courses/117102062/
2	https://nptel.ac.in/courses/117104099/
3	https://nptel.ac.in/syllabus/108106022/
Online Resources:	
1	https://www.coursera.org/lecture/wireless-communications/3-3-mxLbq
2	https://www.coursera.org/lecture/it.../2-1-1-basics-of-wireless-communications-D9aRc
3	https://www.edx.org/course/understanding-wireless-technology-notredamex-eg240x

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C505.1	Understand	Online Quiz	3
C505.2	Understand	Class Presentation	3
C505.3	Analyze	Case study	6
C505.4	Understand	Group Assignment	4
C505.5	Understand	Assignment	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	10	20	20
Understand	50	50	50	50
Apply	-	-	-	-
Analyse	30	40	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB506	MANET PROTOCOLS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Wireless and Mobile Communication Networks

Course Objectives:

1	To explore issues and challenges in designing MAC Protocols in the context of adhoc networks
2	To understand adaptation of the routing protocols in mobile networks
3	To explore issues and challenges variety of attacks and threats over different layer
4	To evaluate the performance of MAC, routing protocols in MANETs.

Course Outcomes:

Upon completion of the course, students shall have ability to

C506.1	Study the characteristic features and applications of adhoc networks.	[R]
C506.2	Understand the various MAC protocols and design issues.	[U]
C506.3	Learn the different types of routing protocols.	[AP]
C506.4	Analyze and design security systems for wireless networks.	[A]
C506.5	Study about cross layer design and integration of adhoc for 4G	[U]

Course Contents:

MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS **15**

Introduction to Adhoc networks - definition, characteristics features, applications, Characteristics of Wireless channel,Mobile ad hoc networks (MANETS)-concepts, architectures and design challenges ,Adhoc Mobility Models - entity and group models MAC Protocols: design issues, goals and classification, Contention based protocols, reservation based protocols, scheduling algorithms, Multi channel MAC-IEEE 802.11.

ROUTING AND TRANSPORT LAYER PROTOCOLS IN AD HOC WIRELESS NETWORKS 15

Routing Protocols: Design issues, goals and classifications, Proactive and reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Power/ Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.Transport layer Protocols: Design Issues and goals in designing, TCP over adhoc wireless networks, Adhoc transport protocols. Security in adhoc wireless networks, Network security Requirements, Issues and challenges in security provisioning, Network security attacks, Secure Routing.

CROSS LAYER DESIGN AND INTEGRATION OF ADHOC FOR 4G **15**

Cross layer Design: Need for cross layer design, Cross layer optimization, Parameter optimization techniques,Cross layer cautionary perspective, Co-operative networks-Architecture, methods of co-operation, Integration of ad hoc network with other Wired and Wireless networks.

Total Hours:	**45**

Text Books:

1	C.Siva Ram Murthy and B.S.Manoj, “Ad hoc Wireless Networks Architectures and protocols", Prentice Hall Professional Technical Reference,2008.
2	Charles E. Perkins, "Ad hoc Networking", Addison - Wesley, 2000.

3	Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, “Mobile ad hoc networking”, Wiley-IEEE press, 2004.
Reference Books:	
1	Carlos De Morais Cordeiro, Dharma Prakash Agrawal “Ad Hoc & Sensor Networks:Theory and Applications”, World Scientific Publishing Company, 2006.
2	Stefano Basagni, Marco Conti, Silvia Giordano and Ivan Stojmenovic, "Mobile adhoc networking", Wiley-IEEE press, 2004.
3	Mohammad llyas, "The handbook of adhoc wireless networks", CRC press, 2002.
Web References:	
1	http://www.dtic.mil/dtic/tr/fulltext/u2/a460089.pdf
2	http://www.ijarcce.com/upload/2013/march/25-ABDUL%20SALEEM%20-%20CROSS% 20LAYER-c.pdf
3	http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1404568
4	http://www.ijmer.com/papers/Vol3_Issue2/CZ3210711074.pdf
Online Resources:	
1	http://disi.unitn.it/~klezovic/papers/whycross-layer.pdf
2	http://www.cs.tut.fi/kurssit/TLT-2756/lect04.pdf
3	https://www.cse.wustl.edu/~jain/cis788-99/ftp/adhoc_routing/
4	https://link.springer.com/content/pdf/10.1007%2F0-387-31173-4_40.pdf

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C506.1	Remember	Classroom or Online Quiz	4
C506.2	Understand	Classroom Power point presentation	4
C506.3	Apply	Group Assignment	4
C506.4	Analyse	Tutorial	4
C506.5	Understand	Seminar	4

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	30	30	30
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB507	WIRELESS SECURITY	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre – requisites		
Course Objectives:		
1	To provide a good conceptual overview of the security principles incorporated in the design of several generations of wireless and mobile networks	
2	To address the growing threat to wireless devices, networks and services	
3	To study the concept of main security threats and techniques to diminish these threats in Communication networks.	
4	To study the Security Standards in current Wireless & Mobile Systems	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C507.1	Remember the basic concepts of Cryptography and basic security techniques	[R]
C507.2	Understand the concept of security principles and architecture in mobile networks	[U]
C507.3	Understand the various methods and protocols to maintain E-mail security and web security	[U]
C507.4	Understand the various methods of password management and protocols to maintain system security	[U]
C507.5	Develop SSL or Firewall based solutions against security threats, employ access control techniques to the existing computer platforms	[AP]
C507.6	To analyze the Security and privacy in current Wireless & Mobile Systems	[A]

Course Contents:

WIRELESS SYSTEM SECURITY **15**

Cryptography Background, Overview of Basic Security Techniques and Attacks, Security in Smart Cars, Sensor and GPS Security, Security using Acoustic Techniques

MOBILE SECURITY **15**

Security of GSM Networks, Security of UMTS Networks, LTE Security, WiFi and Bluetooth Security, SIM/UICC Security Mobile Malware and App Security, Android Security Model, IOS Security Model, Security Model of the Windows Phone, SMS/MMS, Mobile Geolocation and Mobile Web Security , Smart Home and 5G Security, Block chain Security, AI System Security

SECURITY STANDARDS **15**

Security Services for E-mail-attacks possible through E-mail – establishing keys privacy-authentication of the source-Message Integrity-Non-repudiation-Pretty Good Privacy-S/MIME-SSL/TLS Basic Protocol-computing the keys- client authentication-PKI as deployed by SSL Attacks fixed in v3- Exportability-Encoding-Secure Electronic Transaction (SET), Kerberos - WiFi Security (WEP, WPA, WPA-Enterprise)- Cellular Security (GSM, 3G, LTE)-Internet of Things / Wireless Sensor Networks / RFID, Emerging Privacy concerns: location, tracking, traffic analysis, mobile and the cloud

Total Hours:	**45**

Text Books:	
1	Mobile Application Security, Himanshu Dviwedi, Chris Clark and David Thiel,1st Edition
2	Charles Pfleeger, "Security in Computing", Prentice Hall, 4 th Edition, ISBN-10: 0132390779, ISBN-13: 978-01323907744, 2006.
3	William Stallings, "Cryptography and Network Security", Pearson Education, 6th Edition, ISBN 10**:** 0133354695, 2013.
Reference Books:	
1	Ulysess Black, **"**Internet Security Protocols**:** Protecting IP Traffic**",** Prentice Hall PTR; 1st edition, ISBN-10: 0130142492, ISBN-13: 978-0130142498,2000.
2	Amir Ranjbar, "CCNP ONT Official Exam Certification Guide", Cisco Press [ISBN: 978-1-58720-176-3], 2007.
3	Frank Adelstein, Sandeep K.S. Gupta, Golden G. Richard III, and Loren Schwiebert, Fundamentals of Mobile and Pervasive Computing, 2005.
Online Resources:	
1	http://nptel.ac.in/courses/106105031/
2	http://www.nptelvideos.in/2012/11/cryptography-and-network-security.html
3	http://freevideolectures.com/Course/3027/Cryptography-and-Network-Security
Web References:	
1	http://www.ccs.neu.edu/home/noubir/Courses/CS7780/F14/slides/introduction.pdf
2	http://www.ccs.neu.edu/home/noubir/Courses/CS7780/F14/slides/crypto-use-isuse.pdf
3	http://www1.se.cuhk.edu.hk/~eclt5740/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Tentative Assessment Component	Marks (20)
C507.1	Remember	Quiz	3
C507.2	Understand	Quiz	3
C507.3	Understand	Seminar	3
C507.4	Understand	Seminar	3
C507.5	Apply	Group Assignment	4
C507.6	Analyse	Assignment	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment [30 Marks]			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	40	20	10	10
Understand	60	40	40	40
Apply	-	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB508	RF SYSTEM DESIGN	3/0/0/3
Nature of Course	J (Problem analytical)	
Pre requisites	VLSI, Microwave Engineering and Electronic circuits	
Course Objectives:		
1	To understand the principles of MOS physics and different noise in trans-receivers	
2	To perform impedance matching analysis in microwave engineering using S parameters	
3	To understand the working of RF power amplifiers and apply it for improving efficiency of RF systems	
4	To analyse the PLL circuits based on RF frequency to define the frequency synthesizers	
5	To apply the knowledge of mixers to design the RF-mixer oscillator circuits.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C508.1	Understand the CMOS architecture and Noises associated with Trans-Receivers	[U]
C508.2	Designing the RF power amplifier with measuring the impedance level of RF circuit	[AN]
C508.3	Understanding the working principles of RF power amplifiers and ACPR metric	[U]
C508.4	Analyse the PLL model to defining the Demodulator and detector circuit	[AN]
C508.5	Apply the knowledge of PLL towards defining the operation of mixers and oscillators	[AP]

Course Contents:

MOS PHYSICS & TRANSCEIVER ARCHITECTURE **15**

CMOS: Introduction to MOSFET Physics – Noise: Thermal, shot, flicker, popcorn noise Transceiver Specifications: Two port Noise theory, Noise Figure, Sensitivity, Phase noise Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures – Transmitter: Direct up conversion, Two step up conversion.

IMPEDANCE MATCHING AND RF AMPLIFIERS **15**

Introduction, S-parameters with Smith chart, Passive IC components, Impedance matching networks Amplifiers: Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement – High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match – Single ended and Differential LNAs - Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques – Time and Frequency domain considerations–Compensation Power Amplifiers: General model – Class E, F and G amplifiers - Linearization Techniques – Efficiency boosting techniques – ACPR metric.

PLL , MIXERS & APPLICATIONS **15**

PLL: Loop filters and Charge pumps, detector and demodulator circuits, Frequency Synthesizers: Integer-N frequency synthesizers – Direct Digital Frequency synthesizers, wireless synthesizers -

Mixer: characteristics–Non-linear based mixers: Quadratic mixers–Multiplier based mixers: Single balanced and double balanced mixers–sub sampling mixers Oscillators: Describing Functions, Colpitts oscillators–Resonators–Tuned Oscillators–Negative resistance oscillators.	
Total Hours:	**45**
Text Books:	
1	T.Lee, “Design of CMOS RF Integrated Circuits”, Cambridge, 2004.
2	Reinhold Ludwig and Powel Bretchko, “RF Circuit Design – Theory and Applications, Pearson Education Asia” First Edition, 2007.
3	Ronald E.Best, “Phase Locked Loops: Design, simulation and applications” McGraw Hill Publishers 5th edition 2009.
4	B.Razavi, “RF Microelectronics”, Pearson Education, 2003.
5	Jan Crols, Michiel Steyaert, “CMOS Wireless Transceiver Design”, Kluwer Academic Publishers, 1997.
Reference Books:	
1	Hooman Darabi, Radio Frequency Integrated Circuits and Systems, Cambridge University Press, First Edition, 2015.
2	Joseph.J. Carr, Secrets of RF Circuit Design , McGraw Hill Publishers, 3rd Edition, 2000.
3	Mathew M. Radmanesh, Radio Frequency & Microwave Electronics, Pearson Education Asia, Second Edition, 2002.
4	Ulrich L. Rohde and David P. NewKirk, RF / Microwave Circuit Design, John Wiley & Sons USA 2000.
Web References:	
1	https://www.qsl.net/va3iul/
2	http://www.seas.ucla.edu/brweb/teaching.html
3	http://www.nptelvideos.in/2012/12/rf-integrated-circuits.html
4	https://www.microwavejournal.com/articles/29301-circuit-and-system-design-analysis-and-simulation
Online Resources:	
1	https://www.coursera.org/lecture/fundamentals-particle-accelerator-technology/introduction-to-rf-amplifiers-9jCaG
2	https://www.udemy.com/rf-fundamentals_all-basic-concepts_rahsoft/
3	http://ic.sjtu.edu.cn/ic/rf/
4	https://www.classcentral.com/course/coursera-fundamentals-of-particle-accelerator-technology-npap-mooc-13281
Assessment Methods & Levels (based on Blooms Taxonomy)	
Formative assessment based on Capstone Model (Max. Marks:20)	

Course Outcome	Bloom’s Level	Assessment Component	Marks
C508.1	Understand	Classroom and Online Quiz	4
C508.2	Analyze	Class Presentation/Power point presentation	4
C508.3	Understand	Technical Seminar	4
C508.4	Analyze	Tutorial Problem -solving	4

C508.5	Apply	Group Assignment & Tutorial	4

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination**
	CIA-I [10 marks]	**CIA-II [10 marks]**	**CIA-III [10 marks]**	
Remember	10	10	10	10
Understand	50	40	20	40
Apply	40	50	50	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

19PB509	OPTICAL WIRELESS COMMUNICATION	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	-

Course Objectives:

1	To encourage the students to develop their knowledge on the wireless communication theory.
2	To learn about the MIMO techniques for the wireless communication system and their applications.
3	To expose the students in the basic concept of characterization of UV scattering communication channels. And also learn about the free space optical communication.
4	To describe the applications of the wireless sensor networks and free space optical networks.

Course Outcomes:

Upon completion of the course, students shall have ability to

C509.1	Understand the basic concept of optical wireless communication system.	[U]
C509.2	Explain the concept of free space optical communication system.	[R]
C509.3	Recognize the principle and process of the MIMO techniques for wireless communication systems	[U]
C509.4	Demonstrate the concept in the field of visible light communication and to implement them in the real life applications	[A]
C509.5	Apply their idea in visible light communication module	[AP]

Course Contents:

OPTICAL WIRELESS COMMUNICATION THEORY **15**

Coded modulation techniques for optical wireless channels -Atmospheric turbulence channel modelling-Codes on graphs-Coded-MIMO free-space optical communication –Raptor codes for temporally correlated FSO channels-Adaptive modulation and coding (AMC) for FSO communications-Multidimensional coded modulation for FSO communications-Free-space optical OFDM communication-Wireless optical CDMA communication systems -OCDMA system description-Indoor wireless optical CDMA LAN-Free-space optical CDMA systems -Modulation-Experimental prototypes.

MIMO TECHNIQUES FOR INDOOR OPTICAL WIRELESS COMMUNICATIONS **15**

Indoor OW MIMO channel characteristics-MIMO for diffuse OW channels-Spot-diffusing OW MIMO systems -Point-to-Point OW MIMO communications-Future directions-Channel capacity: Introduction and channel models -Capacity results-Modelling and characterization of ultraviolet scattering communication channels: Introduction-Single scattering models -Multiple scattering models -NLOS UV channel measurement systems.The optical wireless channel: Introduction-System configurations -Optical sources-Optical detectors-Optical filters-Nature of the optical wireless channel -Interference sources-Impact of interference on BER- Modulation schemes for optical wireless

VISIBLE LIGHT COMMUNICATIONS AND APPLICATIONS **15**

Introduction-System Description -VLC System Model-SNR Analysis-Channel Delay Spread-System Implementations-Bit Angle Modulation-Pulse Modulation Schemes-PWM with DiscreteMultitone Modulation-Multilevel PWM-PPM-PWM with NRZ-OOK-Multiple-Input-Multiple-Output VLC-Home Access Network.	
Total Hours:	**45**

Text Books:	
1	ShlomiArnon, John R. Barry, George K.Karagiannidis, Robert Schober, Murat Uysal "Advanced Optical Wireless Communication Systems" Cambridge University Press 2012.
2	Z. Ghassemlooy W. Popoola , S. Rajbhandari "Optical Wireless Communications" CRC Press 2013
3	Franz & Jain, Optical Communication Systems, Narosa Publications, New Delhi, 1995
Reference Books:	
1	Keiser G., "Optical fiber communication systems", McGraw-Hill, 2000.
2	Shlomi Arnon, “Visible light Communication”, Cambridge University Press, 2015.
3	V.Kawadia and P.P.Kumar,"A cautionary perspective on Cross-Layer design,"IEEEWirelesscommn.,vol 12, no 1,2005.
Web References:	
1	https://nptel.ac.in/courses/117101002/downloads/handouts/lec12.pdf
2	http://www.circuitstoday.com/visible-light-communication
3	https://cdn.intechopen.com/pdfs/39687.pdf
4	https://pdfs.semanticscholar.org/55c1/db48f6ea51dd433c6ce08cae49457ff4ace0.pdf
Online Resources:	
1	https://www.oreilly.com/library/view/optical-wireless-communications/9781439852354/
2	https://onlinelibrary.wiley.com/doi/10.1002/9781118887691.ch2
3	https://pdfs.semanticscholar.org/c108/1957f6aacf6749142fbf20cfe551fdc88a02.pdf
4	http://www.nitttrchd.ac.in/sitenew1/app_sc/ppts/ofc/4.%20Optical%20Sources_RB.pdf

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C509.1	Understand	Classroom Power point presentation	4
C509.2	Remember	Classroom or Online Quiz	4
C509.3	Understand	Seminar	4
C509.4	Analyse	Tutorial	4
C509.5	Apply	Group Assignment	4

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination**
	CIA-I [10 marks]	**CIA-II [10 marks]**	**CIA-III [10 marks]**	
Remember	30	20	20	20
Understand	40	30	20	20
Apply	30	50	30	30
Analyse	-	-	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

19PB510	VOICE AND DATA NETWORKS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Computer Networks

Course Objectives:

1	To understand the concept Telecommunications and Network Hierarchy for voice communication.
2	To study Network Synchronization Control And Management for voice and data networks
3	To understand about delay models in data networks
4	To realize the importance routing in data networks

Course Outcomes:

Upon completion of the course, students shall have ability to

C510.1	Recall the concepts importance of telephone instruments and signals	[R]
C510.2	Understand the functionalities, standards and technologies involved with voice and data network services	[U]
C510.3	Apply the knowledge of differential routing and delay models in data networking to solve the engineering problems	[AP]

Course Contents:

BACKGROUND AND TERMINOLOGY **15**

Telecommunications Standard Organizations - The Analog Network Hierarchy: Switching Systems - FDM Multiplexing and Modulation - Wideband Transmission Media - Cellular Radio Telephone System – Voice band Data transmission - The Introduction of Digits: Voice Digitization - Time Division Multiplexing – Data under Voice - Digital Switching: Switching Functions - Space Division Switching - Time Division Switching - Two-Dimensional Switching.

NETWORK SYNCHRONIZATION CONTROL AND MANAGEMENT **15**

Timing - Timing Inaccuracies - Network Synchronization - Network Control – Network Management - Wavelength Division Multiplexing - SONET/SDH - Digital Subscriber Access: Integrated Services Digital Network - High-Data Rate Digital Subscriber loops - Traffic Analysis: Traffic Characterization – Loss Systems - Lost Calls Cleared - Lost Calls Returning - Lost Calls Held.

DELAY MODELS AND ROUTING IN DATA NETWORKS **15**

M/M/1, M/G/1 queuing models – Networks of Transmission lines - Time reversibility (Burke's theorem) – Network of Queues (Jackson's theorem) - Wide area networking – Interconnected network Routing – Shortest path Routing – Multicast/Broadcast Routing information – Flow models – Optimal Routing and Topological design.

Total Hours:	**45**

Text Books:

1	John C. Bella, "Digital Telephony" Third Edition, Wiley Publication, 2017

2	William Stallings, *"*High-Speed Networks and Internets: Performance and Quality of Service", Second Edition, *Publisher*: Pearson *Education, 2016.*
3	Wayne Tomasi "Introduction to Data communication and Networking" First Edition, PearsonPublication, 2015
Reference Books:	
1	Gil Held "Voice & Data Internetworking (McGraw-Hill Series on Computer Communications" McGraw-Hill Education, 1st edition, 2016
2	Behrousz A Forouzan, "Data Communication and Networking, McGraw-Hill Publisher, Fourth edition, 2017
3	William Stallings, "Data and Computer Communications", Pearson Publication, Eighth Edition, 2018
Web References:	
1	https://emdaduits.files.wordpress.com/2011/12/digital-telephonythird-edition___john-c-bellamy.pdf
2	http://www.coins-lab.org/pnu/akoubaa/net456/Lectures/Lecture03-ATM.pdf
3	http://download.nos.org/coa631/ch2.pdf
4	https://www.utdallas.edu/~torlak/courses/ee4367/lectures/lecture1.pdf
Online Resources:	
1	https://nptel.ac.in/courses/117105076/pdf/11.1%20Lesson%2036.pdf
2	https://nptel.ac.in/courses/117105076/pdf/1.1%20Lesson%201.pdf
3	http://www.ncti.com/course/understanding-voice-and-data-networks
4	https://www.coursera.org/learn/network-security-communications-sscp

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C510.1	Remember	Online Quiz	4
C510.2	Understand	Power point presentation	6
C510.3	Apply	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	40	40	20	20
Understand	60	60	30	30
Apply	-	-	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB511	DIGITAL CONTROL ENGINEERING	3/0/0/3

Nature of Course	J (Problem Analytical)
Pre requisites	Control Systems

Course Objectives:

1	To introduce to the components of digital control system
2	To introduce to stability concepts in discrete domain
3	To understand Control design methods as well as the modern control design techniques
4	To know the various aspects of digital control engineering

Course Outcomes:

Upon completion of the course, students shall have ability to

C511.1	Analyze and model hybrid systems composed of continuous-time and discrete-time subsystems	[A]
C511.2	Study discrete-time closed-loop systems by using the z-transform	[R]
C511.3	Design discrete-time controllers for hybrid systems	[AP]
C511.4	Understand implementation issues for computer-based control systems	[U]

Course Contents:

INTRODUCTION TO DIGITAL CONTROL **15**

Discrete time system representation, Mathematical modeling of sampling process, Modeling discrete-time systems by pulse transfer function, Revisiting Z-transform, Mapping of s-plane to z-plane, Pulse transfer function of closed loop system, Stability analysis of discrete time systems, Jury stability test, Stability analysis using bi-linear transformation.

TIME RESPONSE OF DISCRETE SYSTEMS **15**

Transient and steady state responses, Time response parameters of a prototype second order system, Design of sampled data control systems, Root locus method, Root locus based controller design using MATLAB, Nyquist stability criteria, Bode plot, Lead compensator design using Bode plot, Lag compensator design using Bode plot, Lag-lead compensator design in frequency domain, Design of digital control systems with deadbeat response, Practical issues with deadbeat response design.

DISCRETE STATE SPACE MODEL **15**

Introduction to state variable model, Characteristic equation, state transition matrix, Solution to discrete state equation, Controllability, observability and stability of discrete state space models, Lyapunov stability theorem, State feedback design, Pole placement by state feedback, Pole placement by state feedback, Reduced order observer, Output feedback design, Output feedback design: Examples, Introduction to optimal control, Basics of optimal control, Performance indices, Linear Quadratic Regulator (LQR) design.

Total Hours: 45

Text Books:

1	B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
2	K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.
3	M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.

Reference Books:

1	G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems.
2	Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.
3	C.L.Philips and J.M.Pan, “Feedback Control System, Pearson, 2013.
Web References:	
1	https://nptel.ac.in/syllabus/108103008/
2	https://www.youtube.com/watch?v=XuR3QKVtx-g
3	https://www.youtube.com/watch?v=EVJSYsZ6QpI
Online Resources:	
1	https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x
2	https://ep.jhu.edu/programs-and-courses/535.645-digital-control-and-systems-applications
3	https://www.udemy.com/control-systems-pid/

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C511.1	Remember	Online Quiz	5
C511.2	Understand	Class Presentation	5
C511.3	Apply	Assignment - I	5
C511.4	Analyse	Assignment - II	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	10	15	10	15
Understand	10	15	10	15
Apply	30	20	30	20
Analyse	50	50	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB512	HUMAN MACHINE INTERFACE	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	

Course Objectives:

1	Understanding the need of Human and Machine interface.
2	Identify the stages in software engineering that need to be modified for effectiveness of interacting with computers.
3	Foster their ability to use various models to design systems.
4	Evaluate the design techniques by applying the statistical approach.

Course Outcomes:

Upon completion of the course, students shall have ability to

C512.1	Recall the concepts of Human and Machine interface.	[R]
C512.2	Determine the relevant software process to improve the effectiveness of interaction.	[U]
C512.3	Analysing the systems by applying various models and statistical approach.	[AP]

Course Contents:

FOUNDATIONS **15**

Introduction to Human, Computer and Interaction - Humans – Information process – Computer – Information Process – Devices for virtual reality and 3D interaction-physical control sensors and special devices - Differences and Similarities between Human, Computer and Interaction – Need for Interaction – Models – Ergonomics – Style – Context – Paradigms – Designing of Interactive systems – Usability – Paradigm shift – Interaction design basics – Design Process – Scenarios – Users need – Complexity of design.

MODELS **15**

Universal design principles – Multimodal systems – User Support – Presentation and Implementation Issues – types – requirements – approaches – Cognitive model – Hierarchical model – Linguistic model – physical and device models – Socio-technical models – Communication and Collaboration models – Task models – Task analysis and design- theories – dialogue and design analysis - Applications – Ubiquitous computing – Virtual reality.

EVALUATION OF INTERACTIVE SYSTEMS **15**

Software Process – Usability engineering – Issue based Information systems – Iterative design practices – Design rules – maximum usability – Principles – Standards and guidelines – design patterns – Programming Tools – Windowing systems – Interaction tool kit – User Interface management system – Evaluation techniques – evaluation design – Evaluating implementations – Observational Methods – Experimental Design and statistical analysis of HCL.

Total Hours:	**45**

Text Books:

1	Martin Helander, “Hand Book of Human Computer Interaction”, Elsevier science publishing company, The Netherlands, 2014.

2	Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale Human Computer Interaction, 3rdEdition Prentice Hall, 2004
Reference Books:	
1	"HCI International poster' s extended abstracts" international conference proceedings, Springer publication.
2	Katherine Balaski, " Emerging Research and trends in interactivity and the human computer interface"
Web References:	
1	https://nptel.ac.in/courses/106103115/34
2	https://nptel.ac.in/courses/106103115/module7/4.pdf
3	https://arl.human.cornell.edu/879Readings/Interaction%20Design%20-%20Beyond%20Human-Computer%20Interaction.pdf
4	https://www.microsoft.com/en-us/research/uploads/prod/2016/12/Chapter1Preview.pdf
Online Resources:	
1	https://www.ics.uci.edu/~ddenenbe/131/IntroToHCI.pdf
2	http://www.eng.utoledo.edu/~wevans/chap15_S.pdf
3	https://www.tutorialspoint.com/human_computer_interface/index.htm
4	https://www.nxp.com/docs/en/application-note/AN3934.pdf

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C512.1	Remember	Classroom or Online Quiz	5
C512.2	Understand	Power point presentation	5
C512.3	Apply	Group Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB513	SMART SYSTEMS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Internet of Things

Course Objectives:

1	To understand the concepts of IoT and its protocols
2	To learn and develop web services and IoT systems
3	To develop an IoT smart application
4	To analyse the real time applications of Bigdata for smart systems

Course Outcomes:

Upon completion of the course, students shall have ability to

C513.1	Understand the concept of IoT, Architecture and its protocols	[U]
C513.2	Develop web services to access/control IoT devices.	[AP]
C513.3	Deploy an IoT application and connect to the cloud.	[A]
C513.4	Analyse applications of Bigdata in IoT in real time scenario	[AP]

Course Contents:

INTERNET OF THINGS (IOT) **15**

Overview of IoT- Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design MethodologyM2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

IOT PROTOCOLS AND SMART SYSTEM APPLICATIONS **15**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP– Security. Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

BIG DATA PLATFORMS FOR THE IOT **15**

Network protocol- data dissemination –current state of art- Improving Data and Service Interoperability with Structure, Compliance, Conformance and Context Awareness: interoperability problem in the IoT context- Big Data Management Systems for the Exploitation of Pervasive Environments - Big Data challenges and requirements coming from different Smart City applications– energy saving in smart building- Intelligent Transportation Systems and Wireless Access in Vehicular Environment Technology for Developing Smart Cities: advantages and achievements- Emerging Technologies in Health Information Systems: Genomics Driven Wellness Tracking and Management System (GO-WELL)

Total Hours:	**45**

Text Books:

1	Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.
2	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of

	Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
3	Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.
Reference Books:	
1	Stackowiak, R., Licht, A., Mantha, V., Nagode, L.,” Big Data and The Internet ofThings Enterprise Information Architecture for A New Age”, Apress, 2015.
2	Dr. John Bates , “Thingalytics - Smart Big Data Analytics for the Internet of Things”, John Bates, 2015
Web References:	
1	https://nptel.ac.in/courses/106105166/
2	https://onlinecourses.nptel.ac.in/noc17_cs22/course
3	https://nptel.ac.in/courses/108108098/4
4	https://nptel.ac.in/courses/106104189/
Online Resources:	
1	https://www.tutorialspoint.com/internet_of_things/
2	https://iot-analytics.com/10-internet-of-things-applications/
3	https://www.tutorialspoint.com/big_data_tutorials.htm

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C513.1	Understand	Classroom or Online Quiz	4
C513.2	Apply	Class Presentation/Power point presentation	6
C513.3	Analyse	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	10	20	-	10
Understand	50	30	30	30
Apply	40	50	30	30
Analyse	-	-	40	30
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB514	SECURE COMPUTING SYSTEMS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Soft Computing

Course Objectives:

1	To develop the knowledge on trust computing systems and its architecture
2	To gain knowledge in validation process and its security properties
3	To familiarize with TPM, TSS and secured devices for various applications
4	To gain knowledge in the trusted computing secure identification systems and key certificates assignments

Course Outcomes:

Upon completion of the course, students shall have ability to

C514.1	Understand the concepts of trusted systems security architecture.	[U]
C514.2	Acquire the knowledge in validation of tasks and its properties	[U]
C514.3	Acquire knowledge in TCPA/TCG and TPM keys	[U]
C514.4	Understand the concepts of TSS and its applications.	[U]
C514.5	Apply the knowledge of trusted computing in identification and administration	[AP]
C514.6	Understand the concepts of key assignments and its recovery tools	[U]

Course Contents:

INTRODUCTION, ARCHITECTURE AND VALIDATION **15**

Introduction – Trust and Computing – Instantiations – Design and Applications – Progression – Motivating scenarios – Attacks. Design goals of the trusted platform modules. Introduction to simulators – Implementation of attacks. Foundations – Design challenges – Platform Architecture – Security architecture – erasing secrets – sources – software threats – code integrity and code loading. Outbound Authentication – Problem – Theory – Design and Implementation - Validation – Process – strategy – Formalizing security properties – Formal verification – other validation tasks – reflection.

TCPA/TCP, TSS CORE SERVICE AND SECURE STORAGE **15**

Experimenting with TCPA/TCG – Desired properties- Lifetime mismatch – Architecture – Implementation – Applications. Writing a TPM device driver- Low level software – Trusted boot – TCG software stack – Using TPM keys.TSS core service – Public key cryptography standard – Architecture – Trusted computing and secure storage – Linking to encryption algorithms – encrypting files and locking data to specific PCs-content protection – secure printing and faxing.

TRUSTED COMPUTING AND SECURE IDENTIFICATION **15**

Trusted Computing and secure identification – Administration of trusted devices – Secure /backup maintenance – assignment of key certificates-secure time reporting-key recovery – TPM tools- Ancillary hardware.

Total Hours: 45

Text Books:

1	Sean W.Smith, “Trusted Computing Platforms: Design and Applications”, Springer Science and Business media, 2005.

Reference Books:

1	Challener D., Yoder K., Catherman R., Safford D., Van Doorn L. “A Practical Guide to Trusted Computing”, IBM press, 2008.
2	. Xujan Zhou, Yue Xu, ,Yuefeng Li, AudunJøsang, and Clive Cox. “The stateof-the-art in personalized recommender systems for social networking. Artificial Intelligence Review”, Issue C, pp. 1-14, Springer, 2011.
3	John Linn, “Trust Models and management in Public Key Infrastructres”, November 2000.
Web References:	
1	https://nptel.ac.in/courses/106106129/21
2	https://nptel.ac.in/courses/106105031/
3	https://nptel.ac.in/courses/106105173/
Online Resources:	
1	https://www.coursera.org/specializations/computer-network-security
2	https://www.coursera.org/learn/design-secure-networked-systems
3	https://www.coursera.org/specializations/computer-security-systems-management

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C514.1	Understand	Classroom or Online Quiz	6
C514.2	Understand	Group Assignment & Tutorial	10
C514.5	Apply	Class Presentation/Power point presentation	4

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	50	50	-	10
Understand	50	50	40	60
Apply	-	-	60	30
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB515	NETWORK ARCHITECTURE AND SECURITY	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Computer Architecture and Computer Networks

Course Objectives:

1	To understand the nature of data flow at register transfer level of a computer architecture.
2	To familiarize with concepts of memory units and characteristics of I/O units.
3	To study the model of network security and different security services offered for various levels in the network.
4	To understand the concept of various security standards involved in designing network architecture

Course Outcomes:

Upon completion of the course, students shall have ability to

C515.1	Recall the concepts of register transfer operations	[R]
C515.2	Understand the machine level operations in higher level terms using Register transfer language	[U]
C515.3	Acquire knowledge of various memory units and secondary storage units	[U]
C515.4	Understand the Input-Output units involved in different data transfer operations.	[U]
C515.5	Understand the security services offered to a network	[U]
C515.6	Acquire knowledge in implementing different security standards for designing a network.	[AP]

Course Contents:

REGISTER TRANSFER LANGUAGE AND MICRO-OPERATIONS 15

Register transfer language – Register transfer – Bus and Memory Transfers - Arithmetic micro-operations – Logic micro-operations – Shift micro-operations – Arithmetic logic shift unit.

MEMORY AND INPUT-OUTPUT UNITS 15

Memory Hierarchy – Main memory – Auxiliary memory - Associative memory – virtual memory systems – address space and memory space – address mapping using pages – Associative memory page table – Replacement- Memory management hardware - cache memory: Basic cache structure – Direct, fully associative and set associative mapping – I/O Interface – Asynchronous data transfer – Modes of transfer – DMA.

NETWORK SECURITY 15

OSI Security Architecture – security attacks, security services – security mechanisms – a model of network security – Transport Level Security: Secure Socket Layer (SSL) – Transport Layer Security (TLS) – HTTPS – Secure Shell (SSH) – Email Security: Pretty Good Privacy (PGP) – IP security: Overview – Security policy–Security Standards: IEEE,RSA - Design of Network Architecture – NIST, PKCS – Wireless Transport layer Security- WAP security.

Total Hours:	**45**

Text Books:

1	M. Morris Mano,"Computer System Architecture", Prentice Hall of India, 1993.
2	William Stallings, "Network Security Essentials, Applications and Standards", Prentice Hall of India, Pearson Education, 2011.

3	DezsoSima, Terence Foundation, Peter Kacsuk, "Advanced Computer Architectures: A design space approach" Addison Wesley, 1997.
Reference Books:	
1	Richard E. Smith, "Internet Cryptography", Addison- Wesley, 2004.
2	William Stallings, "Cryptography and Network Security- Principles and Practice", Prentice Hall of India, Pearson Education, 2011.
3	William Stallings, "Computer Organization and Architecture- Designing for Performance" Prentice Hall of India, 2006.
Web References:	
1	https://en.wikipedia.org/wiki/PKCS
2	https://en.wikipedia.org/wiki/RSA_(cryptosystem)
3	https://en.wikipedia.org/wiki/IEEE_802.10
4	https://en.wikipedia.org/wiki/NIST_Cybersecurity_Framework
5	https://nptel.ac.in/courses/106102062
6	https://nptel.ac.in/courses/106105031
Online Resources:	
1	https://www.edx.org/course/computation-structures-2-computer-mitx-6-004-2x
2	https://www.mooc-list.com/tags/computer-architecture
3	https://www.edx.org/course/network-security-0
4	https://www.coursera.org/specializations/computer-network-security

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C515.1	Remember	Classroom or Online Quiz	6
C515.2	Understand	Group Assignment & Tutorial	10
C515.6	Apply	Class Presentation/Power point presentation	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	30	50	50	30
Understand	70	50	30	50
Apply	-	-	20	20
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB516	OPTIMIZATION TECHNIQUES	3/0/0/3
Nature of Course	F (Theory Programming)	
Pre requisites	-	
Course Objectives:		
1	To introduce the basic concepts of linear programming	
2	To educate on the advancements in Linear programming techniques	
3	To introduce the interior point methods of solving problems	
4	To introduce the dynamic programming method	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C516.1	Understand importance of optimization in process management	[U]
C516.2	Apply basic concepts of mathematics to formulate an optimization problem	[AP]
C516.3	Understand the linear and non linear programming in optimization techniques.	[U]
C516.4	Analyze about computational complexity and performance metrics of various optimization algorithms.	[A]
C516.5	Analyze the different optimization methods based on requirements and strategy.	[A]
C516.6	Analyse and appreciate variety of performance measures for various optimization problems	[A]
Course Contents:		
LINEAR PROGRAMMING AND ADVANCES IN LPP 15 Introduction – formulation of linear programming model-Graphical solution–solving LPP using simplex algorithm – Revised Simplex Method. Dualit theory- Dual simplex method – Sensitivity analysis–-Transportation problems– Assignment problems-Traveling sales man problem -Data Envelopment Analysis. **NON LINEAR PROGRAMMING 15** Classification of Non Linear programming – Lagrange multiplier method – Karush – Kuhn Tucker conditions–Reduced gradient algorithms–Quadratic programming method – Penalty and Barrier method. **INTERIOR POINT METHODS AND DYNAMIC PROGRAMMING 15** Karmarkar's algorithm–Projection Scaling method–Dual affine algorithm–Primal affine algorithm Barrier algorithm.Formulation of Multi stage decision problem–Characteristics–Concept of sub-optimization and the principle of optimality–Formulation of Dynamic programming–Backward and Forward recursion– Computational procedure–Conversion offinal value problem in to Initial value problem.		
Total Hours:		**45**
Text Books:		
1	Hillier and Lieberman "Introduction to Operations Research", TMH, 2000.	
2	R.Panneerselvam, "Operations Research", PHI, 2006	
3.	Hamdy ATaha, "Operations Research –An Introduction", Prentice Hall India, 2003.	
Reference Books:		

1	Philips, Ravindran and Solberg, “Operations Research”, John Wiley, 2002.
2	Ronald L.Rardin, “Optimization in Operation Research” Pearson Education Pvt. Ltd. New Delhi, 2005.

Web References:	
1	https://www.coursera.org/courses?query=optimization
2	https://online.stanford.edu/courses/mse211-introduction-optimization
Online Resources:	
1	https://nptel.ac.in/courses/111105039/
2	https://www.mooc-list.com/tags/optimization-methods

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C516.1	Understand	Classroom or Online Quiz	4
C516.2	Apply	Class Presentation/Power point presentation	6
C516.4	Analyse	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB517	INTERNET OF EVERYTHING	3/0/0/3
Nature of Course	G (Theory Analytical)	
Core requisites		
Course Objectives:		
1	To Understand the vision of IOT from a global context.	
2	To enable the students to understand the State of the Art – IOT Architecture.	
3	To interpret the use of internet principles, protocols and network management in IOT.	
4	To help the students to understand the principles of design in prototyping and provide ability to change and modify it.	
5	To be able to analyze the concepts of Industry 4.0	
6	To illustrate the Application of Industrial IOT	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C517.1	Understanding the concepts of IOT from a global context	[U]
C517.2	Infer the architecture of IOT and future development	[U]
C517.3	Understand the role of network layers in Data Management using IOT.	[U]
C517.4	Interpret the features of prototyping the embedded devices for IOT applications.	[AP]
C517.5	Design and develop an effective usage of IIOT deployment for different sectors.	[A]
C517.6	Illustrate the application of IIOT and identify Real World Design Constraints.	[AP]
Course Contents:		
FUNDAMENTALS OF IOT and IOT PROTOCOLS **15** Introduction – Characteristics - Physical design - Sensing & actuation- Protocols – Logical design – Enabling technologies –Input and output devices for IoT – IoT Levels – Domain Specific IoTs – IoT vs M2M. Future developments, Possible Architecture for the future IoT- Internet communication- IP addresses, MAC addresses- TCP and UDP ports- Application layer protocols- IEEE 802 committee family of protocols- physical layer-Media access control layer **INDUSTRY 4.0** **15** Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis, Cyber security in Industry 4.0, **INDUSTRIAL IOT** **15** Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems, Business Model and Reference Architecture: IIoT-Business Models, IIoT Reference Architecture-Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication IIoT Networking, Cloud Computing in IIoT- Fog Computing in IIoT, Security in IIoT - Application Domains: Factories and Assembly Line, Food Industry, Healthcare, Plant Safety and Security, Applications of UAVs in Industries		
Total Hours:		**45**
Text Books:		
1	Adrian McEwen and Hackim Cassimally," Designing the Internet of Things" , 1st Edition ,John wiley and Sons Ltd.,UK,2014.	
2	"Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist ,Apress, 2016	

3	Internet of Things: Cyber manufacturing Systems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat ,Springer,2017
Reference Books:	
1	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
2	Manoel Carlos Ramon, "Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers", 1st Edition, Apress, 2014
3	Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things - key applications and Protocols",1st Edition, Wiley,2012.
Web References:	
1	http://www.cisco.com/c/en_in/solutions/internet-of-things/resources.html
2	https://openwsn.atlassian.net/wiki
Online Resources:	
1	http://iot.ieee.org/newsletter/january-2016/hypercat-resource-discovery-on-the-internet-of-things.html
2	https://www.coursera.org/specializations/Internet-of-things

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C517.1	Understand	Quiz	2
C517.2	Understand	Quiz	2
C517.3	Understand	Quiz	2
C517.4	Apply	Group Assignment	4
C517.5	Analyze	Simulation Exercise	5
C517.6	Apply	Simulation Exercise	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	10	10	10
Understand	80	40	20	40
Apply	-	50	30	30
Analyse	-		40	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB518	REAL TIME EMBEDDED SYSTEMS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	-

Course Objectives:

1	Learn the architecture and programming of ARM processor.
2	Be familiar with the embedded computing platform design and analysis
3	Be exposed to the basic concepts of real time Operating system
4	Learn the system design techniques and networks for embedded systems

Course Outcomes:
Upon completion of the course, students shall have ability to

C518.1	Describe the architecture and programming of ARM processor	[R]
C518.2	Outline the concepts of embedded systems	[U]
C518.3	Explain the basic concepts of real time Operating system design	[AP]
C518.4	Use the system design techniques to develop software for embedded systems	[A]
C518.5	Differentiate between the general purpose operating system and the real time operating system	[R]
C518.6	Model real-time applications using embedded-system concepts	[A]

Course Contents:

INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS 15

Complex systems and micro processors– Embedded system design process –Design example: Model train controller- Instruction sets preliminaries – ARM Processor – CPU: programming input and output- supervisor mode, exceptions and traps-The CPU Bus-Memory devices and systems–Designing with computing platforms – consumer electronics architecture – platform-level performance analysis – Components for embedded programs-Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

OPERATING SYSTEMS AND SYSTEM DESIGN 15

Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real-time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE.

EMBEDDED SYSTEM DESIGN 15

Design methodologies- Design flows – Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques- Distributed embedded systems – MPSoCs and shared memory multiprocessors. **Case study:**
Data compressor – Alarm Clock – Audio player – Software modem-Digital still camera – Telephone answering machine-Engine control unit – Video accelerator.

Total Hours: 45

Text Books:

1	Marilyn Wolf, “Computers as Components – Principles of Embedded Computing System Design”, Third Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.

Reference Books:

1	Jonathan W.Valvano, “Embedded Microcomputer Systems Real Time Interfacing”, Third Edition Cengage Learning, 2012

2	David. E. Simon, “An Embedded Software Primer”, 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.
3	Raymond J.A. Buhr, Donald L.Bailey, “An Introduction to Real-Time Systems-From Design to Networking with C/C++”, Prentice Hall, 1999.
4	C.M. Krishna, Kang G. Shin, “Real-Time Systems”, International Editions, Mc Graw Hill 1997
5	K.V.K.K.Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, Dream Tech Press, 2005.
6	Sriram V Iyer, Pankaj Gupta, “Embedded Real Time Systems Programming”, Tata Mc Graw Hill, 2004
Web References:	
1	*https://onlinecourses.nptel.ac.in/noc17_cs05/*
2	*https://www.udemy.com/topic/embedded-systems*
Online Resources:	
1	https://in.udacity.com/course/embedded-systems--ud169
2	*https://www.coursera.org/courses?query=embedded%20systems*
3	*https://www.coursera.org/learn/real-time-systems*

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C518.1	Remember	Classroom or Online Quiz	4
C518.2	Understand	Class Presentation/Power point presentation	6
C518.3	Apply	Group Assignment	5
C518.4	Analyse	Tutorial	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	40	40	40	30
Analyse	10	10	10	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PB519	RESEARCH METHODOLOGY AND IPR	3/0/0/3
Course Objectives:		
1	To impart knowledge of handling data for carrying out research work effectively.	
2	To impart the ability to use optimization technique for problem solving.	
3	To impart decision making skills using statistical tool.	
4	To impart report writing skills.	
5	To impart knowledge about the procedure for filing patent and protecting intellectual properties right.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C519.1	Understand the fundamental search concepts and data collection methods for conducting research work.	[U]
C519.2	Experiment the test hypothesis and analyze the outcome.	[A]
C519.3	Report the research work and write research proposals for various funding agencies.	[Ap]
C519.4	Analyze the procedure for patent rights, licensing and transfer of technology.	[A]

Course Contents:

FUNDAMENTALS AND DATA COLLECTION **15**

Research methodology - definition, objectives, mathematical tools for analysis, Research design. Types of research, exploratory research, conclusive research, modelling research, algorithmic research, Research process- steps. Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. **HYPOTHESES TESTING AND ANALYSIS:** Hypotheses testing – Testing of hypotheses concerning means, concerning variance – one tailed Chi-square test. Introduction to Discriminant analysis, Factor analysis, cluster analysis, multidimensional scaling, conjoint analysis. **OPTIMIZATION TOOLS:** Introduction about Taguchi, Artificial Neural Network, Grey Relationship Analysis, Design of Experiment, Life cycle Assessment.

REPORT WRITING AND PRESENTATION **15**

Report writing- Types of report, guidelines to review report, report format, typing instructions, oral presentation, power point presentation, Data analysis using excel sheet, Proposal submission for funding agencies. Plagiarism, tools to avoid plagiarism, research ethics. Case study: (Use software) report format, Prepare review paper, Reference formation end note, Grammar verification. **PATENT RIGHTS:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. 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.

NATURE OF INTELLECTUAL PROPERTY **15**

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.

	Total Hours:	**45**

Text Books:

1	Ranjith Kumar, Research Methodology, SAGE publication, 2018.
2	Robert Coe, Michael Waring, Larry V Hadges, James Aruthur, Research Method and Methodology in Education, SAGE Publication, 2017.

3	Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
Reference Books:	
1	Dahlia K. Remler, Gregg G. Van Ryzin, Research Methods in Practice (Strategies for Description and Causation),SAGE Publication, 2015.
2	Uwe Flick, Introducing Research Methodology-A Beginer, SAGE, 2015.
3	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.
Web References:	
1	https://nptel.ac.in/courses/109103024/40
2	https://nptel.ac.in/syllabus/107108011/
3	http://textofvideo.nptel.ac.in/121106007/lec26.pdf
Online Resources:	
1	https://www.wipo.int/edocs/pubdocs/en/intproperty/958/wipo_pub_958_3.pdf
2	https://www.isical.ac.in/~palash/research-methodology/RM-lec9.pdf

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C519.1	Understand	Assignment	5
C519.2	Analyze	Quiz	5
C519.3	Apply	Case studies	5
C519.4	Analyze	Case studies	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	50	40	40	40
Understand	40	20	20	20
Apply	10	20	20	20
Analyze	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

19PF502	COMPUTER VISION	3/0/0/3
Nature of Course:	D (Theory application)	

Course Objectives:

1	To focus on development of algorithms and techniques to analyze and interpret the visible world around us.
2	To understand the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis, stochastic optimization etc.
3	To explore and contribute to research and further developments in the field of computer vision.

Course Outcomes :

Upon completion of the course, students shall have ability to

C502.1	Develop algorithms and techniques to analyze and interpret the visible world around us.	[U]
C502.2	Demonstrate multi-dimensional signal processing, feature extraction, pattern analysis, stochastic optimization techniques.	[AP]
C502.3	Design and explore research and further developments in the field of computer vision.	[AP]
C502.4	Analyze a problem and assess the strengths and weaknesses of different methods and techniques for solving it.	[AP]

Course Contents:

DIGITAL IMAGE FORMATION AND LOW-LEVEL PROCESSING **15**

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. Depth estimation and Multi-camera views - Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel. Feature Extraction - Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

IMAGE SEGMENTATION **15**

Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection. Pattern Analysis - Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

MOTION ANALYSIS **15**

Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Shape from X - Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Total Hours	**45**

Text Books:

1	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag

	London Limited 2011.
2	Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

Reference Books:

1	Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2	K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3	R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Web References:

1. IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
2. IJCV (International Journal of Computer Vision) - Springer.

Online References:

1.	16-385 - Computer Vision, Spring 2018 (Instructor: Ioannis Gkioulekas)
2.	16-385 - Computer Vision, Spring 2017 (Instructor: Kris Kitani)

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C502.1	Understand	Online Quiz	5
C502.2	Understand	Assignment	5
C502.3	Apply	Group Assignment	5
C502.4	Apply	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination (50 Marks)
	CIA1 (10 marks)	CIA2 (10marks)	CIA3 (10marks)	
Remember	-	-	-	-
Understand	80	60	60	60
Apply	20	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100