SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF

ELECTRONICS & COMMUNICATION ENGINEERING

CURRICULUM

DESIGNED FOR M.E APPLIED ELECTRONICS

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 - V

CURRICULUM AND SYLLABI

M.E. APPLIED ELECTRONICS

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
		Algorithm for VLSI Design Automation	3	3	3	2	2	1	1				2	2
		Signal Processing Lab	3	3	3	2	3	1	1				2	2
		Audit Course I						1	1	3	2	3	2	
	II	Digital System Design and Testing	3	2	2	1	1	1	1				2	3
		Embedded Controller and Applications	3	3	3	2	1	1	1				2	2
		Power and Nano Electronic Devices	3	3	3	1		1	1				1	1
		Embedded Controller Lab	3	3	3	2	3	1	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	Virtual Instrumentation Systems	3	3	3	3	2	1	1				2	1
		Robotics Technology and Intelligence	3	3	2	2	1	1	1				1	1
		Electromagnetic Interference and Compatability	3	3	2	2	1	1	1				1	1
		Pattern Classification	3	3	2	2	1	1	1				1	1
		System on Chip	3	3	2	3	1	1	1				1	1
		Electronic Product Design	3	3	3	2		1	1				1	1
		Sensor, Actuators and Interface Electronics	3	3	3	2	1	1	1				1	1
		Signal Integrity for High Speed Design	3	3	2	2	1	1	1				1	1
		Non Linear Control System	3	2	3	2	1	1	1				2	2

		Embedded C	3	3	2	2	1	1	1				2	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 Applied Electronics

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	19PA101	Algorithm for VLSI Design Automation	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	19PA201	Digital System Design and Testing	3/0/0	3	3	50/50	PC
2	19PA202	Embedded Controller and Applications	3/0/0	3	3	50/50	PC
3	19PA203	Power and Nano Electronic Devices	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	19PA204	Embedded Controller Lab	0/0/4	4	2	50/50	PC
PROJECT							
7	19PA205	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	19PA301	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	19PA401	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	19PA501	Virtual Instrumentation Systems	3/0/0	3	3	PE
2	19PA502	Robotics Technology and Intelligence	3/0/0	3	3	PE
3	19PA503	Electromagnetic Interference and Compatability	3/0/0	3	3	PE
4	19PA504	Pattern Classification	3/0/0	3	3	PE
5	19PA505	System on Chip	3/0/0	3	3	PE
6	19PA506	Electronic Product Design	3/0/0	3	3	PE
7	19PA507	Sensor, Actuators and Interface Electronics	3/0/0	3	3	PE
8	19PA508	Signal Integrity for High Speed Design	3/0/0	3	3	PE
9	19PA509	Non Linear Control System	3/0/0	3	3	PE
10	19PA510	Embedded C	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
		I	II	III	IV	
1	Program Core	11	11	-	-	22
2	Program Electives	6	6	3	-	15
3	Project Work	-	-	10	16	26
4	Open Elective	-	-	3	-	3
5	Mini Project	-	2	-	-	2
Total		**17**	**19**	**16**	**16**	**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 arises 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

19PA101	ALGORITHM FOR VLSI DESIGN AUTOMATION	3/0/0/3

Nature of Course	G (Theory Analytical)
Pre requisites	VLSI Design

Course Objectives:

1	To design miniaturized VLSI circuits by making extensive use of Computer Aided Design (CAD) VLSI design tool.
2	To understand placement, routing and floor planning .
3	To map the given structural representation into layout representation optimally using computers so that the resulting layout satisfies topological, geometric , timing and power consumption constraints of the design

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Able to understand graph minimization algorithms	[U]
C101.2	Write code for algorithms used for computational and geometrical simplification and minimization using data structures for CAD tools	[AP]
C101.3	Write code for partitioning, floor planning, chip planning and pin assignment	[AP]
C101.4	Able to apply different algorithms used for placement of cells during the physical design of a chip.	[AP]
C101.5	Write code for algorithms used for routing of cells, clock and power supply	[AP]

Course Contents:

GRAPH ALGORITHMS AND COMPUTATIONAL GEOMETRY ALGORITHMS **15**

Graph search Algorithms, Spanning tree Algorithm, Shortest path Algorithm, Matching Algorithm, Min cut and Max cut Algorithms and Steiner Tree Algorithm, Line sweep method and extended line sweep method.

BASIC DATA STRUCTURES **15**

Linked list of blocks, Bin based method, neighbor pointers and corner stitching. Graph Algorithms for physical design: Classes of graphs in physical design, relationship between graph classes, graph problems, Algorithms for interval graphs and Algorithms for permutations graphs.

PARTITIONING **15**

Group migration Algorithms. Floor planning and Pin assignment: floor planning, chip planning and pin assignment. Placement: Simulated annealing, simulated evolutions, force directed placement, sequence pair technique, Breuer's Algorithm, Terminal propagation Algorithm .**Routing**: Maze routing Algorithms: Lee's Algorithm, Soukup's Algorithm and Hadlock's Algorithm.Single layer routing Algorithms and two layer routing Algorithms. Over the cell routing, Via minimization.

Total Hours:	**45**

Text Books:

1	Naveed Sherwani, "Algorithms for VLSI Physical Design Automation" 3 rd edition, Springer international, Indian Reprint 2005.
2	S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.

Reference Books:

1	Drechsler, R.," Evolutionary Algorithms for VLSI CAD", Kluwer Academic Publishers, Boston, 1998.

2	Hill, D., D. Shugard, J. Fishburn and K. Keutzer," Algorithms and Techniques for VLSI Layout Synthesis", Kluwer Academic Publishers, Boston, 1989.
Web References:	
1	http://cdn.intechopen.com/pdfs-wm/26726.pdf
2	http://www.smdp2vlsi.gov.in/smdp2vlsi/downloads/RS_trends-method-cad1.pdf
3	http://www.vlsiacademy.org/open-source-cad-tools.html
4	https://www.academia.edu/6267437/VLSI_CAD_TOOLS
Online Resources:	
1	http://nptel.ac.in/courses/IIT-MADRAS/CAD_for_VLSI_Design_I
2	https://www.coursera.org/learn/vlsi-cad-logic
3	https://nptel.ac.in/courses/106106088

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	Understand	Class Presentation/Power point presentation	10
C101 .2,3,4,5	Apply	Coding	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	20	20	20
Understand	50	30	30	30
Apply	-	50	50	50
Analyse	-	-	-	-
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

19PA201	DIGITAL SYSTEM DESIGN AND TESTING	3/0/0/3

Nature of Course	J (Problem analytical)
Pre requisites	Digital Electronics

Course Objectives:

1	To design synchronous sequential circuit and realization of ASM.
2	To analyze asynchronous sequential circuit design and the Hazards involved in logic circuits.
3	To learn algorithms for finding different faults and testing for varied fault models.
4	To learn and write VHDL code for various combinational and sequential logic circuits.

Course Outcomes:

Upon completion of the course, students shall have ability to

C201.1	Analyze synchronous sequential logic network and to realize ASM for CSSN.	[AN]
C201.2	Analyze asynchronous sequential logic circuit to understand races and analyzing of various hazards.	[AN]
C201.3	Understand the various fault diagnosis algorithms and create fault models.	[AP]
C201.4	Analyse the logic involved in combinational and sequential logic circuits using VHDL with timing analysis.	[AN]

Course Contents:

SEQUENTIAL CIRCUIT DESIGN AND ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN **15**

Analysis of Clocked Synchronous Sequential Networks (CSSN)-Modeling of CSSN–State Stable Assignment and Reduction–Design of CSSN–Design of Iterative Circuits – ASM Chart – ASM Realization. Analysis of Asynchronous Sequential Circuit (ASC)–Flow Table Reduction–Races in ASC– State Assignment–Problem and the Transition Table–Design of ASC–Static and Dynamic Hazards–Essential Hazards –Designing Vending Machine Controller.

SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES **15**

Designing Synchronous Sequential Circuit using GAL–EPROM–Realization State machine using PLD – FPGA –Xilinx 2000-Xilinx 3000. Fault diagnosis and testability algorithms: Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques – The Compact Algorithm – Practical PLA's – Fault in PLA– Test Generation – Masking Cycle – DFT Schemes – Built-in Self Test.

SYSTEM DESIGN USING VHDL **15**

VHDL Operators –Types of Modelling using VHDL - VHDL Description for Combinational logic Circuits - Serial Adder, Binary Multiplier–Binary Divider – VHDL Description for Sequential logic Circuits Flip Flops – Registers – Counters – Sequential Machine –Design of a Simple Microprocessor.

Total Hours:	**45**

Text Books:

1	Donald G. Givone "Digital principles and Design", Tata McGraw Hill 2017.
2	John M Yarbrough "Digital Logic applications and Design", Thomson Learning, 2006
3	Nripendra N Biswas "Logic Design Theory", Prentice Hall of India, 2005

Reference Books:	
1	Charles H. Roth Jr. “Digital System Design using VHDL”, Thomson Learning, 2008.
2	Navabi.Z, “VHDL Analysis and Modeling of Digital Systems”, McGraw International, 1998.
3	Parag K Lala, “Digital System design using PLD”, BS Publications, 2009.
Web References:	
1	https://www.cse.iitb.ac.in/~supratik/courses/cs226/slides/ch5.pdf
2	https://ceit.aut.ac.ir/~szamani/index_files/.../16_2_asynchronous.ppt
3	https://course.ccs.neu.edu/cs3650/ssl/TEXT-CD/Content/.../VHDL/vhdl-tutorial.pdf
4	www.micc.unifi.it/seidenari/wp-content/uploads/2010/01/vhdl.pdf
Online Resources:	
1	https://www.globalspec.com/reference/58563/203279/8-10-analysis-of-synchronous-sequential-circuits
2	https://www.geeksforgeeks.org/digital-logic-asynchronous-sequential-circuits/
3	www.ee.ncu.edu.tw/~jfli/vlsi21/lecture/ch06.pdf
4	*https://www.tutorialspoint.com/vlsi_design/vlsi_design_vhdl_introduction.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
C201.1,2,4	Analyze	Tutorial	6
C201.3	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	20	20	20	20
Apply	30	20	40	40
Analyse	30	40	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA202	EMBEDDED CONTROLLER AND APPLICATIONS	3/0/0/3

Nature of Course	F (Theory Programming)
Pre requisites	Microprocessor And Its Applications

Course Objectives:

1	Be exposed to the 8051 microcontroller hardware details, addressing modes with its instructions
2	Be familiar the PIC microcontroller hardware details and addressing modes
3	Understand the ARM architecture with their instruction set
4	Gain the knowledge of MASP430 and their exceptions

Course Outcomes:

Upon completion of the course, students shall have ability to

C202.1	Get an insight into the overall landscape and characteristics of 8051 Microcontroller	[U]
C202.2	Explore the 8051 addressing modes and instructions	[U]
C202.3	Ability to write Microcontroller programs	[AP]
C202.4	Understand the hardware details, instructions and Addressing modes of PIC microcontroller	[U]
C202.5	Exposed with ARM processor for Embedded systems	[U]
C202.6	Get an deep insight of MSP430 with fewer applications	[AP]

Course Contents:

8051 ARCHITECTURE **15**

Introduction, 8051 Microcontroller hardware, Input/ Output pins, Ports and Circuits, External memory, counters and timers, serial data Input/Output Interrupts. 8051 addressing modes and instructions, Applications of MCS-51, Atmel 89C51 and 89C2051 microcontrollers. PIC microcontrollers: Overview and features, PIC 16C6X/7X, File Selection Register, PIC reset actions, PIC oscillator connections, PIC memory organization, PIC 16C6X/7X instructions, Addressing modes, I/O ports, Interrupts in PIC 16C61/71

INTRODUCTION TO 16/32 BIT PROCESSOR **15**

ARM architecture, ARM 7, ARM 9, ARM Cortex M3, ARM instruction set, Thumb Instruction set, Exception handling in ARM

MSP430 **15**

The Texas Instruments MSP430: The outside view- Pin out, The inside view, Functional Block Diagram, Memory, Central Processing Unit, Memory mapped input- output, Clock generator, Architecture of the MSP430, Central Processing Unit, Addressing Modes, Constant generator and Emulated instructions, Instruction set. A Simple tour of the MSP 430: Light LEDs in Assembly language, Automatic control: Flashing light by software delay, use of sub routines, flashing light by polling Timer_A

Total Hours:	**45**

Text Books:

1	Kenneth J.Ayala & Dhananjay V.Gadre, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”,Cengage Learning, India Edition, 2nd Edition, 2010.
2	Ajay V Deshmukh, “Microcontrollers Theory and Applications”, Tata McGrawHill, 4th Reprint, 2006.
3	Raj Kamal, “Microcontrollers Architecture programming Interfacing and Systems Design”, Pearson Education, 2nd Edition, 2012.

Reference Books:	
1	John H.Davies, " MSP430 Microcontroller Basics", Elsevier, 1st Edition, 2008.
2	Subrata Goshal, " 8051 Microcontroller Internals, Instruction Programming and Interfacing", Pearson , 2nd Edition, 2014.
3	Manesh K Patel,"The 8051 Microcontroller based Embedded Sytems", Tata McGraw Hill, 2014
Web References:	
1	https://onlinecourses.nptel.ac.in/noc19_ee11/preview
2	https://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers
Online Resources:	
1	ttps://bmsit.ac.in/system/study_materials/documents/000/000/009/original/Microcontrollers_8051_MSP430_Notes_for_IV_Sem_Students.pdf?1477059498
2	http://www.te.kmutnb.ac.th/~ptt/lectures/01_Microprocessors/05_Tutorial_TI/Lecture-1_Reviewed_Short.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
C202 .1, 2, 4, 5	Understand	Class Presentation/Power point presentation	10
C202.3,6	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	10	10	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	10	10	-

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

19PA203	POWER AND NANO ELECTRONIC DEVICES	3/0/0/3

Nature of Course	J (Problem analytical)
Pre requisites	-

Course Objectives:

1	To understand an overview of different types of power semiconductor devices and their switching characteristics.
2	To enhance the knowledge of DC-DC converter to analyse the operation, characteristics and performance parameters of controlled rectifiers with switching activities
3	To understand the operations of Nano MOSFETS and analysis of Geometric scaling systems
4	To analyse single electron transistor for the future applications in MEMS technology

Course Outcomes:

Upon completion of the course, students shall have ability to

C203.1	Recall the concepts of switch realization of power semiconductor	[R]
C203.2	Apply the knowledge of DC-DC converter to design buck & boost	[AP]
C203.3	Understand the operation of advanced power electronic FACTS devices	[U]
C203.4	Apply the concepts of Nano electronic devices and defining the scaling of nano devices	[AP]
C203.5	Analyse the CNFET using single electron transistor and nano wires towards the application in MEMS	[AN]

Course Contents:

POWER ELECTRONIC DEVICES **15**

Switch Realization: Survey of power semiconductor devices, Power diode, SCR, GTO, LASCR, RCT, SITH, BJT, MOSFET, IGBT, Switching losses, driver circuits, protection, cooling, applications of power semiconductor devices, DC-DC converter: Non-isolated dc-dc converters: Buck, boost, buck-boost, Cuk, SEPIC, Zeta in DCM and CCM, Isolated dc-dc converters: Fly back, forward, Cuk, SEPIC, Zeta, half bridge, push-pull and bridge in DCM and CCM, FACTS devices : TCR (Thyristor controlled reactor), TSC (Thyristor switched capacitors), STATCOM (Static synchronous compensator), SSSC(Static series synchronous compensator), UPFC (Unified power flow controller), IPFC (Interline power flow controller).

NANO ELECTRONIC DEVICES **15**

Introduction to Nano electronic Devices, Basic Structure of Nano devices, Nano diode,Tunnel junction and applications of tunneling-Field Emission, Gate-Oxide Tunneling and Hot Electron Effects in nano MOSFETs, Theory of Scanning Tunneling Microscope, Double Barrier Tunneling and the Resonant Tunneling Diode, Scaling of physical systems – Geometric scaling & Electrical system scaling.

THE SINGLE ELECTRON TRANSISTOR **15**

The Single Electron Transistor, Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs

and SETs, Coulomb Blockade in a Nanocapacitor, Molecular SETs and Molecular Electronics, Quantum Computing Using Superconductors-Carbon Nanotubes for Data Processing- Molecular Electronics, **Future applications:** MEMS , robots, random access memory, mass storage devices.	
Total Hours:	**45**
Text Books:	
1	R.S. Ramshaw, "Power Electronics Semiconductor Switches", Champman & Hall Publishers, 5th Edition ,2016.
2	N. Mohan, T. M. Undeland and W.P. Robbins,"Power Electronics, Converter,Application and Design", 4th Edition, John Willey & Sons, 2012.
3	Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, Reprinted 2014
4	Supriyo Datta,"Lessons from Nanoelectronics: A New Perspective on Transport", World Scientific2012
5	Jaap Hoekstra, "Introduction to Nanoelectronic Single-Electron Circuit Design", Pan Stanford Publishing 2010
Reference Books:	
1	Joseph Vithayathil,' Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2013.
2	Daniel.W.Hart, "Power Electronics", Indian Edition, Mc Graw Hill, 3rd Print, 2013.
3	W. Ranier, "Nano Electronics and Information Technology", John Wiley & Sons 2012
4	Korkin, Anatoli; Rosei, Federico (Eds.), "Nanoelectronics and Photonics",Springer 2008
Web References:	
1	https://www.classcentral.com/course/nptel-fundamental-of-power-electronics-12949
2	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/
3	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-701-introduction-to-nanoelectronics-spring-2010/readings/MIT6_701S10_notes.pdf
4	https://www.edx.org/course/fundamentals-nanoelectronics-basic-purduex-nano520x
Online Resources:	
1	https://nptel.ac.in/downloads/108105066/
2	https://nptel.ac.in/courses/108101038/
3	https://nptel.ac.in/courses/117108047/
4	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/

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	Remember	Assignment	4
C203.2	Apply	Problem Solving Assignment	4
C203.3	Understand	Quiz	4
C203.4	Apply	Case study	4
C203.5	Analyse	Technical 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	30	20	20	30
Understand	30	30	20	30
Apply	40	50	40	30
Analyse	-	-	20	10
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA204	EMBEDDED CONTROLLER LABORATORY	0/0/4/2

Nature of Course	: M (Practical application)
Pre-requisites	Fundamentals of microcontrollers Assembly level and C programming

Course Objectives:

1	To understand the IDE tools used for controller programming and debugging.
2	To understand the programming of Real Time Operating Systems
3	To understand the working of LCD, UART, Seven segment display and stepper motor.

Course Outcomes:

Upon completion of the course, students shall have ability to

C204.1	Understand the Keil IDE for programming the microcontroller in different aspects.	[U]
C204.2	Understand the functionalities of timer and counter in microcontrollers	[AN]
C204.3	To know the procedure to interface UART, LCD, Seven segment displays, Motors	[AN]
C204.4	Understand the Task creation, Queue and scheduling methods in RTOS	[AP]

Course Contents:

Sl.**No**	**List of Experiments**	**CO Mapping**	**RBT**
1.	Study of Keil Software	C204.1	[U]
2.	Assembly and High level language programs for 8051 - ports - timers - Seven Segment display – UART – LCD interface	C204.1	[AP]
3.	RTOS – Simple task creation, Round Robin Scheduling, Preemptive scheduling, Semaphores, Mailboxes	C204.2	[AN]
4.	Assembly and High level language programs for R8C-ports-timers-Seven segment display – UART – LCD interface – Stepper Motor control	C204.3	[AN]
5.	Assembly and High level language programs for MSP 430 - ports – timers - Seven Segment display – UART – LCD interface – Stepper Motor control	C204.4	[AP]
6.	Understand the architecture of ARM cortex microcontroller and assembly language programming	C204.4	[AP]
		Total Hours:	**30**

Reference Books:

1	Jonathan W.Valvano,"Embedded Microcomputer Real time systems",Cengage Learning, 3rd Edition, 2011

2	James M. Fiore," Embedded Controllers Using C and Arduino , 2nd Edition, Open Text Book Library,2018
3	J.P.Agarwal, "Microcontroller and Embedded Systems", 2nd Edition, New Academic Sciences, 2016
Web References:	
1	https://onlinecourses.nptel.ac.in/noc19_cs22
2	https://nptel.ac.in/courses/108102045/31
3	http://vlabs.iitkgp.ernet.in/rtes/
Online Resources:	
1	http://staging.isi.org/embedded_system_lab_manual_using_keil.pdf
2	http://lota.sveplant.qdec.madepeople.se/arduino_technology_lab_manual.pdf
3	http://training.splunk.function1.com/msp430_microcontroller_lab_manual_vtu.pdf

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

19PA501	VIRTUAL INSTRUMENTATION SYSTEMS	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre requisites	Measurement and Instrumentation	
Course Objectives:		
1	To introduce the concept of virtual instrumentation	
2	To select proper data acquisition hardware and Configure data acquisition hardware in LabVIEW.	
3	To develop basic VI programs using loops, case structures, etc.	
4	To apply in image, signal processing and motion control.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C501.1	demonstrate the working of LabVIEW and explain the various types of structures used in LabVIEW	[R]
C501.2	analyze and design different type of programs based on data acquisition	[U]
C501.3	demonstrate the use of LabVIEW for signal processing, image processing etc.	[AP]
Course Contents:		
VIRTUAL INSTRUMENTATION OVERVIEW **15** Historical perspective, Block diagram and Architecture of Virtual Instruments. Data-flow Techniques: Graphical programming in data flow, Comparison with conventional programming **VI PROGRAMMING TECHNIQUES** **15** VIs and sub-VIs, Loops and Charts, Arrays, Clusters and graphs, Case and sequence structures, Formula nodes, Local and global variables, Strings and file I/O. Data Acquisition Basics: ADC, DAC, DIO, Counters and timers. **COMMON INSTRUMENTATION INTERFACES** **15** RS232C/ RS485, GPIB, PC Hardware structure, DMA software and hardware installation. Use of Analysis Tools: Advanced analysis tools such as Fourier transforms, Power spectrum, Correlation methods, Windowing and filtering and their applications in signal and image processing, Motion Control.		
	Total Hours:	**45**
Text Books:		
1	Johnson, G., “LabVIEW Graphical Programming”, McGraw Hill (2006)	
2	Sokoloft, L., “Basic Concepts of LabVIEW 4”, Prentice Hall Inc. (2004).	
3	Wells, L.K. and Travis, J., “LabVIEW for Everyone”, Prentice Hall Inc. (1996)	
Reference Books:		
1	Gupta, S. and Gupta, J.P., “PC Interfacing for Data Acquisition and Process Control, Instrument Society of America” (1988).	
2	Olansen Jon B. and Rosow Eric, “Virtual Bio-Instrumentation Biomedical, Clinical, and Healthcare Applications in LabVIEW”, National instrument Virtual instrument series	
3	Paton Barry E. “Sensor,transducer and labview”. Tata McGraw Hill, New Delhi 2012	
Web References:		
1	http://www.ni.com/en-in/innovations/white-papers/06/virtual-	

	instrumentation.html
2	https://peer.asee.org/design-and-development-of-virtual-instrument-vi-modules-for-electrical-power-systems-course.pdf
3	https://www.semanticscholar.org/paper/Design-of-a-Virtual-Instrumentation-System-for-a-Portillo-Cabanes/82ba85ab315a671e5498536f4eca5a4031e29d5c
4	https://www.globalspec.com/reference/67234/203279/chapter-1-introduction-to-virtual-instrumentation
Online Resources:	
1	https://onlinecourses.nptel.ac.in/noc17_ec09/preview
2	https://onlinecourses.nptel.ac.in/noc19_me04/preview
3	https://mindmajix.com/labview/virtual-instrumentation-using-labview
4	https://www.smeclabs.com/labviewtraining.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
C501.1	Remember	Classroom or Online Quiz	4
C501 .2	Understand	Class Presentation/Power point presentation	6
C501.3	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

19PA502	ROBOTICS TECHNOLOGY AND INTELLIGENCE	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Embedded System

Course Objectives:

1	Understand the basic concepts of Robotics and its kinematics
2	Familiarize the concepts and techniques in the design and implementation of Micro/Nano robotics system
3	To gain knowledge in Understanding the basics of artificial intelligence in robotics.
4	To introduce the skill of applying AI concepts in the field of Robotics.

Course Outcomes:

Upon completion of the course, students shall have ability to

C502.1	Ability to understand basic concept of robotics.	[U]
C502.2	Ability to understand the micro and nano robotic system for real time robotic applications	[U]
C502.3	Identify appropriate AI methods to solve a given problem and carry out different algorithms on a problem formalisation	[AP]

Course Contents:

OVERVIEW OF ROBOTS **15**

Basic components of robot-Laws of robotics- classification and application of robots -work space- accuracy-resolution –repeatability of robot. Rotary to rotary motion, Rotary to linear motion, Harmonics drives. Robot kinematics: Introduction- Matrix representation- Rigid motion & homogeneous transformation- forward & inverse kinematics (DH – Parameter) - trajectory planning.

MICRO/NANO ROBOTICS SYSTEM **15**

Micro/Nano robotics system overview-Scaling effect-Top down and bottom up approach-Actuators of Micro/Nano robotics system-Nanorobot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nanorobot in targeted drug delivery system.

AI IN ROBOTICS **15**

History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. PROBLEM SOLVING: Solving problems by searching –Informed search and exploration–Constraint satisfaction problems–Adversarial search, knowledge and reasoning– knowledge representation – first order logic. Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

Total Hours:	**45**

Text Books:

1	King Sun Fu, Rafael C. González, C. S. George Lee, “Robotics: control, sensing, vision, and intelligence”, Tata Mcgraw-Hill Publication, 2014.
2	Julian W. Gardner., “Micro sensor MEMS and Smart Devices”, John Wiley & Sons, 2016
3	Russell Stuart, Norvig Peter, “Artificial Intelligence Modern Approach”, CreateSpace Independent Publishing Platform, 2016.

Reference Books:

1	Saeed B. Niku, “Introduction to Robotics: Analysis, Systems, Applications”, 2nd edition, Pearson Education India, 2011.
2	Negnevitsky, M, “Artificial Intelligence: A guide to Intelligent Systems”,. Harlow: Addison-Wesley, 2002.
3	David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 1992.
Web References:	
1	http://www.cs.cornell.edu/courses/cs4750/2017fa/syllabus/
2	http://nptel.ac.in/courses/112101099/
3	http://www.robotbooks.com/general-robotics-links.html
4	https://nptel.ac.in/courses/112101098/21
Online Resources:	
1	https://www.edx.org/course/robotics-columbiax-csmm-103x
2	https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/lecture-notes/
3	https://robohub.org/robots-micro-and-nano-robotics/
4	http://www.ieee-ras.org/micro-nano-robotics-and-automation

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	Group assignment	5
C503.3	Apply	Mini project	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	10	20	10
Understand	70	60	20	50
Apply	10	20	60	30
Analyse	-	10	-	10
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA503	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Electro Magnetic Fields

Course Objectives:

1	To understand the basics of EMI and its coupling methods
2	To study the principle of various EMI control techniques
3	To develop solution methods of EMI in PCB
4	To analyse the concept of cable routing and controlling of signals in EMC
5	To analyse the Measurement technique for emission

Course Outcomes:

Upon completion of the course, students shall have ability to

C503.1	Understand the basic concepts of EMI/EMC and various EMI coupling methods.	[U]
C503.2	Understand the principles of EMI control techniques	[U]
C503.3	Design the solution methods in PCB	[AP]
C503.4	Analyse the concept of cable routing and controlling of signals in EMC	[AN]
C503.5	Analyse the EMI measurements, standards and specifications.	[AN]

Course Contents:

EMI/EMC CONCEPTS AND COUPLING PRINCIPLES **15**

EMI-EMC definitions and Units of parameters; Sources and victim of EMI; Conducted and Radiated EMI Emission and Susceptibility; Transient EMI, ESD; Radiation Hazards. Conducted, radiated and transient coupling; Common ground impedance coupling; Common mode and ground loop coupling; Differential mode coupling; Near field cable to cable coupling,cross talk; Field to cable coupling; Power mains and Power supply coupling.

EMI CONTROL TECHNIQUES AND ITS DESIGN **15**

Shielding- Shielding Material-Shielding integrity at discontinuities, Filtering- Characteristics of Filters-Impedance and Lumped element filters-Telephone line filter, Power line filter design, Filter installation and Evaluation, Grounding- Measurement of Ground resistance-system grounding for EMI/EMC-Cable shielded grounding, Bonding, Isolation transformer, Transient suppressors, Cable routing, Signal control. EMI gaskets.EMI Suppression Cables-Absorptive, ribbon cables-Devices-Transient protection hybrid circuits, Component selection and mounting; PCB trace impedance; Routing; Cross talk control- Electromagnetic Pulse-Noise from relays and switches, Power distribution decoupling; Zoning;Grounding; VIAs connection; Terminations.

EMI MEASUREMENTS AND STANDARDS **15**

Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Transmitter /Receiver Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Receiver and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN, BSI, AS/NZS, CENELEC, ACEC; Military standards-MIL461E/462. Frequency assignment - spectrum conversation. British VDE standards, Euro norms standards in Japan - comparisons. EN Emission and Susceptibility standards and Specifications

Total Hours: 45

Text Books:

1	V.P.Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press, Newyork, 1996.
2	Clayton R.Paul,” Introduction to Electromagnetic Compatibility”, John Wiley

	Publications, 2008
3	Henry W.Ott.,"Noise Reduction Techniques in Electronic Systems", A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988.
Reference Books:	
1	Bemhard Keiser, "Principles of Electromagnetic Compatibility", Artech house, Norwood, 3rd Ed, 1986.
2	Don R.J.White Consultant Incorporate, "Handbook of EMI/EMC", Vol I-V, 1988.
3	Xingcun Colin Tong, "Advanced Materials and Design for Electromagnetic Interference Shielding", Tylor and Francis Group, CRC Press, 2016
Web References:	
1	http://www.nasa.gov/centers/johnson/pdf/639521main_EMI-EMC_User_Test_ Planning_ Guide.pdf
2	http://www.cvel.clemson.edu/emc/
3	http://www.users.ece.gatech.edu/mleach/ece4391/set1ab.pdf
Online Resources:	
1	http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Guidance Documents/ucm077210.htm
2	http://www.fda.gov/RadiationEmittingProducts/RadiationSafety/Electromagneti c Compatibility EMC/ucm116566.htm
3	https://www.techopedia.com/definition/1738/electromagnetic-interference-emi

Assessment Methods & Levels (based on Blooms Taxonomy)

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

Course Outcome	Bloom's Level	Assessment Component	Marks
C503.1,2	Understand	Classroom or Online Quiz	4
C503.3	Apply	Class Presentation/Power point presentation	6
C503.4,5	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	40	20	-	10
Understand	60	60	20	30
Apply	-	20	40	30
Analyse	-	-	40	30
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA504	PATTERN CLASSIFICATION	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Linear algebra & Random Process

Course Objectives:

1	Understand basic concepts in pattern recognition
2	Gain knowledge about state-of-the-art algorithms used in pattern recognition research
3	Understand pattern recognition theories, such as Bayes classifier, linear Discriminant analysis
4	Apply pattern recognition techniques in practical problems

Course Outcomes:

Upon completion of the course, students shall have ability to

C504.1	Explain and compare a variety of basic functions along with its uses, pattern classification and pattern recognition, pattern classifier and combination techniques.	[U]
C504.2	Summarize, analyze, and relate the techniques to research in the pattern recognition area verbally and in writing.	[R]
C504.3	Apply performance evaluation methods and pattern recognition techniques for pattern recognition and real-world problems such as document analysis and recognition.	[AP]

Course Contents:

LINEAR ALGEBRA & BAYES DECISION THEORY **15**

Linear Algebra: Inner product, outer product, inverses, Eigen values & vectors, Singular values & vectors. Bayes Decision Theory: Minimum error rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and Discriminant functions. Discrete features.

PARAMETER ESTIMATION AND REDUCTION **15**

Parameter Estimation Methods: Maximum-Likelihood Estimation: Gaussian case. Maximum Posteriori estimation. Bayesian estimation: Gaussian case. Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Nonparametric techniques for density estimation. Parzen-window method. K-Nearest Neighbour method. Dimensionality reduction: Principal component analysis - relationship to Eigen analysis. Fisher Discriminant analysis - Generalised Eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis.

NEURAL NETWORKS & PATTERN CLASSIFICATION **15**

Artificial neural networks: Multilayer perception – feed forward neural network. A brief introduction to deep neural networks, convolution neural networks, recurrent neural networks. Non-metric methods for pattern classification: Non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART).

Total Hours:	**45**

Text Books:

1	R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
2	S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3	C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Reference Books:	
1	T.M. Mitchell, Machine learning, Mc Graw-Hill, New York, 1997.
2	Sergios T and Konstantinos K, Pattern Recognition, 4th edition, Academic Press, 2008.
Web References:	
1	https://nptel.ac.in/downloads/117108048/
2	https://nptel.ac.in/courses/117105101/
3	https://nptel.ac.in/downloads/106108057/
Online Resources:	
1	https://www.coursera.org/learn/data-patterns
2	https://www.coursera.org/lecture/machine-learning/classification-wlPeP
3	https://www.coursera.org/learn/machine-learning

Assessment Methods & Levels (based on Blooms Taxonomy)

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

Course Outcome	Bloom's Level	Assessment Component	Marks
C 504.1	Understand	Class Presentation/Power point presentation	5
C504.2	Remember	Technical Quiz	5
C504.3	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	15	15	15	15
Understand	35	35	35	35
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA505	SYSTEM ON CHIP	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Microprocessor and Microcontrollers, Embedded systems, C and C++ Programming Languages	
Course Objectives:		
1	To learn the principles of SOC design methodology and system-level design of complex SOC	
2	To study the principles of software modelling and hardware implementation	
3	To design advanced processors in system-on-chip	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C505.1	Differentiate circuit-level and system-level designs and frame design methodology for any complex SOC module	[R]
C505.2	Understand the software and hardware approaches for configurable processors	[U]
C505.3	Learn some of the techniques for design validation and testing of SOC	[AP]
Course Contents:		
SOC DESIGN METHODOLOGY **15** SOC Design Flow, Major Issues in SOC Design, Accelerating Processors for Traditional Software Tasks, System Design with Multiple Processors, Complex SOC System Architecture, Processor-Centric SOC Organization: ARM 7. **CONFIGURABLE PROCESSOR DESIGN** **15** Software Approach- Introduction to SystemC, Processor Hardware and Software Cogeneration, Process of Instruction Definition and Application Tuning, The Basics of Instruction Extension, Programmer's Model, Processor Performance Factors Hardware Approach -Introduction to Configurable Processors, Introduction to Pipelines and Processors, Hardware Blocks to Processors, Designing the Processor Interface **DESIGN VALIDATION AND TESTING** **15** Core level validation –Test benches-SoC design validation –Cosimulation–Hardware/software Co-verification, SoC Test issues –Testing of digital logic cores.		
	Total Hours:	**45**
Text Books:		
1	Wayne Wolf, "Modern VLSI Design – System – on – Chip Design", Prentice Hall, 3rd Edition2008	
2	S. Furber, ARM System-on-Chip Architecture, Second Edition, AW, 2000.	
3	C. Rowen, Engineering the Complex SOC: Fast, Flexible Design with Configurable Processors, Prentice Hall, 2004.	
4	RochitRajsuman, "System-on-a-chip: Design and Test", Artech House, London, 2000	
Reference Books:		
1	M. Keating, R. J. Rickford and P. Bricaud, Reuse Methodology Manual for System-on-a- Chip Designs, Third Edition, Springer, 2006.	
2	D. Black, J. Donovan, SystemC: From the Ground Up, Springer, 2004.	
3	D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, Embedded System Design:	

	Modeling, Synthesis, Verification, Springer, 2009.
Web References:	
1	http://electro.fisica.unlp.edu.ar/arq/downloads/Papers/ARM/Addison%20Wesley%20-%20ARM%20System-on-Chip%20Architecture,%202Ed.pdf
2	http://cs.anu.edu.au/courses/ENGN3213/lectures/lectures16_17_ARM.pdf
3	http://www.cc.gatech.edu/~hyesoon/spr10/lec_arm.pdf
4	http://freevideolectures.com/Course/2341/Embedded-Systems/10
Online Resources:	
1	https://nptel.ac.in/courses/108102045/10
2	http://www.digimat.in/nptel/courses/video/108102045/L25.html
3	https://www.coursera.org/lecture/real-time-cyber-threat-detection/design-of-a-soc-7SMBP

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	Remember	Online Quiz	5
C505 .2	Understand	Seminar	5
C505.3	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	40	50	50
Apply	-	60	50	20
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA506	ELETRONIC PRODUCT DESIGN	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Electron Devices

Course Objectives:

1	Understand various aspects of development process
2	An ability to select and apply different packaging for product development
3	Learn about the various methodology for design process
4	Use various statistical process for system design
5	To impart knowledge on various electronic devices

Course Outcomes:

Upon completion of the course, students shall have ability to

C506.1	Understand the basics of product development and design concepts	[U]
C506.2	Study the different system design techniques	[R]
C506.3	Analyse the different packaging and metrics used for product development	[A]
C506.4	To analyse thermal issue and technique for thermal management for product design	[A]
C506.5	Study of portable electronic design	[R]

Course Contents:

ELECTRONIC PRODUCT DESIGN INTRODUCTION **15**

The basic product development process-product lifecycle -product planning-design and engineering-procurement-manufacturing -functionality-performance-user interface-form factor-battery life-cost-time to market (TTM)-reliability-marketing and distribution-service and support. System Design: Top down design-product concept-innovation-creativity-validation - communication-product requirements-physical and mechanical design-Tolerance and reliability.

ELECTRONIC PACKAGING **15**

IC packaging: Leaded package, TABITCP package-COB, flip-chip, BGA, CSP-Discrete components-Board to board connectors-substrates- PCA/module design metrics- I/O hardware : buttons, switches, dials and touch screens, speakers , microphones, antennas, and external connectors. Mechanical Design : Housings-EMI shielding-Thermal management: High level thermal analysis - DFMA analysis.

QUALITY IN THE DESIGN PROCESS **15**

Quality control -quality assurance-quality functional deployment-assignment matrices-checklist-quality in the design process-concurrent design-risk analysis-quality in production, Rapid prototyping- concept, advantages, Rapid prototyping processes. Portable Electronics : analog devices, sensors, wireless communication, system memory and mass storage-Displays: Display technologies-LCD- input-power sources-Battery technologies: photovoltaic cells, fuel cells-product implementation-high level power analysis-Case study: Cellular phones-portable PCs-Personal digital assistants-digital imaging products.

Total Hours:	**45**

Text Books:

1	Bert Haskell, " Portable Electronics Product Design and Development: For Cellular Phones, PDAs, Digital Cameras, Personal Electronics and More", McGraw-HILL, 2010

2	Tony Ward and James Angus, ”Electronic Product Design”, Chapman and Hall publications,1996
3	V.S.Bagad,” Electronic product design”, Technical Publications, 2009
Reference Books:	
1	Marc Annacchino.” The Pursuit of New Product Development: The Business Development Process”, Elsvier,2007.
2	Clive L.Dym, Patrick Little, “Engineering Design: A Project-based Introduction”, 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
3	Mandar J. Khurjekar. “Electronic Product Design”, Chinttan Publications, First Edition, 2012.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc17_me16/preview
2	https://onlinecourses.nptel.ac.in/noc18_de02/preview
3	https://www.kemi.se/en/prio-start/chemicals-in-practical-use/product-design-and-development
4	http://www.ulrich-eppinger.net/
Online Resources:	
1	https://www.centennialcollege.ca/programs-courses/full-time/product-design-and-development/
2	https://nptel.ac.in/courses/112107217/4
3	https://www.slideshare.net/QRCE/product-design-development
4	https://nptel.ac.in/downloads/112107217/

Assessment Methods & Levels (based on Blooms Taxonomy)

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

Course Outcome	Bloom’s Level	Assessment Component	Marks
C506.2,5	Remember	Classroom or Online Quiz	4
C506.1	Understand	Class Presentation/Power point presentation	6
C506.1,3	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	50	20	30	20
Understand	30	50	30	30
Apply	20			20
Analyse		30	20	30
Evaluate				
Create				

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

19PA507	SENSOR,ACTUATORS AND INTERFACE ELECTRONICS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	18EC201 Electronic Devices

Course Objectives:

1	Understand static and dynamic characteristics of measurement systems
2	Study various types of sensors.
3	Study different types of actuators and their usage.
4	Study State-of-the-art digital and semiconductor sensors.

Course Outcomes:

Upon completion of the course, students shall have ability to

C507.1	Define units and standards, their conversions, characteristics and error analysis of measurement systems	[U]
C507.2	Understand the fundamental physical and technical base of sensors and actuators.	[U]
C507.3	Evaluate Resistive and Reactive sensors.	[AP]
C507.4	Discuss Self-generating sensors.	[AP]
C507.5	Compare Actuators.	[AP]
C507.6	Apply the concepts of sensors and actuators to interface the peripherals	[AP]

Course Contents:

INTRODUCTION TO MEASUREMENT SYSTEMS **15**

Measurement systems, sensor classification, general input-output configuration, static characteristics of measurement systems: accuracy, precision, sensitivity, other characteristics: linearity, resolution, systematic errors, random errors, dynamic characteristics of measurement systems: zero-order, first-order, and second-order measurement systems and response.

RESISTIVE,REACTIVE SENSORS AND SELF-GENERATING SENSORS **15**

Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light-dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.

ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS **15**

Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, Hydraulic actuators, variable transformers: synchros, resolvers, Inductosyn resolver-to-digital and digital-to-resolver converters. Digital sensors: position encoders, Resonant Sensors, Sensors based on semiconductor junctions, sensors based on MOSFET transistors, CCD imaging sensors , ultrasonic sensors, fiber-optic sensors.

Total Hours: **45**

Text Books:

1	Pallas-Areny Ramon, John G. Webster. Sensors and signal conditioning. New York: Wiley, 2001.

2	De Silva, Clarence W. Sensors and actuators: Engineering system instrumentation. CRC Press, 2015.
3	Ripka, Pavel, Alois Tipek, eds. Modern sensors handbook. John Wiley & Sons, 2013.
Reference Books:	
1	Tumanski, Slawomir. Handbook of magnetic measurements. CRC Press, 2016.
2	Ian Sinclair, Sensors and Transducers, Elsevier, 3rd Edition, 2011.
3	Andrzej M. Pawlak Sensors and Actuators in Mechatronics Design and Applications, 2006.
Web References:	
1	https://www.elsevier.com/journals/sensors-and-actuators-b-chemical/0925-4005/guide-for-authors
2	https://www.sciencedirect.com/journal/sensors-and-actuators-a-physical
3	http://technav.ieee.org/tag/1527/sensors-and-actuators
Online Resources:	
1	https://www.imt.kit.edu/lectures_321.php
2	https://nptel.ac.in/courses/112103174/3
3	https://www.mdpi.com/journal/jsan
4	http://web.eecs.umich.edu/~jfr/embeddedctrls/files

Assessment Methods & Levels (based on Blooms Taxonomy)

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

Course Outcome	Bloom's Level	Assessment Component	Marks
C507.1	Understand	Classroom or Online Quiz	4
C507 .2	Apply	Class Presentation/Power point presentation	6
C507.3,4,5,6	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	20	20	20
Understand	60	40	30	30
Apply	-	40	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA508	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre requisites	Electromagnetic & Transmission Lines and networks	

Course Objectives:

1	To Understand the fundamentals of signal integrity concepts
2	Recall the Electromagnetic theory and Transmission Line Fundamentals needed for signal integrity.
3	To Understand the multi conductor transmission lines and design parameters that affect signal integrity including reflections, attenuation, and crosstalk
4	To Understand the power considerations and timing design
5	To Understand the clock distribution and oscillators

Course Outcomes:

Upon completion of the course, students shall have ability to

C508.1	Understand the fundamentals of signal integrity concepts	[U]
C508.2	Apply the knowledge of multi conductor transmission lines to improve the signal integrity	[AP]
C508.3	Analysis sources that affecting the speed of digital circuits	[AN]
C508.4	Understand the power considerations and timing design	[U]
C508.5	Understand the clock distribution and oscillators	[U]

Course Contents:

SIGNAL PROPAGATION ON TRANSMISSION LINES **15**

Signal Integrity – Importance of Signal Integrity – Electromagnetic Fundamentals – Maxwell's Equation, Wave propagation, Electrostatics, Magnetostatics, Reflections of Electro Magnetic Waves – Transmission Line Fundamentals – Infinite uniform transmission line, Effects of source and load impedance, Special transmission line cases, Line impedance and propagation delay -terminations –per UNIT- length parameters, PCB layer stackups, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline - Reflection and terminations, input impedance, skin-effect.

MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK **15**

Multi-conductor transmission-lines, coupling physics, per UNIT- length parameters - Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) - Differential signaling, termination, balanced transmission lines, S-parameters, Lossy and Lossless models, Non-ideal signal return paths– gaps, via transitions, Parasitic inductance and capacitance, Transmission line losses - Common-mode current, differential-mode current – Connectors.

POWER CONSIDERATIONS AND CLOCK DISTRIBUTION **15**

SSN/SSO, SMT decoupling, Power consumption and system power delivery, Logic families and speed Package types and parasitic, SPICE, IBIS models, Eye diagrams , jitter, inter-symbol interference Bit-error rate ,Timing analysis. **CLOCK OSCILLATORS** :Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, cancelling parasitic capacitance, Clock jitter.

Total Hours: **45**

Text Books:

1	Stephen H.Hall, Howard L.Heck, "Advanced Signal Integrity for High Speed Design", Wiley- IEEE Press, 2009.
2	Hanqiao Zhang," High Speed Digital Design: Design of High Speed Interconnects and Signaling", Morgan Kaufmann, ISBN-13: 978-0124186637,

	2015
3	Clayton R.Paul, “Analysis of Multiconductor Transmission Lines”, John Wiley & Sons, 2008
Reference Books:	
1	Stephen C.Thierauf,”Understanding Signal Integrity”,Artech House,USA,2011.
2	H. W. Johnson and M. Graham, “High-Speed Digital Design: A Handbook of Black Magic”, Prentice Hall, 2008.
3	Douglas Brooks, ”Signal Integrity Issues and Printed Circuit Board Design”, Prentice Hall PTR, 2003.
Web References:	
1	https://nptel.ac.in/noc/individual_course.php?id=noc17-ee18
2	https://www.udemy.com/vlsi-academy-crosstalk/
3	https://ep.jhu.edu/programs-and-courses/525.634-high-speed-digital-design-and-signal-integrity
4	https://www.besserassociates.com/Courses/Course-Description/CTID/243
Online Resources:	
1	https://www.oreilly.com/library/view/pcb-signal-integrity/9780133548563/1_1.html
2	https://www.ucsc-extension.edu/certificate-program/offering/jitter-essentials
3	https://www.intel.com/content/dam/www/programmable/us/en/pdfs/literature/wp/wp_sgnlntgry.pdf
4	https://ieeexplore.ieee.org/document/5716113

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	Online Quiz	5
C508.2	Apply	Class Presentation/Power point presentation	5
C508.3	Analyse	Group Assignment	5
C508.4,5	Understand	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	20	-	30	20
Understand	50	20	50	40
Apply	30	30	20	20
Analyse	-	50	-	20
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA509	NON-LINEAR CONTROL SYSTEM	3/0/0/3
Nature of Course	J (Problem analytical)	
Pre requisites	Linear Control Systems	
Course Objectives:		
1	To impart knowledge on phase plane analysis of non-linear systems.	
2	To impart knowledge on Describing function based approach to non-linear systems	
3	To educate on stability analysis of systems using Lyapunov's theory.	
4	To introduce the concept of sliding mode control.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C509.1	Demonstrate the knowledge of the effects of non-linearities on the operation of control systems and applying the describing function method to nonlinear feedback systems.	[AP]
C509.2	Understand the concepts behind Nonlinear Systems and Equilibrium Points	[U]
C509.3	Understand the methods for reducing nonlinear effects in control systems and feedback linearization and to simulate the sliding mode controller	[A]

Course Contents:

PHASE PLANE ANALYSIS **15**

Concepts of phase plane analysis- -Phase plane Analysis of Linear and Nonlinear Systems-Simulation of phase portraits in mat lab. Describing Function Fundamentals-Definitions - Assumptions-Computing Describing Functions-Common Nonlinearities and its Describing Functions - Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles. Simulation of limit cycles in matlab.

LYAPUNOV THEORY **15**

Nonlinear Systems and Equilibrium Points - Concepts of Stability-Linearization and Local Stability - Lyapunov's Direct Method - Positive definite Functions and Lyapunov Functions - Equilibrium Point Theorems - Invariant Set Theorems - LTI System Analysis based on Lyapunov's Direct Method - Krasovski's Method - Variable Gradient Method – Physically motivated lyapunov functions – Control Design based on Lyapunov's Direct Method. Concepts of stability for non autonomous systems,Lyapunov analysis of non autonomous systems, Barbalat's Lemma and stability analysis, Positive real systems: PR and SPR Transfer functions.

FEEDBACK LINEARIZATION **15**

Feedback Linearization and the Canonical Form - Mathematical Tools – Input - State Linearization of SISO Systems – input Output Linearization of SISO Systems -. Multi input systems Sliding Control -Sliding Surfaces - Filippov's construction of the equivalent dynamics, direct implementations of switching control laws, Continuous approximations of switching control laws, modeling and performance trade offs Lie derivative, Lie Bracket, Back stepping method for non-feedback linearizable systems.

Total Hours:	**45**

Text Books:

1	Jean- Jacques Slotine and Weiping Li, Applied nonlinear Control, Prentice Hall,1991, ISBN: 0-13-040890

2	H.K. Khalil, Nonlinear Systems, 3rd ed., Prentice hall, 2002.
3	D. Elliott, Bilinear Systems, Springer, 2009.
Reference Books:	
1	J A E Slotine and W Li, Applied Nonlinear control, PHI, 1991.
3	S H Zak, "Systems and control", Oxford University Press, 2003.
4	Torkel Glad and Lennart Ljung, "Control Theory –Multivariable and Nonlinear Methods", Taylor & Francis, 2002.
5	G. J. Thaler, "Automatic control systems", Jaico publishers, 1993
6	Felix L. Chernousko, Igor M.Ananievski, Sergey A.Reshmin, "Control of Nonlinear Dynamical Systems Methods and Applications, Springer, First Indian Reprint 2013.
Web References:	
1	http://web.mit.edu/nsl/www/videos/lectures.html
2	http://www.nptel.ac.in/courses/108106024/
3	http://freevideolectures.com/Course/2348/Intelligent-Systems-and-Control/5
Online Resources:	
1	http://web.stanford.edu/class/engr209a/
2	http://www.ioe.nchu.edu.tw/Pic/CourseItem/4497_APPLIED%20NONLINEAR%20CONTROL_slotine_Part1.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	Remember	Classroom or Online Quiz	4
C509.2	Understand	Class Presentation/Power point presentation	6
C509.3	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
Understand	30	30	30	30
Apply	50	50	50	20
Analyse	-	20	20	30
Evaluate	-	-	-	-
Create	-	-	-	-

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

19PA510	EMBEDDED C	3/0/0/3

Nature of Course	F (Theory Programming)
Pre requisites	Fundamentals of Computing & C programming

Course Objectives:

1	To study essential embedded language features required for embedded systems programming.
2	To study pointers and arrays, bit manipulation, register usage.
3	To study real-time constraints to common embedded hardware and software problems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C510.1	Write code using C language for the given task and Select hardware and Software modules depending on the requirement.	[AP]
C510.2	Apply structures concepts to the codes.	[AP]
C510.3	Analyze and run various embedded applications**.**	[AN]

Course Contents:

INTRODUCTION AND READING SWITCHES **15**

Introduction to Embedded C, Interfacing C with Assembly. Embedded programming issues - Reentrancy, Portability, Optimizing and testing embedded C programs. Introduction - Basic techniques for reading from port pins - Example: Reading and writing bytes - Example: Reading and writing bits (simple version) -Example: Reading and writing bits (generic version) - the need for pull-up resistors - Dealing with switch bounce - Example: Reading switch inputs (basic code) -Example: Counting goats - various types of motor interfacing.

ADDING STRUCTURE TO THE CODE **15**

Introduction - Object-oriented programming with C - The Project Header (MAIN.H) - The Port Header (PORT.H) - Example: Restructuring the 'Hello Embedded World' example - Example: Restructuring the goat-counting example - UART programming.

REAL-TIME CONSTRAINTS **15**

Introduction - Creating 'hardware delays' using Timer 0 and Timer 1 - Example: Generating a precise 50 ms delay - Example: Creating a portable hardware delay - The need for 'timeout' mechanisms - Creating loop timeouts - Example: Testing loop timeouts - Example: A more reliable switch interface - Creating hardware timeouts - Example: Testing a hardware timeout - LCD interfacing program. CASE STUDY-Intruder Alarm System Introduction - The software architecture - Key software components used in this example - running the program - the software.

Total Hours:	**45**

Text Books:

1	Michael J. Pont,"Embedded C", Pearson Education, 2nd Ed.2008
2	Nigel Gardner," PIC micro MCU C-An introduction to programming, The Microchip PIC in CCS C", CCS Inc., 2nd edition, 2002.
3	David E Simon, "An Embedded Software Primer", Pearson Education Asia, 2005.

Reference Books:

1	Kirk Zurellm, "C Programming for Embedded Systems", CRC Press, 2000.

2	Behrouz A. Forouzan and Richard F. Gilberg, “Computer Science: Structured Programming Approach Using C”, Third Edition, Course Technology Inc., 2006.
3	Mark Siegesmund, “Embedded C Programming: Techniques and Applications of C and PIC MCUS”, First Edition, Newnes,2014.
Web References:	
1	http://freevideolectures.com/Course/2999/Embedded-Systems-I/5
2	http://ir.nmu.org.ua/bitstream/handle/123456789/110776/2adbe2fcfcc9b3fd758f3fac7bde709a.pdf?sequence=1
3	http://www.learn-c.org/
4	http://www.eng.auburn.edu/~nelson/courses/elec3040_3050/C%20programming%20for%20embedded%20system%20applications.pdf
Online Resources:	
1	https://www.coursera.org/learn/introduction-embedded-systems
2	http://www.8051projects.net/wiki/Keil_Embedded_C_Tutorial
3	https://blog.udemy.com/embedded-c-tutorial/
4	http://www.edgefx.in/steps-to-build-embedded-c-programming-tutorial/
5	http://www.embedded.com/electrical-engineer-community/general/4402974/Free-MIT-online-C-programming-course

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	Apply	Classroom or Online Quiz on Programming	5
C510 .2	Apply	Class Presentation/Power point presentation	5
C510. 3	Analyse	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	10	10
Understand	30	30	20	30
Apply	50	50	40	30
Analyse	-	-	30	30
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