E.G.S. PILLAY ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai
Accredited by NAAC with 'A'Grade |Accredited by NBA (CIVIL, CSE, ECE, EEE, IT, MECH)

NAGAPATTINAM – 611 002

B.E ELECTRONICS AND COMMUNICATION ENGINEERING

Third Year – Seventh Semester

Course Code	Course Name	L	T	P	C	Maximum Marks			Category
						CA	ES	Total	
Theory Course									
1902EC701	Microwave Engineering	3	0	0	3	40	60	100	PCC
1902EC702	Optical Communication and Networks	3	0	0	3	40	60	100	PCC
1902EC703	Digital Image Processing	2	0	0	2	40	60	100	PCC
	HSS Elective II	3	0	0	3	40	60	100	HSSC
	Open Elective II	3	0	0	3	40	60	100	OEC
	Professional Elective - III	3	0	0	3	40	60	100	PEC
Laboratory Course									
1902EC751	Microwave and Optical Laboratory	0	0	2	1	50	50	100	PCC
1902EC752	Digital Image Processing Laboratory	0	0	2	1	50	50	100	PCC
1904EC753	Internship / In-plant Training	0	0	0	1	100	-	100	EEC
1904GE751	Comprehensive Viva	2	0	0	2	100	-	100	EEC
1904GE753	Mini Project	0	0	2	1	100	-	100	EEC
Total		**19**	**0**	**6**	**23**	**640**	**460**	**1100**	

Course Code	Course Name	L	T	P	C	Maximum Marks		
						CA	ES	Total
HSS Elective - II								
1901HS001	Innovation & Entrepreneurship fundamentals	3	0	0	3	40	60	100
1901HS002	Intellectual Property Rights for Engineers	3	0	0	3	40	60	100
1901HS003	Startup Entrepreneurship	3	0	0	3	40	60	100
1901HS004	Business Model Innovation	3	0	0	3	40	60	100
Open Elective – II (odd Semester)								
The courses listed below are offered by the Department of Electronics and Communication Engineering for students of								

other Departments.								
1903EC017	Embedded System	3	0	0	3	40	60	100
1903EC007	Automotive Electronics	3	0	0	3	40	60	100
1903EC026	Mobile Communication	3	0	0	3	40	60	100
1903EC004	Display systems	3	0	0	3	40	60	100
1903EC027	Analog and Digital Communication	3	0	0	3	40	60	100
Professional Elective - III								
1903EC011	Micro Electronics	3	0	0	3	40	60	100
1903EC012	Robotics	3	0	0	3	40	60	100
1903EC013	Network Security	3	0	0	3	40	60	100
1903EC014	Soft Computing	3	0	0	3	40	60	100
1903EC015	Advanced Digital Signal Processing	3	0	0	3	40	60	100

1902EC701		**MICROWAVE ENGINEERING**	**3**	**0**	**0**	**3**

Course Objectives:	
	1. To gain knowledge about RF Electronics.
	2. To study about the various microwave components.
	3. To study about the various microwave signal generators and amplifiers.
	4. To gain knowledge about microwave integrated circuits.
	5. To study about the microwave measurement techniques.

Unit I	**INTRODUCTION TO RF ELECTRONICS**	**9 Hours**

The Electromagnetic Spectrum, units and Physical Constants, Microwave bands, RF behavior of Passive components: Tuned resonant circuits, Vectors, Inductors and Capacitors. Voltage and Current in capacitor circuits, Tuned RF/IF Transformers.

Unit II	**MICROWAVE COMPONENTS**	**9 Hours**

Introduction to Microwaves and their applications, Coaxial Line Components, Wave-guide Components, Directional Couplers, Hybrid Tee Junction, Magic Tee, Attenuators, Ferrite Devices, Isolators, Circulators, Cavity Resonators, Re - entrant Cavities, Wave-meters, Microwave Filters, Detectors, Mixers.

Unit III	**MICROWAVE SIGNAL GENERATORS AND AMPLIFIERS**	**9 Hours**

Vacuum Tube Triodes, Resonant Cavity Devices, Reflex Klystron, Two –Cavity Klystron, Multi – Cavity Klystron, Slow – Wave Devices, TWT, Crossed Field Devices, Magnetrons, Semiconductor Devices, Microwave BJTs, FETs, Tunnel Diodes, Gunn Diode, IMPATT, TRAPATT Diodes.

Unit IV	**MICROWAVE INTEGRATED CIRCUITS**	**9 Hours**

Materials, Substrate, Conductor, Dielectric and Resistive Materials, MMIC Growth, Fabrication Techniques, MOSFET Fabrication, NMOS Growth and CMOS Development, Thin Film Formation.

Unit V	**MICROWAVE MEASUREMENTS**	**9 Hours**

VSWR, Frequency, Guide Wavelength, Coupling and Directivity measurements

	Total:	**45 Hours**

Further Reading:	
	1.Recent trends in Microwave application.

Course Outcomes:	
	After completion of the course, Student will be able to
	1.Explain about electromagnetic spectrum and passive components in Microwave field.
	2.Identify the component for microwave application.
	3.Discuss signal generator and amplifiers.
	4. Illustrate the concept of microwave integrated circuits.
	5.Experiment with microwave devices to measure microwave parameter.

References:

1. Reinhold Ludwing, Pavel Bretchko, “RF Circuit design: Theory and applications”, Pearson Education Asia Publication, New Delhi 2001.

2.Foundations For Microwave Engineering, R. R. Collin, McGraw Hill

3.Microwave Communications – Components and Circuits, E. Hund, McGrawHill.

4.Microwave Devices and Circuits, S. Y. Liao, PHI.

5.Microwave Engineering, R. Chatarjee, East – West Press Pvt. Ltd.

1902EC702	OPTICAL COMMUNICATION AND NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures
2. To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors. Design optimization of SM fibers, RI profile and cut-off wave length.
3. To learn about various Optical Sources and Detectors.
4. To Explore the trends of optical fiber measurement systems.
5. To Enrich the idea of optical fiber networks algorithm such as SONET/SDH and optical CDMA

Unit I	**INTRODUCTION TO OPTICAL FIBERS**	**9 Hours**

Evolution of fiber optic system- Element of an Optical Fiber Transmission link Ray theory transmission- Total internal reflection-Acceptance angle –Numerical aperture – Skew rays – Electromagnetic mode theory of optical propagation –EM waves – modes in Planar guide – phase and group velocity – cylindrical fibers –SM fibers- Graded Index fiber structure.

Unit II	**SIGNAL DEGRADATION OPTICAL FIBERS**	**9 Hours**

Attenuation - Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides-Information Capacity determination -Group Delay-Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibers-Polarization Mode dispersion, Intermodal dispersion- Pulse Broadening in GI fibers-Mode Coupling -Optical fiber connectors**,** Fiber alignment and Joint Losses – Fiber Splices – Fiber connectors – Expanded Beam Connectors – Fiber Couplers

Unit III	**SOURCES AND DETECTORS**	**9 Hours**

Optical sources: Light Emitting Diodes - LED structures - surface and edge emitters, mono and hetero structures - internal - quantum efficiency, lasers Diodes-Modes and Threshold condition -Rate equations -External Quantum efficiency -Resonant frequencies- injection laser diode structures.
Optical Detectors: PIN Photo detectors, Avalanche photo diodes, construction, characteristics and properties, Comparison of performance, Photo detector noise –Noise sources, Signal to Noise ratio , Detector response time.

Unit IV	**FIBER OPTIC RECEIVER AND MEASUREMENTS**	**9 Hours**

Fundamental receiver operation, Pre amplifiers, Error sources – Receiver Configuration– Probability of Error – Quantum limit. Fiber Attenuation measurements- Dispersion measurements – Fiber Refractive index profile measurements – Fiber cut- off Wave length Measurements – Fiber Numerical Aperture Measurements – Fiber diameter measurements.

Unit V	**OPTICAL NETWORKS AND SYSTEM TRANSMISSION**	**9 Hours**

Basic Networks – SONET / SDH – Broadcast – and –select WDM Networks –Wavelength Routed Networks – Non linear effects on Network performance –-Link Power budget -Rise time budget- Noise Effects on System Performance- Operational Principles of WDM Performance of WDM + EDFA system – Solitons – Optical CDMA – Ultra High Capacity Networks**.**

	Total:	**45 Hours**

Further Reading:

1. Design Optimization of SM fibers-RI profile and cut-off wavelength.
2. Fiber amplifiers- Power Launching and coupling, Lencing schemes

Course Outcomes:

After completion of the course, Student will be able to

1. Discuss the various optical fiber modes, configurations.
2. Demonstrate various signal degradation factors associated with optical fiber.
3. Classify various optical sources and optical detectors and their use in the optical communication system.
4. Explain Various Fiber Optic measurements.
5. Calculate the digital transmission and its associated parameters on system performance.

References:

1. Gerd Keiser, "Optical Fiber Communication" Mc Graw -Hill International, 4th Edition., 2010.
2. John M. Senior , “Optical Fiber Communication”, Second Edition, Pearson Education, 2007.
3. Ramaswami, Sivarajan and Sasaki “Optical Networks”, Morgan Kaufmann, 2009
4. J.Senior, "Optical Communication, Principles and Practice", Prentice Hall of India, 3rd Edition, 2008.
5. J.Gower, "Optical Communication System", Prentice Hall of India, 2001.

1902EC703		DIGITAL IMAGE PROCESSING	L	T	P	C
			3	0	0	3

Course Objectives:

1. To make the students to understand the digital image fundamentals.
2. To study the digital image using different transforms.
3. To acquire the basic knowledge in filters, image enhancement, image restoration and compression techniques.

Unit I	DIGITAL IMAGE FUNDAMENTALS	9 Hours

Elements of digital image processing systems, Elements of visual perception, Image sampling andquantization, Basic Relationships between pixels. Image Transforms: Discrete Fourier transform, Cosine, Hadamard, Haar, Walsh and Slant transform.

Unit II	IMAGE ANALYSIS	9 Hours

Histogram processing, Equalization and specification techniques,Basics of spatial filtering, Smoothing spatial filters, Sharpening spatial filters, Image smoothing and sharpening using frequency domain filters.

Unit III	IMAGE SEGMENTATION	9 Hours

Point, line and edge detection-Detection of isolated points, Line detection, Edge models, Basic edgedetection, Edge linking and boundary detection. Thresholding-basic global thresholding, Otsu's method,Multiple, Variable and multivariable thresholding. Region-based segmentation-Region growing, Regionsplitting and merging.

Unit IV	IMAGE RESTORATION AND RECOGNITION	9 Hours

Image degradation/ restoration model, Noise models, Restoration-Spatial Filtering, Constrained Leastsquare filtering, Inverse filtering, Wiener Filtering, Object recognition-Patterns and patternclasses,Matching-Minimum Distance classifiers, Neural networks-Background, Training by Back Propagation.

Unit V	IMAGE COMPRESSION	9 Hours

Fundamentals, Basic compression methods-Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run – length coding, Lossless and Lossy predictive coding, Block transform coding, Waveletcoding.

	Total:	45 Hours

Further Reading:

transform and their properties, Homomorphic filtering, Morphological image processing – Erosion and Dilation, Opening and closing, Segmentation using morphological watersheds, Applications of neural networks in image processing, Digital image watermarking.

Course Outcomes:

After completion of the course, Student will be able to

1. Analyze the image using image transforms.
2. Develop a methodology for smoothening and sharpening of the image
3. Segment the image using edge detection, thresholding and region-based approach.
4. Develop a method to restore the image and object recognition
5. Compress the image using lossy and lossless compression techniques.

References:

1. C.Rafeal Gonzalez and E.Richard Woods, Digital Image Processing, Third Edition, Pearson Education 2008.
2. Anil K.Jain, Fundamentals of Digital Image Processing, PHI, 2010.
3. S Jayaraman, S Esakkirajan T Veerakumar, Digital Image Processing , Mc Graw- Hill, 2010
4. K.William Pratt, Digital Image Processing, John Wiley, 1997.
5. M.A.Sid Ahmed, Image Processing Theory, Algorithm and Architectures, McGraw - Hill, 1995.

LABORATORY COURSE

1902EC751		Microwave and Optical Communication Lab	L	T	P	C
			0	0	4	2

Course Objectives:

1. To have a detailed practical study on microwave signal and its components.
2. To study the optical devices and to use in appropriate application.

List of Experiments:

MICROWAVE EXPERIMENTS:

1. Reflex Klystron – Mode characteristics
2. Gunn Diode – Characteristics
3. VSWR, Frequency and Wave Length Measurement
4. Directional Coupler – Directivity and Coupling Coefficient – S – parameter measurement.
5. Circulator – S - parameter measurement
6. Attenuation and Power measurement
7. S - matrix Characterization of E-Plane T, H-Plane T and Magic T.
8. Radiation Pattern of Antennas.
9. Antenna Gain Measurement

OPTICAL EXPERIMENTS:

1. DC characteristics of LED and PIN Photo Diode.
2. Mode Characteristics of Fibers.
3. Measurement of Connector and Bending Losses.
4. Fiber Optic Analog and Digital Link
5. Numerical Aperture Determination for Fibers
6. Attenuation Measurement in Fibers.

Additional Experiments:

1. Study of Manchester coding.

List of Hardware/Software Required

1. Trainer kit for carrying out LED and PIN diode characteristics, Digital multi meter, optical power meter. – 2 Nos
2. Trainer kit for determining the mode characteristics, losses in optical fiber.- 2 Nos.
3. Trainer kit for analyzing Analog and Digital link performance, 2 Mbps PRBS Data source, 10 MHz signal generator, 25 MHz Analog storage Oscilloscope. – 5 Nos.
4. Kit for measuring Numerical aperture and Attenuation of fiber - 2 Nos.
5. Glass and plastic fiber patch chords- 2 set.
6. LEDs with ST / SC / E2000 receptacles – 650 / 850 nm - 2 set.
7. PiN PDs with ST / SC / E2000 receptacles – 650 / 850 nm - 2 set.
8. Microwave test Bench at X band to determine Directional coupler characteristics. - 2 Nos.
9. Microwave test Bench at X band and Antenna turn table to measure Radiation pattern of Horn antenna, 2 Horn antennas. - 2 Nos.
10. Microwave test Bench at X band to determine VSWR for Isolator and Circulator, VSWR meter, Isolator, Circulator, E Plane Tee, H plane Tee. - 2 Nos.
11. Microwave test Bench at X band, Variable attenuator, Detector and 25 MHz Analog Oscilloscope. - 2 Nos.

Course Outcomes:

After completion of the course, Student will be able to

1. Experiment with microwave devices to measure microwave parameter.
2. Analyze the performance of Fiber optic cable for analog and digital signals.

References:

1. Reinhold Ludwing, Pavel Bretchko, “RF Circuit design: Theory and applications”, Pearson Education Asia Publication, New Delhi 2001.

2.Foundations for Microwave Engineering, R. R. Collin, McGraw Hill
3.Microwave Communications – Components and Circuits, E. Hund, McGrawHill.
4.Microwave Devices and Circuits, S. Y. Liao, PHI.
5.Microwave Engineering, R. Chatarjee, East – West Press Pvt. Ltd.

1902EC752		DIGITAL IMAGE PROCESSING LAB	L	T	P	C
			0	0	4	2

Course Objectives:

1. To make the students to understand the digital image fundamentals.
2. To demonstrate the digital image using different transforms.
3. To apply the concepts and basic knowledge in filters, image enhancement, image restoration and compression techniques.

List of Experiments:

1. The thresholding an image and the evaluation of its histogram using histogram equalization and illustrates the relationship among the intensities (gray levels) of an image and its histogram
2. Show image rotation, scaling, and translation using Geometric transformations.
3. Perform the Two-dimensional Fourier transform operation in an image.
4. Perform the Linear filtering using convolution in an image
5. Image Edge Detection Using Sobel Filtering and Canny Filtering
6. Perform the following operations in an image.

(a) erosion,
(b) dilation,

7. Perform the following operations in an image.

(a) opening,
(b) closing,

Total: 45 Hours

Additional Experiments:

1. Color image segmentation algorithm development
2. Image filtering in spatial and frequency domain
3. Morphological operations in analyzing image structures

List of Hardware/Software Required

1. MATLAB with Simulink and Image Processing Tool Box or Equivalent Software in desktop systems -15 Nos

Course Outcomes:

After completion of the course, Student will be able to

1. Understand the Fundamentals of Digital image processing and its applications.
2. Perform the image enhancement technique for the improvement of pictorial information for human perception
3. Apply the concepts of image segmentation and compression
4. Demonstrate object detection and recognition technique learning

References:

1. C.Rafeal Gonzalez and E.Richard Woods, Digital Image Processing, Third Edition, Pearson Education 2008.
2. Anil K.Jain, Fundamentals of Digital Image Processing, PHI, 2010.
3. S Jayaraman, S Esakkirajan T Veerakumar, Digital Image Processing , Mc Graw- Hill, 2010
4. K.William Pratt, Digital Image Processing, John Wiley, 1997.
5. M.A.Sid Ahmed, Image Processing Theory, Algorithm and Architectures, McGraw - Hill, 1995.

1904GE751		Comprehensive Viva	L	T	P	C
		(TECHNICAL SEMINAR)	**0**	**0**	**4**	**2**
		BE (ECE)				

Course Objectives:

1. To develop self-learning skills of utilizing various technical resources to make a technical presentation
2. To promote the technical presentation and communication skills.
3. To impart the knowledge on intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
4. To promote the ability for Interacting and sharing attitude.
5. To encourage the commitment-attitude to complete tasks

GUIDELINES

1. The students are expected to make two presentations on advanced topics (recent trends) related to IV year/ VII semester subjects
2. A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also
3. It is mandatory that each student will interact individually a seminar/model on agreed topic and share their technical knowledge
4. Students are encouraged to use various teaching aids such as overhead Projectors. power point presentation and demonstrative models
5. During the final seminar sessions each student is expected to prepare and present a topic, for duration of not less than 15 minutes. At the end of the semester student would have to submit the Report on the presentation

TOTAL	**30 HOURS**

Course Outcomes:

After completion of the course, Student will be able to

3. Identify and utilize various technical resources available from multiple field
4. Improve the technical presentation and communication skills
5. Improve communicative competence
6. Interact and share their technical Knowledge
7. Understand and adhere to deadlines and commitment to complete the assignments

EVALUATION SCHEME

Distribution of Marks for Continuous Assessment	Marks
Presentation I	40
Report	10
Presentation II	40
Report	10
Total 100	100

Continuous Assessment (100 Marks)

References: https://spectrum.ieee.org/

1904GE753		**MINI PROJECT**	**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**

Course Objectives:	The students should be made to:
	1. To develop self-learning skills of utilizing various technical resources to make a technical presentation.
	2. To test technical presentation and communication skills.

The students (with team size no more than 4 students in a team) are expected to make mini project on topics (Preferably in recent trends) related to Electronics and Communication Engineering. A faculty guide is to be allotted if requested and he / she will guide and monitor the progress of the student and maintain attendance also (If no guide is requested then course co coordinator will take care of attendance). Students are encouraged to use various teaching aids such as power point presentation and demonstrative models which should be presented to panel which consist no less than three faculties (excluding course co coordinator). The average of the mark given by all panel members is taken into consideration.

Evaluation Scheme: Continuous Assessment (100)

Distribution of marks for Continuous Assessment:

ZEROTH REVIEW :	10 marks
FIRST REVIEW:	20 marks
SECOND REVIEW:	20 marks
FINAL REVIEW/DEMO:	30 marks
REPORT:	20 marks
Total Marks:	**100**

	Total:	**30 Hours**

Course Outcomes:	After completion of the course, Student will be able to
	1. Utilize various technical resources available from multiple fields.
	2. Improve the technical presentation and communication skills.
	3. Connect different domains to make intelligent system.
	4. Maximize their technical knowledge with discussing others.
	5. Produce different assignments based on real time systems.

HSS Elective II

1901HS001	Innovation & Entrepreneurship Fundamentals	L	T	P	C

PREREQUISITE:

The course assumes no prior skill or background in design, art or engineering. It is open to all undergraduates and graduate students with an interest in learning design thinking, and is especially recommended for those students planning social-venture and other kinds of design interventions

COURSE OBJECTIVES:

1. Cultivate the mindset and skills of successful entrepreneurs
2. Lead innovative teams
3. Develop and refine your strategy in today's fast-changing, dynamic markets
4. Grow your customer base through inbound and outbound marketing

Module I	Entrepreneurship Basics	9 Hours

Entrepreneurship Basics – Skills, Mindset, Myth vs Fact, Entrepreneurial Leadership: Navigating Uncertainty, Critical lessons in entrepreneurial leadership, innovation, teamwork, communications, and problem-solving & Risk management. Business Opportunity Identification, Idea Validation, Case Study : Entrepreneurs Story

Module II	Innovation & Creativity	9 Hours

Analyzing the Current Business Scenario, Innovation and Creativity- An Introduction, Innovation in Current Environment, Types of Innovation, School of Innovation, Challenges of Innovation, Steps of Innovation Management, Idea Management System, Divergent V/s Convergent Thinking, Design Thinking and Entrepreneurship

Module III	Business Models & Strategies for Innovation	9 Hours

Experimentation in Innovation Management, Idea Championship, Participation for Innovation, Co-creation for Innovation, Proto typing to Incubation, What is a Business Model, Who is an Entrepreneur, Social Entrepreneurship, Blue Ocean Strategy-I, Blue Ocean Strategy-II

Module IV	Marketing & Sustainability of Innovation	9 Hours

Marketing of Innovation, Technology Innovation Process, Technological Innovation Management Planning, Technological Innovation Management Strategies, Technology Forecasting, Sustainability Innovation and Entrepreneurship, Innovation Sustainable Conditions, Innovation: Context and Pattern, SME'S strategic involvement in sustainable development, Exploration of business models for material efficiency services

Module V	Managing Innovation : IPR	9 Hours

Management of Innovation, creation of IPR ,Management of Innovation, creation of IPR, Types of IPR, Patents and Copyrights, Patents in India, Business Models and value proposition, Business Model Failure: Reasons and Remedies, Incubators : Business vs Technology, Managing Investor for Innovation , Future markets and Innovation needs for India.

TOTAL: 45 HOURS

Course Outcomes:

1. Explain the basics of Entrepreneurship & Innovation
2. Analyze Leadership Styles and compare them
3. Choose business models based on the requirement and justify with cases
4. Develop a method or mechanism for Innovation marketing and sustainability
5. Develop a Business Model and Strategy framework and demonstrate through presentation

FURTHER READING:

1. 8 Steps To Innovation : Going From Jugaad To Excellence- Book by Rishikesha T. Krishnan and Vinay Dabholkar
2. Innovation and Entrepreneurship Book by Peter Drucker
3. HBS series on Innovation and Entrepreneurship

REFERENCES:

1.The Lean StartupBook by Eric Ries, 2013

2.Zero to One Book by Blake Masters and Peter Thiel, 2014

3. Founders at Work: Stories of Startups' Early Days Book by Jessica Livingston, 2001
4. Crossing the Chasm Book by Geoffrey Moore, 1991
5. Hooked: How to Build Habit-Forming Products Book by Nir Eyal, 2013
6. Rework Book by David Heinemeier Hansson and Jason Fried, 2010
7. https://nptel.ac.in/courses/127/105/127105007/

1901HS002		INTELLECTUAL PROPERTY RIGHTS FOR ENGINEERS	L	T	P	C
			3	0	0	3

Course Objectives:

1. To know about their rights for the protection of their invention done in their project work.
2. To learn about the patents processing system
3. To be familiar with copyrights and IPR related issues.

Unit I	INTRODUCTION TO IPR	9 Hours

Basic types of property - Tangible and Intangible property - Movable Property and Immovable Property - Intellectual Property – Invention and Creativity - Innovation – Intellectual Property (IP) – Importance – Protection of IPR.

Unit II	CLASSIFICATIONS OF IPR	9 Hours

IP – Patents – Copyrights and related rights – Trade Marks and rights arising from Trademark registration – Definitions – Industrial Designs and Integrated circuits – Protection of Geographical Indications at national and International levels – Application Procedures.

Unit III	INTERNATIONAL TREATIES ON IPR	9 Hours

International convention relating to Intellectual Property – TRIPS Agreement - Madrid Agreement - Hague Agreement - Budapest Treaty; Berne convention-Patent cooperation treaty-Paris convention-Lisbon Agreement – Establishment of WIPO – Mission and Activities – History – General Agreement on Trade and Tariff (GATT).

Unit IV	INDIAN IPR LEGISLATIONS	9 Hours

Indian Position Vs WTO and Strategies – The Patent Act, 1970 – Inventions Non-Patentable – Compulsory licensing – Patents of Addition – commitments to WTO-Patent Ordinance and the Bill – Draft of a national Intellectual Property Policy – Present against unfair competition.

Unit V	IPR IN ELECTRONICS AND INFORMATION TECHNOLOGY	9 Hours

IPR in Electronics & Information Technology -Case Studies on – Patents pertaining to Electronics & Information Technology – Software patents International scenario – Patent & Copyright Protection for software& Electronic inventions - IPR in Electronics and Information Technology.

Total:	45 Hours

Further Reading:

1. New developments in trade mark law
2. Foundations of patent law

Course Outcomes:

After completion of the course, Student will be able to

1. Understands the legal issues on Intellectual Property Rights
2. An ability to register a trade mark, copyrights, patents
3. Predict issues related to Intellectual property rights on trademarks, copyrights and patents
4. Summarize and evaluate trade secrets, unfair competition which is being adopted by various firms.
5. Distinguish between legal procedures for patents and copyrights.

References:

1. BARE ACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. V. Sople Vinod, Managing Intellectual Property by (Prentice Hall of India Pvt.Ltd), 2006.
3. Deborah E. Bouchoux, ―Intellectual Property Rights,‖ Cengage Learning India Private Ltd, 2005.
4. Stim,―Intellectual Property Copyrights, trademarks, and Patents,‖ Cengage Learning India Private Ltd,

	2004.
5.	Prabuddha Ganguli, ―Intellectual Property Rights,‖, TMH, 2001.
6.	Lal, C.S, ―Intellectual property handbook: copyright, designs, patent and trademarks‖, Law Publishers Allahabad, 2000.

1901HS003	STARTUP ENTREPRENEURSHIP	L	T	P	E

PREREQUISITE:

The course assumes no prior skill or background in design, art, engineering, or science It is open to all undergraduates and graduate students with an interest in learning Entrepreneurship, and is especially recommended for those students planning venture creation and other kinds of entrepreneurial interventions

COURSE OBJECTIVES:

1. Understand the terminology and conceptual of Entrepreneurship & Startups
2. Understand real time problem solving methodologies with tools
3. Recognize the ethical and social dilemmas and obligations of the practice of design of solutions
4. Diagnose common adoption barriers in individuals, groups and organizations.
5. Develop a design theory from independent and qualitative research and observations
6. Participate in and lead innovation in creative and collaborative settings
7. Undertake complex and unstructured problem-solving challenges in unfamiliar domains

Module I	Entrepreneurship & Startup Basics	5 Hours

Entrepreneurship basics – Skill Set, Mindset, Examples, Startup basics overview, Indian Startup Ecosystem, Problems – Identification, Selection, Evaluation, Validation, Teaming

Module II	Customer Discovery Process	7 Hours

Customer Discovery Process, Opportunity Identification, Evaluating Opportunities, Customer discovery with at least 15 interviews. Results presentation and hypothesis refinement. Focus on customer segments of the business model canvas.

Module III	Ideation	5 Hours

Ideation – Brainstorming, Technology driven Ideation, Continued customer discovery and updates to hypothesis. Focus on value proposition of business model canvas.

Module IV	Market Analysis	6 Hours

Market Analysis – Perform market research, Competitive advantage landscape, Market Size, Go-To Market Strategies, Continued customer discovery and updates to hypothesis. Focus on channels of business model canvas.

Mid-term presentation on startup idea, refined hypothesis through customer discovery

Module V	Minimum Viable Product	5 Hours

Minimum Viable Product/Validation: Product market fit, use customer discovery in defining the MVP, Build Proof Of Concepts for specific customer use-cases. Focus on metrics of business model canvas.

Module VI	Business Models	7 Hours

Business Models/Metrics – Chosen business model for the venture, Focus on key resources/activities of business model canvas. Start customer validation phase.

Module VII	Pivoting	3 Hours

Pivoting - Pivot product and business models based on customer discovery and validation, Choose pivot direction. Focus on cost structures and partners of business model canvas. Continued customer validation.

Mid-term presentation on startup prototype, preliminary results from customer validation,

	prototype refinements and plan.	
Module VIII	**IP/Legal**	**4 Hours**
IP/Legal: Importance of IP, Protect IP, Licensing IP, IP based Entrepreneurship; Examples, Continued customer validation.		
Module IX	**Capital**	**3 Hours**
Capital: Capital requirement for the venture, Raising capital & increments, Continued customer validation. Liquidity/Exit: Liquidity events, Trade-offs		
Final presentations of startup idea, refined prototype, customer validation, and future plans		
	TOTAL: 45 HOURS	

Course Outcomes:

1. Detail Entrepreneurship and Startup Basics
2. Employ the methods and tools of Problem Solving in business context
3. Project Startup Idea Development Process and Methodologies through Real Problem Solving
4. Develop Startup Prototype through Customer Validation and Business Models
5. Explain Intellectual Property Rights and its importance in business context

FURTHER READING:

1. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company by Steve Blank
2. Value Proposition Design: How to Create Products and Services Customers Want (Strategyzer) by Alexander Osterwalder
3. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers by Alexander Osterwalder
4. The Four Steps to the Epiphany, Steven Blank

REFERENCES:

1. Creative Confidence: Unleashing the Creative Potential Within Us All Book by David M. Kelley and Tom Kelley, 2013

2. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation Book by Tim Brown, 2009

3. The art of Innovation by Tom Kelly, 2011

4. Design Thinking for Strategic Innovation: What They Can't Teach You at Business Or Design School Book by Idris Mootee, 2013

5. The Design of Everyday Things Book by Don Norman, 1988

6. The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems Book by Michael Lewrick, 2017

7. https://nptel.ac.in/courses/109104109/

1901HS004	Business Model Innovation	L	T	P	C

PREREQUISITE:

The course assumes no prior skill or background in design, art, engineering, or prototyping. It is open to all undergraduates and graduate students with an interest in learning design thinking, and is especially recommended for those students planning social-venture and other kinds of design interventions

COURSE OBJECTIVES:

1. Understand the Business Model Canvas
2. Master the different types of Innovation
3. Design Innovative Business Models
4. Differentiate from Competition
5. Understand purchasing psychology
6. Define innovative revenue models

Module I	**Introduction to Business Models**	**9 Hours**

Introduction to Business Model Generation, Business Model Canvas, Examples: Uber Innovation Model, Facebook, Customers, Value Proposition, Sales & Delivery Channels, Customer Relationships, Revenue Streams, Resources, Activities, Partners

Module II	**Introduction to Designing Innovative Business Models, Product and Design Innovation**	**9 Hours**

Disrupting Markets, Examples; AirBnb model, Better Product, Success stories of Tinder and Uber – Case studies, Visual Design, Tesla Innovation Model

Module III	**Customer Innovation: Customer niches, Sales & Delivery Channels, Marketing**	**9 Hours**

Disrupting Customer Relationships, Acquire first time customer, Disrupting Customer segments, Focus on underserved market niche, Disrupt delivery Channels, Digital Sales channel

Module IV	**Resource Driven Innovation**	**6 Hours**

New product development strategies, Innovative production techniques, Automation of small and medium companies

Module V	**Revenue Model Innovation & Purchasing Psychology**	**12 Hours**

Disrupting revenue models, Subscription models, Freemium and Micro payments, advertising, affiliates and franchising, Why People Buy – Necessity, Loss Aversion, Fear, Convenience, Belonging & Vanity, Scarcity

TOTAL: 45 HOURS

Course Outcomes:

1. Describe Key Concepts and basics of Design Thinking Principles
2. Elaborate the Design Thinking Approach through IDEO's method & Customer Journey Maps
3. Conduct user interviews and synthesize learnings to uncover insights and identify opportunities for innovation
4. Develop Design Driven Innovative Solutions to RealWorld Problems

FURTHER READING:

1. HBR's 10 Must Reads on Business Model Innovation (with featured article "Reinventing Your Business Model" by Mark W. Johnson, Clayton M. Christensen, and Henning Kagermann) (English, Paperback, Review Harvard Business)
2. The Business Model Book (Adam J. Bock, Gerard George)
3. The Field guide to Human Centered Design by IDEO.org

REFERENCES:

1.The Business Model Innovation Factory: How to Stay Relevant When The World is Changing Hardcover – April 24, 2012, Saul Kaplan

2.Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation Book by Tim Brown, 2009

3. The business model navigator is a book that comes out from the research of Oliver Gassmann, Karolin Frankenberger, and Michaela Csik.

4. Business Model Generation: A Handbook for Visionaries, Game…by Alexander Osterwalder

5. The Design of Everyday ThingsBook by Don Norman, 1988

6. Testing Business Ideas: A Field Guide for Rapid Experimentation (Strategyzer) 1st Edition by David J. Bland (Author), Alexander Osterwalder
7. https://nptel.ac.in/courses/109104109/

OPEN ELECTIVE-II

1903EC017		EMBEDDED SYSTEMS	L	T	P	C
		(Open Elective)	3	0	0	3

Course Objectives:

1. Discuss the concepts of basic embedded systems.
2. Describe about the ARM architecture.
3. To introduce various technologies and protocols involved in Embedded communication protocols.
4. To study about the different I/O device interfacing modules.
5. To use the embedded controllers in real time applications.

Unit I	**Introduction**	**9 Hours**

Introduction to Embedded System, Embedded System Architecture, Embedded hardware, Embedded software, Classifications of Embedded Systems and Characteristics, Challenges and Design issues in Embedded systems, Embedded System on-chip. .

Unit II	**ARM Processor**	**9 Hours**

ARM processor naming, Types. CISC vs. RISC, Von-Neumann vs. Harvard architecture, ARM M3 features, Architecture, pipeline, Mode of operation, Instruction set, Exception handling

Unit III	**Embedded Communication Protocols**	**9 Hours**

Communication protocols – USART, I2C, CAN, SPI. Wireless communication protocols: Bluetooth, ZigBee, Z wave.

Unit IV	**I/O Device Interfacing**	**9 Hours**

C Programming, Interfacing Simple I/O Devices Like LED, Seven Segment, LCD, Switches, Motor (DC, Stepper, Servo), Relays and Sensors. Introduction to IOT

Unit V	**Embedded controllers Application**	**9 Hours**

Home automation, Wireless sensor monitoring, Environmental monitoring, Gas leakage detection, Elevator design, Alarm clock using timers, Washing machine, Auto focusing Digital camera and Wearable devices

Total:	**45Hours**

Further Reading:

1. Arduino
2. Machine learning using raspberry pi

Course Outcomes:

After completion of the course, Student will be able to

1. Outline the properties of embedded system.
2. Point out the functionality of ARM processor
3. Make use of the communication protocols in application specific purposes
4. Interface I/O device peripherals with microcontroller
5. Solve the real life problems using embedded systems

References:

1. Raj Kamal, "Embedded Systems- Architecture, Programming and Design", Second Edition, Tata McGraw-Hill Publications, 2008.
2. Julio Sanchez Maria P.Canton, “Microcontroller Programming: The microchip PIC”, CRC Press, Taylor & Francis Group, 2007.
3. The 8051 Microcontroller and Embedded Systems Using Assembly and C Second Edition Muhammad Ali Mazidi Janice GillispieMazidiRolin D. McKinlay
4. Martin Bates, "Interfacing PIC microcontrollers-Embedded Design by Interactive Simulation", Newnes Publication, 2006

1903EC007		**AUTOMOTIVE ELECTRONICS**	**L**	**T**	**P**	**C**
		(Open Elective)	**3**	**0**	**0**	**3**

Course Objectives:

1. To describe on Automotive Sensors, Actuators and Instrumentations
2. To articulate functions of various systems in automobiles.

Unit I	**VEHICLE SYSTEMS**	**9 Hours**

Power Train System (Air System, Fuel System (Carburettor& Diesel Fuel Injection), Ignition System, Exhaust System and other Auxiliary Systems (Cooling, Lubrications & Electrical Systems)),

Unit II	**VEHICLE AUXILLARY SYSTEMS**	**9 Hours**

Transmission System (Front, Rear &4 wheels Drive, Manual, Automatic Transmission, Differential). Braking System (Drum, Disc, Hydraulic, Pneumatic), Steering System (Rack and Pinion, Power Steering).

Unit III	**ELECTRONIC CONTROL**	**9 Hours**

Digital Engine Control, EGR Control, Electronic Ignition Control, Integrated Engine Control System, Anti-locking Braking System, Electronic Suspension System, Electronic Steering Control.

Unit IV	**SENSORS AND INDICATORS**	**9 Hours**

Computer Based Instrumentation, Display Devices, Flat Panel Display, Fuel Quantity Measurement, Coolant Temperature Measurement, Oil Pressure Measurement, Speed Measurement,

Unit V	**COMMUNICATION AND NAVIGATION**	**9 Hours**

High-Speed Digital Communication (CAN BUS), Telematics, GPS Navigation, GPS System Structure, Automotive Diagnostics.

	Total:	**45 Hours**

Further Reading: E-Vehicles, Hybrid trains.

Course Outcomes:

After completion of the course, Student will be able to

1. Describe various vehicle systems in an automobile
2. Illustrate different types of auxiliary system in an automobile
3. Outline the various electronic control systems
4. Demonstrate various sensor and measurement techniques
5. Examine various communication and navigation techniques

References:

1. Joerg Schaeuffele, Thomas Zurawka, ―Automotive Software Engineering Principles, Processes, Methods and Tools‖, SAE International, 2005.
2. BOSCH Automotive Handbook, 6th Edition, 2014.
3. William B. Ribbens, “Understanding Automotive Electronics- An Engineering Prespective”,7th Edition, Butterworth-Heinemann Publications, 2012.
4. Young A.P. & Griffiths, “Automotive Electrical Equipment” , ELBS & New Press,1999.
5. Tom Weather Jr. &Cland c. Ilunter, “Automotive computers and control system”, Prentice Hall Inc., New Jersey.
6. Crouse W.H., “Automobile Electrical Equipment” , Mc Graw Hill Co. Inc., New York ,1995. 5. Bechhold, “ Understanding Automotive Electronic”, SAE,1998

1903EC026		**MOBILE COMMUNICATION**	**L**	**T**	**P**	**C**
		(Open Elective)	**3**	**0**	**0**	**3**

Course Objectives:

1. To impart the fundamentals concepts of wireless communication systems.
2. To introduce various technologies and protocols involved in wireless cellular communication.
3. To understand the concepts of signalling schemes for fading channels and analyze its channel capacity.

Unit I	**INTRODUCTION TO WIRELESS MOBILE COMMUNICATION**	**9 Hours**

History and evolution of mobile radio systems, Types of mobile wireless services/systems – Cellular, WLL, Paging, Satellite systems, Standard, Future trends in personal wireless systems

Unit II	**CELLULAR MOBILE WIRELESS SYSTEMS**	**9 Hours**

Cellular Systems: Structure - Cell Cluster - Frequency reuse - Channel Interference - Cell splitting and sectoring - Channel Assignment schemes: Fixed, Dynamic and Hybrid - Network Architecture - Mobility Management - Location Management - Resource Management: Microcell Concept.

Unit III	**WIDEBAND SYSTEMS**	**9 Hours**

GSM Network Architecture - GPRS: Network Architecture, Signaling, Mobility management, Location Management, Roaming. CDMA: IS95 systems, Forward link, Reverse Link, PN sequence related to CDMA - UMTS: Network Architecture and Interface.

Unit IV	**WORKING PRINCIPLE OF CELL PHONE**	**9 Hours**

Basics of cell phones, How cell phone work, Cell phone network, Cell phone call travel, Setting up a call process, making a call, receiving a call, Invention of mobile.

Unit V	**MOBILE TECHNOLOGY**	**9 Hours**

GSM.3G, 4G (LTE), NFC systems, WLAN technology. WLL. Hyper LAN. Ad hoc networks. Bluetooth.

Total:	**45 Hours**

Further Reading:

1. 5G Communication
2. FSOC

Course Outcomes:

After completion of the course, Student will be able to

6. Describe the concept of cellular and wireless mobile communication.
7. Design Base Station (BS) parameters and analyze the antenna configurations.
8. Explain the various concept of Wideband systems.
9. Summarize the working principles of cell phone
10. Assess the latest wireless technologies.

References:

1. Cory Beard and William Stallings, "Wireless Communication Networks and Systems" Pearson, 2015.
2. A.F.Molisch, Wireless Communications, Wiley, 2005.
3. T.S.Rappaport, Wireless Communications: Principles and Practice, Second Edition, Pearson Education / Prentice Hall of India, Third Indian Reprint 2003.
4. ITI SahaMisra, "Wireless Communication and Networks : 3G and beyond", McGraw Hill Education Pvt. Ltd., Second edition, 2013.
5. K. Daniel Wong, "Fundamentals of Wireless Communication Engineering Technologies" Wiley, 2012.
6. P.MuthuChidambaraNathan, Wireless Communications, PHI, 2008
7. A.Goldsmith, Wireless Communications, Cambridge University Press, 2005.

1903EC004		**DISPLAY SYSTEMS**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:	
	1. To expose the students to the basics of the display systems and to illustrate the current design practices of the display systems.

Unit I	**Introduction to Display systems**	**9 Hours**
Introduction to displays. Requirements of displays. Display technologies, CRT, Flat panel and advanced display technologies. Technical issues in displays.		
Unit II	**Head Mounted Display**	**9 Hours**
Head mounted displays. Displays less than and greater than 0.5 m diagonal. Low power and light emitting displays.		
Unit III	**Working Operation of Display**	**9 Hours**
Operation of TFTs and MIMS. LCDs, Brightness. Types of LCD displays.		
Unit IV	**Types of Display**	**9 Hours**
Emissive displays, ACTFEL, Plasma display and Field emission displays, operating principle and performance.		
Unit V	**Applications of Display**	**9 Hours**
Types of Displays: 3D, HDTV, LED, Touch screen.		
	Total:	**45 Hours**

Further Reading:	
	1. 5G Communication
	2. FSOC

Course Outcomes:	
	After completion of the course, Student will be able to
	1. appreciate the technical requirement of different types of displays systems
	2. analyze the various low power lighting systems
	3. understand the operation of TFTs and LCD displays.
	4. analyze the various kinds of emissive displays
	5. critically evaluate the recent advancements in the displays device technology.

References:

1. L.W. Mackonald& A.C. Lowe, Display Systems, Design and Applications, Wiley, 2003.
2. E.H. Stupp&M. S. Brennesholtz, Projection Displays, Wiley,1999
3. Peter A. Keller, Electronic Display Measurement: Concepts, Techniques, and Instrumentation, Wiley-Inter science, 1997.
4. Recent literature in Display Systems.

1903EC027		**ANALOG AND DIGTIAL COMMUNICATION**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:	
	1. To introduce the concepts of various modulations and their spectral characteristics.
	2. To learn Pulse modulation techniques.
	3. To understand the various Band pass signaling schemes and spread spectrum techniques.

Unit I	**AMPLITUDE MODULATION**	**9 Hours**
Introduction to communication systems – Modulation – Need for modulation – Classifications of modulation techniques – Amplitude Modulation – Generation and Detection of AM – Transmitters and Receivers of AM –Super heterodyne receiver – Double Side Band Suppressed Carrier (DSBSC) systems - generation and detection – Single Side Band (SSB) systems – SSB-SC generation and detection, Vestigial Side Band (VSB) – Comparison of various AM systems.		
Unit II	**ANGLE MODULATION**	**9 Hours**
Frequency modulation: Narrowband and wideband FM – Generation of FM signal: Direct FM, indirect FM – Demodulation of FM signals using detectors – FM transmitters – FM receivers – Phase Modulation – Phase Locked Loop – Comparison of AM,FM and PM.		
Unit III	**PULSE MODULATION TECHNIQUES**	**9 Hours**
PAM – PWM – PPM – Comparison of Pulse modulation – Sampling of Band limited signals – Anti aliasing and reconstruction filters - Quantization – Companding - Pulse Code Modulation – Differential pulse code modulation - Delta modulation – Adaptive Delta modulation – Intersymbol Interference – Eye pattern		
Unit IV	**PASSBAND DATA TRANSMISSION TECHNIQUES**	**9 Hours**
Generation, Detection, Representation of signal, Signal constellation diagram, Error probability and Power spectrum of ASK, FSK, BPSK, DPSK, QPSK, MSK, GMSK and QAM coherent schemes – Comparison and BER Analysis.		
Unit V	**SYNCHRONIZATION AND SPREAD SPECTRUM TECHNIQUES**	**9 Hours**
Importance of Synchronization – Carrier, frame and symbol/Chip synchronization techniques, Spread Spectrum- PN Sequence code and properties – Direct Sequence and Frequency Hopping Spread Spectrum Systems –Processing gain and Jamming Margin – Multiple access techniques TDMA – FDMA – CDMA		
	Total:	**45 Hours**

Further Reading:	
	3. Design of AM and FM radio, Television Receivers.
	4. Mobile radio propagation.

Course Outcomes:	
	After completion of the course, Student will be able to
	1. Examine the spectrum and methods of generation and detection of AM systems and its types.
	2. Develop the mathematical model for time domain representation, spectrum and methods
	of generation and detection of angle modulation systems.
	3. Apply the concepts of sampling process and determine the characteristics of Pulse Modulation schemes.
	4. Analyze the performance of different digital modulation /demodulation techniques
	5. Apply the knowledge on the principle of spread spectrum and synchronization.

1. Simon Haykin, “Communication Systems” John Wiley &Sons , 4th Edition-2016.
2. J.G. Proakis, “Digital Communications” McGraw Hill, 5th edition -2007
3. B.P. Lathi, “Communication Systems” BS Publication-2004.
4. V.Chandrasekar, “Analog communication”, Oxford University press-2010
5. Bernard Sklar, “Digital Communication”,2nd Edition, Pearson Education, 2006.
6. Nptel link: https://nptel.ac.in/courses/117/105/117105143/
7. Nptellink : https://onlinecourses.nptel.ac.in/noc20_ee17/course

PROFESSIONAL ELECTIVES – III

1903EC011		**MICROELECTRONICS**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:	
	1. To be exposed of basics of semiconductor and applications.
	2. To be familiar with advanced semiconductors and its applications.
	3. To study the different types of amplifiers and its types.
	4. To know about fabrication methodologies and circuit designing.

Unit I	**INTRODUCTION TO MICROELECTRONICS:**	**9 Hours**
Basic physics of semiconductor-diode models and circuits-physics of MOS transistor-MOS amplifiers –operational amplifiers- semiconductor theory- diodes –bipolar junction transistor(BJT)-BJT amplifiers-field effect transistor – FET amplifiers.		
Unit II	**MOSFET AND IC AMPLIFIERS:**	**9 Hours**
Devices structure and physical operation-VI characteristics-biasing in MOS amplifier circuits-small signal operation and models-SPICE MOSFET-IC design philosophy-comparison of MOSFET and BJT-current sources –current mirrors-current steering circuits-high frequency response.		
Unit III	**MULTI STAGE AMPLIFIER AND FEEDBACK:**	**9 Hours**
MOS differential pair –small signal operation of MOS differential pair-BJT differential pair-other non ideal characteristics and differential pair-differential amplifier with active words-multistage amplifiers-general feedback structure-four basic feedback topologies-series,shunt feedback-determining the loop gain- stability problems-effect of feedback in amplifiers poles-frequency compensation.		
Unit IV	**MICROELECTRONICS FABRICATION:**	**9 Hours**
Clean room technology-silicon wafer production-thermal oxidation –lithography –advanced lithography –etching-diffusion process and ion implementation-thin film deposition –packaging –yields processing-CMOS & BIPOLAR process integration in practice-photo lithography-CVD epitaxy-plasma etching.		
Unit V	**MICROELECTRONIC DEVICES AND CIRCUITS:**	**9 Hours**
Modelling-uniform semiconductor equilibrium-Uniform excitation of semiconductors- Nonuniform Situations:The Five basic equations-Non uniform Carrier Injection :Flow Problems –Non uniformly Doped Semiconductors-Junction Diodes-Bipolar Junction Transistors-The MOS capacitor-Field effect Transistors-Single Transistor Linear Amplifiers Stags-Differential Amplifiers Stages-High Frequency Analysis of Linear Amplifiers.		
	Total:	**45 Hours**

Further Reading:	
	1. Commercial applications of Microelectronic circuits.
	2. Finfet

Course Outcomes:	
	After completion of the course, Student will be able to
	1.Explain the theory, principle of semiconductors and its devices.
	2.Learn the characteristics of advanced semiconductors and its applications
	3.Discuss the working principle and characteristics of different types of amplifiers.

	4.Explain the fabrication methodology of microelectronics components and devices
	5.Explain the various characteristics of microelectronics devices and circuits
References:	
1.Microelctronics by Claudio talarico,A.S.Sedra and K.C.Smith,microlctrcircuits,5/e,oxford university press.	
2.Introduction to microelectronic fabrication by prof.glenn chapman.	
3.Microelectronic devices and circuts 2006 electronic edition by clitonG.Fonsand.	
4.Fundamentals of microelectronics, Behzadrazavi ,johnwileyindia pvt,ltd,2008.	
5.Microelectronics – analysis and design,sundaram Natarajan. Tata McGraw hill.2007	

1903EC012		**ROBOTICS**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

1. To demonstrate the concepts behind robots
2. To interpret the electronics applications in robot for various purpose

Unit I	**INTRODUCTION**	**9 Hours**

Introduction – Definition and origin of robotics, Purpose of Robots, Artificial Intelligence, Robot Anatomy, Robot specifications, Robot characteristics – accuracy, precision, and repeatability, classification of robots, social issues of robotics.

Unit II	**ROBOTIC DRIVE SYSTEMS**	**9 Hours**

Robotic drive systems and actuators: Hydraulic, Pneumatic and Electric drives. Specification, principle of operation and areas of application of: Stepper motor, Servo motor and brushless DC motor, Microprocessor control of electric motors, speed control using PWM and direction control using H- Bridge

Unit III	**SENSORS**	**9 Hours**

Position and displacement sensors, Strain gauge based forcetorque sensors, Tachometers, Touch and Pressure, Piezoelectric material, Switches, Bend sensors, Pressure sensor, Smell, Humidity, Testing sensor.

Unit IV	**POWER AND NAVIGATION**	**9 Hours**

Photovoltaic Cells, Fuel Cells, Li ion Batteries
Vision,Voice communication, Route planning,Adaptive control ,Error monitoring and recovery,Autonomy and intelligence in robots, Automated Guided Vehicles

Unit V	**CASE STUDIES**	**9 Hours**

Pick and Place robot,Industrial applications of Robots in material handling and assemblySpeech-controlled mobile robot, Medical robots, Underwater bots, Aerobots, Drones And Robotic arm

	Total:	**45 Hours**

Further Reading:

1. Humanoid robots
2. Kinematics, Inverse Kinematics, Jacobians

Course Outcomes:

After completion of the course, Student will be able to

1. Articulate the concepts behind robots
2. Outline the concepts of drive systems in robots
3. Summarize the sensors used in robots with its purpose
4. Examine various power sources for robot
5. Inspect various techniques related to navigation of robot.
6. Elaborate the applications of the robots

References:

1. Mikell and Groover, Industrial Robotics – Technology, Programming and Applications,McGraw Hill, 2/e, 2012
2. Saeed B. Niku Introduction to Robotics. Analysis and control, applications- Wiley student edition, 2010
3. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990.
4. D J Todd "FUNDAMENTALS of ROBOT TECHNOLOGY" Springer Netherlands 1986
5. Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006

1903EC013		**NETWORK SECURITY**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

1. To gain knowledge on the various attacks in a network
2. To acquire knowledge on various encryption standards.
3. To build the ability to develop security standard based on the requirement

Unit I	**INTRODUCTION**	**8 Hours**

Security Threats, Security Attacks, Security Services, Mechanisms- Model for Network Security- Classical Encryption Techniques- Substitutions-Transpositions Techniques- Stream Cipher, Block Cipher-Block Cipher Modes-ECB-CBC-CFB-OFB.

Unit II	**BLOCK CIPHERS AND THE DATA ENCRYPTION STANDARD**	**8 Hours**

Simple DES-Differential cryptanalysis- DES-Modes of operation-Triple DES-AES-RC4 –RSA.

Unit III	**HASH ALGORITHM, KEY MANAGEMENT**	**9 Hours**

Hash Function-Message Digest algorithm (MD 5)- Secure Hash Algorithm- Diffie-Hellman Key Exchange- Key Management Techniques- Key Distribution- Key Agreement - Elliptic Curve Cryptography - Digital Signatures- Authentication Protocols

Unit IV	**SECURITY PRACTICE & SYSTEM SECURITY**	**9 Hours**

Authentication applications – Kerberos – X.509 Authentication services - Internet Firewalls for Trusted System: Roles of Firewalls – Firewall related terminology- Types of Firewalls - Firewall designs - SET for E-Commerce Transactions. Intruder – Intrusion detection system – Virus and related threats – Countermeasures – Firewalls design principles – Trusted systems – Practical implementation of cryptography and security.

Unit V	**E-MAIL, IP & WEB SECURITY**	**11 Hours**

E-mail Security: Security Services for E-mail-attacks possible through E-mail - establishing keys privacy-authentication of the source-Message Integrity-Non-repudiation-Pretty Good Privacy-S/MIME. IP Security: Overview of IPSec - IP and IPv6-Authentication Header-Encapsulation Security Payload (ESP)-Internet Key Exchange (Phases of IKE, ISAKMP/IKE Encoding). Web Security: SSL/TLS Basic Protocol-computing the keys-client authentication-PKI as deployed by SSL Attacks fixed in v3- Exportability-Encoding-Secure Electronic Transaction (SET).

	Total:	**45 Hours**

Further Reading:

1. Attacks- Primarily test- factoring, Discrete Logarithms
2. Malicious software-viruses-Firewalls- Security Standards.

Course Outcomes:

After completion of the course, Student will be able to

1. Identify vulnerability of computer networks to security threats.
2. Acquire knowledge on existing security algorithms and cryptography standards.
3. Understand various cryptography techniques and their implications on network security
4. Analyze the type of security threat and the appropriate security standard to be adopted
5. Formulate and implement new security standards

References:

1. William Stallings,"Cryptography and Network Security: Principles and Practice",Prentice Hall Professional Technical Reference, Fourth Edition. 2004
2. Alfred J. Menezes, Paul C.VanOorSchot, Scott A.Van Stone, "Handbook Of Applied Cryptography", CRC Press, 1996.
3. Atul Kahate "Cryptography and Network Security". Tata McGraw-Hill
4. Bruce Schneier,"Applied Cryptography: Protocols, Algorithms, and Source Code in C",Second Edition,
5. Wiley, John & Sons, Incorporated, October 1995.
6. Richard E. Smith,"Internet Cryptography", Addison- Wesley, 1997

1903EC014		SOFT COMPUTING	L	T	P	C
			3	0	0	3

Course Objectives:

1. Tosummarize the concepts of genetic algorithm, neural networks
2. To employ fuzzy logic principles
3. To explain principles of python language

Unit I **NEURAL NETWORKS** **9 Hours**

Need of Softcomputing-Biological Neurons Networks – Artificial Neural Networks - Supervised - .unsupervised learning - Reinforcement Learning – Activation functions - Perceptron - Back Propagation networks – Radial Basis Function Networks - Adaptive Resonance architectures-TDNN -Convolution Neural Network.

Unit II **FUZZY LOGIC** **9 Hours**

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions -Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making.

Unit III **GENETIC ALGORITHM** **9 Hours**

Genetic algorithm and search space - general genetic algorithm – operators - Generational cycle - stopping condition – constraints - classification - genetic programming – multilevel optimizations.

Unit IV **INTRODUCTION TO PYTHON** **9 Hours**

Why Python? – Advantages of Python – Environment setting-Function Declaration - Import - Objects - Indenting as Requirement - Exceptions - Unbound Variables - Case Sensitive – Scripts- Native Data Types - Booleans - Numbers - Lists -Arrays-Tuples - Sets - Dictionaries – Comprehensions.

Unit V **PROGRAMMING CONCEPTS IN PYTHON** **9 Hours**

Conditions-Loops (While, Do while, For)-Module -Scope-Exception Handling- Files I/O - List of Functions - Packages - Classes – Inheritance-Polymorphism- Encapsulation- Common Gateway Interface.

Total: 45 Hours

Further Reading:

Machine learning

Course Outcomes:

After completion of the course, Student will be able to

1. **Design of various neural networks based on application**
2. **Use fuzzy logic based on application**
3. **Examine various types of genetic algorithms**
4. **Describe the concepts of Python**
5. **Discuss various concepts of OOPS in Python**

References:

1. J.S.R.Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI / Pearson Education 2004.
2. Mark Pilgrim, ―Dive into Python 3‖, Apress, 2009.
3. S.Rajasekaran and G.A.VijayalakshmiPai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.
4. David E. Goldberg, “Genetic Algorithm in Search Optimization and Machine Learning” Pearson Education India, 2013.
5. George J. Klir, Ute St. Clair, Bo Yuan, “Fuzzy Set Theory: Foundations and Applications” Prentice Hall, 1997.

E-References:

1. **https://cse.iitkgp.ac.in/~dsamanta/courses/archive/sca/Slides.htm**
2. https://docs.python.org
3. Programming for Everybody (Getting Started with Python) Coursera By University of Michegan

1903EC015		**ADVANCED DIGITAL SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
			2	**2**	**0**	**3**

Course Objectives:

1. To explore the concepts of multi rate signal processing and multi rate filters.
2. To study the adaptive filters and its applications.
3. To know about Linear and Prediction concepts.
4. To learn fundamental concepts on signal processing in power spectrum estimation.

Unit I	**Multirate Digital signal Processing**	**9 Hours**

Introduction-Sampling and Signal Reconstruction-Sampling rate conversion – Decimation by an integer factor – interpolation by an integer factor –Sampling rate conversion by a rational factor – poly-phase FIR structures – FIR structures with time varying coefficients - Sampling rate conversion by a rational factor- Multistage design of decimator and interpolator.

Unit II	**Multirate FIR Filter Design**	**9 Hours**

Design of FIR filters for sampling rate conversion –Applications of Interpolation and decimation in signal processing –Filter bank implementation –Two channel filter banks-QMF filter banks –Perfect Reconstruction Filter banks – tree structured filter banks - DFT filter Banks – M-channel filter banks-octave filter banks

Unit III	**Linear Estimation and Prediction**	**9 Hours**

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

Unit IV	**Design of Adaptive filters**	**9 Hours**

FIR Adaptive filters - Newton's steepest descent method – Adaptive filters based on steepest descent method -LMS Adaptive algorithm – other LMS based adaptive filters- RLS, Exponentially weighted RLS - Sliding window RLS – Simplified IIR Application: channel equalization, noise cancellation, prediction.

Unit V	**Power Spectral Estimation**	**9 Hours**

Estimation of spectra from finite duration observations of a signal –The Periodogram-Use of DFT in Power spectral Estimation –Non-Parametric methods for Power spectrum Estimation – Bartlett. Welch and Blackman–Tukey methods –Comparison of performance of Non – Parametric power spectrum Estimation methods –Parametric Methods - Relationship between auto correlation and model parameters, Yule-Walker equations, solutions using Durbin's algorithm,AR, MA, ARMA model based spectral estimation.

Total:	**30 + 15 Hours**

Further Reading:

Applications of adaptive filters: Adaptive channel equalization Adaptive echo canceller - Adaptive noise cancellation-, 1/M-octave-band filter banks, Speech enhancement using spectrum estimation

Course Outcomes:

After completion of the course, Student will be able to

1. Design and implement decimator and interpolator and to design multi rate filter bank and acquires knowledge of how a multi rate system work
2. Understand different spectral estimation techniques and linear prediction
3. Explain about LMS and RLS adaptive filters for signal enhancement, channel equation
4. Illustrate different Power spectrum methods and solutions

References:

1. H. Monson Hayes, **Statistical Digital Signal Processing and Modeling**, John Wiley and Sons, Inc., 2008.
2. G. John Proakis and G. Dimitris Manolakis, **Digital Signal Processin***g*, Pearson Education, 2006.
3. P.P.Vaidyanathan, **Multirate Systems and Filter Banks**, Pearson Education, 2008.
4. N.J.Filege, **Multirate Digital Signal Processing**, John Wiley and Sons, 2000.
5. John Proakis, **Algorithms for Statistical Signal Proc ssing**, Pearson Education, 2002.
1. G.Dimitris and C.Manolakis, **Statistical and Adaptive Signal Processing**, McGraw Hill, 2002.
6. Sophoncles J. Orfanidis, **Optimum Signal Processing**, McGraw Hill, 2007.