Pandit Deendayal Petroleum University, Gandhinagar

School of Technology
Information & Communication Technology

Undergraduate Curriculum Handbook
(Academic Year 2020-24)

Semester-I

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR

SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B. TECH. IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester I			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Mathematics – I	3	1	0	4	4	25	50	25	--	--	100
2		Engineering Chemistry	3	0	0	3	3	25	50	25	-	-	100
3		Engineering Chemistry Lab	0	0	2	1	2	--	--	--	50	50	100
4		Element of Mechanical Engineering	3	0	0	3	3	25	50	25	-	-	100
5		Element of Mechanical Engineering Lab	0	0	2	1	2	--	--	--	25	25	50
6		Basic Electronics	2	0	0	2	2	25	50	25	--	--	100
7		Basic Electronics Lab	0	0	2	1	2	--	--	--	25	25	50
8		Computer Programming - I	1	0	0	1	1	25	50	25	--	--	100
9		Computer Programming Lab - I	0	0	2	1	2	--	--	--	25	25	50
10		Professional Ethics and Human Values	1	0	0	1	1	25	50	25	--	--	100
11		NCC/NSS/Sports	0	0	2	1	2	--	--	--	100		100
		Total	13	1	10	19	24						900

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LW- Lab work, LE- Lab Exam

20MA101T					MATHEMATICS-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To be able to evaluate problems related to differential and integral calculus of complex functions.
- To be able to obtain area, volume using integral calculus.
- To be able to formulate and solve various engineering problems using the calculus.
- To study the properties of Matrix algebra and apply them to solve system of algebraic equations.

UNIT 1 DIFFERENTIAL CALCULUS AND ITS APPLICATIONS **08 Hrs.**

Partial derivative and its application, - Euler's theorem - Total derivatives - Jacobians – Maxima and Minima of two variables using Lagrange's multipliers. Convergence of infinite series.

UNIT 2 INTEGRAL CALCULUS AND ITS APPLICATIONS **12 Hrs.**

Definition Evaluation of double integral (Cartesian – Polar form) – Change of orders - Change of variables – Evaluation of triple integral, change of variables (Cartesian to spherical – and cylindrical) – Applications, area – volume – center of mass – center of gravity by double and triple integral.

UNIT 3 MATRIX ALGEBRA AND ITS APPLICATIONS **10 Hrs.**

Solution of system of algebraic equation - Rank of a matrix, consistency of system of equation - Characteristic equation of a square matrix- Eigen values and Eigenvectors of a real matrix - Properties of eigen values and eigen vectors - Cayley-Hamilton theorem (without proof) - finding inverse of a matrix - Diagonalisation of a matrix using orthogonal transformation.

UNIT 4 VECTOR CALCULUS **10 Hrs.**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector Integration – Simple problems on line, surface and volume integrals – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (without proofs) – Simple application involving cubes and rectangular parallelepipeds.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify the use of convergence of infinite series in engineering aspects.
CO2 – Understand the concept of Directional derivative, Irrotational and Solenoidal vector fields.
CO3 – Apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution in context with theory.
CO5 – Appraise mathematical problems from real to complex domain.
CO6 – Evaluate problems on Green's, Stokes' and Divergence theorems.

TEXT/REFERENCE BOOKS

- B. S Grewal, Higher Engineering Mathematics, (43rd Edition), Khanna Pub., Delhi (2014).
- R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd Ed., 2007.
- Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th Ed., 2015.
- G. Strang, Linear Algebra and its applications, 4th Edition, Cengage Learning, 2005.
- K. Hoffman and R. A. Kunze, Linear Algebra, Prentice Hall of India, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: 10 questions 3 marks each	30 Marks (40 min)
Part B: 5 questions 6 marks each	30 Marks (50 min)
Part C: 5 questions 8 marks each	40 Marks (90 min)

16SC101T					Engineering Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop the fundamental understanding about atomic structure and interatomic bonding.
- To provide the knowledge about structural features, synthesis, properties of various categories of materials.
- To develop the skills for phase, microstructural and elemental characterisation of materials.
- To provide the knowledge about the role of chemistry in modern engineering applications.

UNIT 1 Atomic structure and interatomic bonding **12 Hrs**

Electrons in atoms, Bohr atomic model, wave mechanical model, introduction to quantum chemistry, wave functions and probability densities, quantum numbers, orbital shapes - *s,p,d,f*- LCAO-MO of H_2, covalent, ionic and metallic bonding, bonding forces and energies, lattice energy and Madelung constant, metallic crystal structure, ceramic crystal structure and influencing factors.

UNIT 2: Chemistry of materials **10 Hrs**

Introduction and classification of materials; structural features, synthesis, properties of metallic (e.g. noble metal), polymeric (e.g. thermoplastic and thermosetting), glass-ceramic (e.g. silicates, metal oxides) carbonaceous materials (e.g. fullerene, carbon nanotube, graphene); Introduction to nanomaterials, surface area to volume ratio and aspect ratio of nanomaterials, quantum confinement, top-down and bottom up chemical/physical approaches for synthesis of nanomaterials.

UNIT 3: Chemistry of Fuels and energy devices **10 Hrs**

Fuels – Classification of fuels; Determination of calorific values of solid fuels by bomb calorimeter – Manufacture of synthetic petrol by Fischer-Tropsch method – Knocking in IC engines – Octane and cetane rating of fuels; Petrol and Diesel Engine, chemistry for alternative source and storage of energy (supercapacitor, fuel cell, battery); role of chemistry on in photo-voltaic devices (solar cell).

UNIT 4: Instrumental methods of chemical analysis **12 Hrs**

Characterization of materials using X-ray diffraction (XRD), thermal Analysis (TGA-DTA-DSC), basics and application of Microwave spectroscopy, FTIR, UV-visible spectroscopy; NMR spectroscopy; Chromatographic techniques (GC, HPLC).

Max. 44 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental concept about atomic structure and interatomic bonding.

CO2 - Acquire knowledge about metallic and ceramic crystal structure.

CO3 - Acquire knowledge about structural features, properties of different classes of materials including nanomaterials.

CO4 - Explain the methodologies for the synthesis of different categories of materials.

CO5 - Develop the skill for phase, microstructural and elemental characterisation of materials.

CO6 - Develop the knowledge on the role of chemistry in various modern engineering applications.

TEXT/REFERENCE BOOKS

- An Introduction to Materials Science & Engineering, W.D. Callister, John Wiley & Sons (2007).
- Fundamental of Ceramics, MW Barsoum, IOP publishing (2003).
- Text book of Nanoscience and Nanotechnology, T. Pradeep, Mc. Graw Hill Education (2003).
- Textbook of Nanoscience and Nanotechnology, Murty, Shankar, B Raj, Rath, Murday, Springer (2013).
- Materials Science and Engineering, V. Raghavan, Prentice-Hall of India Private Limited (2003).
- Principles of Instrumental Analysis, Douglas A. Skoog, Donald M.West, 6th Edition, Cengage (2014)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A/Question: 3 Questions from each unit, each carrying 3 marks	36 Marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks	64 Marks

16SC101P					Engineering Chemistry Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To enhance and develop scientific and analytical skills
- To relate concepts learned in chemistry and engineering to the real-world situations.
- To acquire skills to perform laboratory experiments.
- To demonstrate safe and proper use of standard chemistry glassware and equipment.

LIST OF EXPERIMENTS

1. **External Indicator**–To determine the strength of given solution of ferrous ammonium sulphate by titrating against standard N/40 $K_2Cr_2O_7$ using potassium ferricyanide as an external indicator
2. **Iodometry**– To determine the strength of given copper sulphate solution by titrating against N/20 sodium thiosulphate (hypo) solution
3. **Iodimetry**– To determine the strength of given ascorbic acid by titrating against standard N/10 iodine solution
4. **Complexometric Titration**– To determine the total, permanent and temporary hardness of given water by complexometric titration using standard 0.01M EDTA solution
5. **pH metric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a pH-metric titration
6. **Conductometric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a conductometric titration
7. **Potentiometric titration**– To determine the strength of given HCl solution potentiometrically
8. **Chemical Kinetics**– To study the kinetics of decomposition of sodium thiosulphate by a mineral acid
9. **Chloride in Water**– Determination of Chloride in the given water sample by Mohr Method
10. **Polymerization**– To prepare a polymer (Nylon 6,10), identify the functional groups by FT-IR
11. **Spectrophotometry**– To determine the λmax and concentration of given unknown potassium permanganate using UV-Visible Spectroscopy technique

Max. 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the concepts learned in chemistry and engineering to the real-world situations.

CO2 - Enhanced ability to identify, analyse and interpret the results from the experiments

CO3- Carry out quantitative analysis by instrumental method using Conductometer.

CO4- Analyse compounds by titrimetric, gravimetric and instrumental methods

CO5- Determine the concentration of unknown solutions by Spectrophotometric method.

CO6- Investigate the reaction rate and predict the order and rate constant

TEXT/REFERENCE BOOKS

- College Practical Chemistry, VK Ahluwalia, S Dhingra, A Gulati, Universities Press
- Foundations of Experimental Chemistry, JB Baruah, P Gogoi, PharmaMed Press.
- A Text Book of Chemistry Practicals Vol I & II, SS Sawhney, M S Jassal, SP Mittal, APH Publishing Corp.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3Hrs**

Part A : Lab Work – Continuous Assessment 50 Marks

Part B : Lab Exam and Viva 50 Marks

					Elements of Mechanical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To introduce and define the basics concept of mechanical engineering.
- To familiarize the working principles of IC engines and industrial robotics systems.
- To enable the students to understand the details about the energy systems and its components.
- To demonstrate the various machine elements, materials and its function.
- To help the students acquire knowledge about the various manufacturing process.

UNIT 1 **10 Hrs.**

Introduction to Thermodynamics: Definition and applications, systems and control volumes, thermodynamic properties, thermodynamic systems, state and equilibrium processes and cycles, temperature and Zeroth law of thermodynamics, forms of Energy, energy transfer by work and heat, law of conservation of energy, energy conversion efficiencies.

Properties of Pure substances: Definition, examples and phases, phase change of pure substances, property diagrams and property tables. Solution of Numerical Problems through EES Software.

UNIT 2 **10 Hrs.**

Law of degradation of Energy: Limitations of First Law, Thermal Energy reservoirs, heat engines, Refrigerators and Heat pumps, Kelvin Plank and Clausius statement and their equivalence.

Internal Combustion Engines: Introduction, classification and brief description of I.C. engines mechanism, 4-Stroke and 2-Stroke cycles and engines. Otto, Diesel and dual cycles; MEP and air standard efficiencies.

UNIT 3 **10 Hrs.**

Engineering materials: Stresses, strains and material properties.

Introduction to Manufacturing Processes: Conventional manufacturing process: Lathe Machines, CNC machines, drilling machines, universal Milling machines. Non-conventional manufacturing processes: Additive Manufacturing, 3D printing.

UNIT 4 **10 Hrs.**

Introduction to industrial robotics: Introduction, Industrial and Non-industrial robots, Anatomy and configuration of Industrial Robots, Robot Components, Robot Applications.

Introduction to Industry 4.0.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define the "fundamentals' and "terminologies" used in Engineering Thermodynamics.
CO2: Explain the energy conservation principles applicable for ideal gas and pure substance applications
CO3: Analyse the performance of thermodynamic cycles.
CO4: Evaluate the performance of power cycles
CO5: Identify the principles of different machining techniques and material properties.
CO6: Understand the anatomy, applications of robots and introduction to industry 4.0.

TEXT/REFERENCE BOOKS

- Yunus A. Cengel& Bole, Thermodynamics- Engineering Approach by Tata Mcgraw Hill.
- Sharma PC. A Textbook of Production Enginerring. S. Chand Publishing.
- P. K. Nag, Engineering Thermodynamics, Tata Mcgraw Hill, New Delhi.
- Industrial Robotics, Mikell Groover, McGraw-Hill Education (India) Pvt Limited

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Unit 1 and 2: Two question from each unit (Total 4 question with subparts)	40 Marks
Unit 3 and 4: Two question from each unit (Total 4 question with subparts)	60 Marks

					Elements of Mechanical Engineering Lab.		
Teaching Scheme					**Examination Scheme**		
L	**T**	**P**	**C**	**Hrs/Week**	**Practical**		**Total Marks**
					Continuous Evaluation	**End Semester LE/Viva**	
0	**0**	**2**	**1**	**2**	**25**	**25**	**50**

COURSE OBJECTIVES:

- To Perform experiments and collect experimental data on thermal and mechanical systems to validate theoretical principles.
- **To analyse, differentiate** and **evaluate** Law of conservation of energy on thermal systems.
- **To evaluate** performance of heat engine and heat pumps.
- **To calculate and compare** the components, application of the conventional manufacturing machines, non-conventional manufacturing machines and industrial robotic systems.
- **To demonstrate** the working principle of heat engine and additive manufacturing process.

List of Experiments:

1. To understand and perform fluid property evaluation using property tables and engineering equation solver software.
2. To perform experimental study and verify 1st law of thermodynamics by energy balance of heat exchanger.
3. To evaluate thermodynamic systems using Engineering Equation Solver.
4. To determine Performance of Heat pump and evaluate its coefficient of performance.
5. To understand and demonstrate components and working cycle of Internal Combustion engine.
6. To understand and demonstrate construction and working of conventional manufacturing machine.
7. To understand and demonstrate construction and working of non-conventional manufacturing machine.
8. To study additive manufacturing process applied for 3D printing.
9. To develop a working model of a simple robotic system.

Course Outcomes (COs): On completion of the course, students will be able to

CO1 - Understand and **evaluate** conservation law of thermodynamics through experimentation.
CO2 - Understand and **analyse** thermal systems data using engineering equation solver.
CO3 – Measure the coefficient of performance of heat pump.
CO4 - Examine the internal combustion engine components and its working.
CO5 - Demonstrate the various components of convention and non-conventional manufacturing machines and elaborate their applications.
CO6 – C**lassify** the components in industrial robots and **develop** a simple robotic system.

Resources/Text/Reference books

- Sukhatme, S.P. and Nayak, J.K., 2008. Principles of thermal collection and storage. Solar Energy, 3rd Edition, Tata McGraw Hill Publishing company, New Delhi.
- Cengel, Y.A., Klein, S. and Beckman, W., 1998. Heat transfer: a practical approach (Vol. 141). New York: McGraw-Hill.
- Industrial Robotics, Mikell Groover, McGraw-Hill Education (India) Pvt Limited

End Semester Lab Examination

Max. Marks	**Exam Duration: 2 hrs**
Quiz/Experiment	10 Marks
Viva	15 Marks

20ICXXX					Basic Electronics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	0	0	100

COURSE OBJECTIVES

- To understand rectification through p-n junction diode and applications of diode.
- To learn different configurations and static characteristics of bipolar junction transistor and MOSFET.
- To illustrate the OPAMP application in different real life circuits.
- To introduce basic concepts of digital electronics.

UNIT 1: DIODES AND RECTIFIERS **08 Hrs.**

Review of p-n junction diode, 1-phase half wave, full wave and bridge rectifier using diode. Calculation of average & rms value, PIV, efficiency, transformer utilization factor and ripple for different diode rectifier circuit. Use of Capacitor Filter for ripple reduction, voltage multipliers, Zener diode in load and line regulation.

UNIT 2: BJT, FET AND MOSFET **07 Hrs.**

Working of a BJT, transistor biasing, different transient circuit configuration (CB, CE and CC), static characteristic for BJT, transistor as switch, amplifier, concept of feedback amplifier and oscillator. Classification of FET, static characteristics of FET, FET biasing and load line, MOSFET, static characteristic of MOSFET and biasing

UNIT 3: OPAMP **04 Hrs.**

Introduction, Block Diagram and Characteristics of Ideal Op-Amp, Parameters of an Op-Amp, Virtual Ground, Inverting and Non- Inverting Amplifier, Integrator and Differentiator, Adder, Subtractor, Comparator.

UNIT 4: DIGITAL ELECTRONICS **07 Hrs.**

Number system, Binary arithmetic, logic gates and combinational logic, Boolean algebra, DeMorgan's Theorems, Logic minimization and Karnaugh maps, full adder, multiplier, multiplexing, Flip Flops, Introductory Sequential Logic, Counters, Registers

Total 26 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 –Demonstrate application of different diode in circuits.

CO2 – Evaluate zener diode as voltage regulator.

CO3- Apply BJT, FET and MOSFET in different circuits.

CO4–Understand static characteristics OPAMP.

CO5–Illustrate basic concepts and theorem of digital systems.

CO6–Build digital circuits using logic gates and flip flops.

TEXT/REFERENCE BOOKS

- Boylestad and Nashlesky, "Electronic Devices and Circuit Theory", PHI.
- N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, "Basic Electronics And Linear Circuits", McGraw Hill Education (India).
- R. A. Gaikwad, "Operational Amplfier and Linear Integrated Circuits", PHI.
- Morris Mano, "Digital Design", PHI.
- J. Millman, C. Halkias and C. Parikh, "Integrated Electronics", Tata McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.(10 to 20 marks each)	80 to 60 Marks

20ICXXX					Basic Electronics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	0	0	0	25	25	50

COURSE OBJECTIVES

- To understand the characteristics of PN junction diodes and their applications.
- To Observe properties of BJT, FET and MOSFET.
- To illustrate the OPAMP application in different real life circuits.
- To introduce basic concepts of digital electronics.

Experiment Sessions would be simulation based covering but not limited to following topics:

1. To study the simulation tool and its features for analog circuit simulation.
2. To study the VI characteristic of silicon and germanium diodes.
3. To study reverse characteristics of zener diode.
4. To study half wave, full wave and bridge rectifiers
5. To study BJT as switch.
6. To study common emitter amplifier.
7. To study different biasing circuits of BJT.
8. To study transfer and drain characteristic of FET and MOSFET.
9. To study the simulation of digital circuits.
10. To study and verify logic gates.
11. To implement X-OR and X-NOR gates using basic gates.
12. To study and design adder and subtracter circuits.
13. To study and design flip flops.
14. To study OPAMP and its properties.
15. To study ADC and DAC.
16. Design of mini project in a group of 4-5 students.

Some of the above topics would be covered through the associated theory course

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Study the fundamentals of electronic components.
CO2: Understand the working principle of semiconductor devices.
CO3: Apply the analog and digital concept in building real time circuits.
CO4: Analyze the behaviour of semiconductor devices, OPAMP, ADC and DAC.
CO5: Evaluate different circuit for different device parameters.
CO6: Build analog and digital sub-system.

TEXT/REFERENCE BOOKS

- Boylestad and Nashlesky, “Electronic Devices and Circuit Theory”, PHI.
- N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, “Basic Electronics And Linear Circuits”, McGraw Hill Education (India).
- R. A. Gaikwad, “Operational Amplfier and Linear Integrated Circuits”, PHI.
- Morris Mano, “Digital Design”, PHI.
- J. Millman, C. Halkias and C. Parikh, “Integrated Electronics”, Tata McGraw Hill.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks:25 **Exam Duration:2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Computer Programming - I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	25	50			100

COURSE OBJECTIVES

- To develop a greater understanding of the issues involved in programming language, design and implementation
- To inculcate functional and logical problem-solving skills through programming.
- To understand the basic concepts of C programming

UNIT 1 BASICS OF C PROGRAMMING 4 Hrs.

Input, Output constructs, different data types, types of Operators, Precedence and associativity of Operators, Control Structure and Loop Structure

UNIT 2 ARRAY AND STRINGS 4 Hrs.

1-dimensional, 2-dimensional and 3-dimensional arrays, different types of user defined functions, String operations in form of Character arrays, In-built String functions

UNIT 3 POINTERS 4 Hrs.

Basic pointer arithmetic, arrays and String using Pointer, call the functions using Call-by reference property

UNIT 4 FILE HANDLING 2 Hrs.

open the file in write mode and write the data into it, open the file in read mode and read from the file, Open the file in append mode and append the contents in the file, handle the File operations using seek function.

Max. 14 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand functional and logical problem-solving skills through programming

CO2 - Write, compile and debug programs in C language

CO3 – Use basic and derived data types in C and Operators in C.

CO4 - Design programs involving decision structures, loops, and functions in C.

CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers.

CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

- E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
- Jeri R. Hanly and Elli B.Koffman, Problem Solving and Program Design in C.
- Brain W.Kernighan & Dennis Ritchie, C Programming Language, PHI

SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A: 10 Questions of 2 marks each-No choice 20 Marks

Part B: 2 Questions from each unit with internal choice, each carrying 80 Marks

Pandit Deendayal Petroleum University					School of Technology					
<Course Code>					**Computer Programming Lab- I**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
0	**0**	**2**	**1**	**2**	**-**	**-**	**-**	**25**	**25**	**50**

COURSE OBJECTIVES

- To understand the basic concepts of C programming
- To understand design and implementation issues involved with variable allocation and binding, control flow, types, subroutines, parameter passing
- To develop understanding of Compilation process.

LIST OF EXPERIMENTS:

Practical list should be prepared based on the content of the subject and following guidelines should be useful.
- Computer Programming covering all constructs of C language.

Following list gives some programming examples. Faculty can prepare their own list in same manner keeping above guidelines and syllabus in mind.

1. Add, subtract, multiply, divide two numbers.
2. Convert hours into minutes, minute to hours.
3. Conversion related programs dollars into Rs. Where 1 $ = 48 Rs. , grams to KG, Kilobytes to Megabytes.
4. Convert Celsius into Fahrenheit. F = (9/5 * C) + 32 and Fahrenheit into Celsius. C = 5/9 * (F – 32)
5. Calculate simple and compound interest where I = PRN/100.
6. Calculate area & perimeter of a square, rectangle, circle, triangle.
7. Program to sort N numbers. (Ascending and Descending)
8. Program to calculate string length, reverse the string.
9. Program to check the string and number is palindrome or not.
10. Program to generate sine, cosine, tan series.
11. Program to generate Fibonacci series.
12. Program to calculate factorial using recursion.
13. Program to create a database using array of structures.
14. Programs related to pointers.
15. Programs related to file.

Design based Problems (DP)/Open Ended Problem:

1. Develop a game/Puzzle in C language.
2. Use interrupts to develop programs related to basic operations.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand functional and logical problem-solving skills through programming.
CO2 - Write, compile and debug programs in C language.
CO3 – Use basic and derived data types in C and Operators in C.
CO4 - Design programs involving decision structures, loops, and functions in C.
CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers.
CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

- E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
- Jeri R. Hanly and Elli B.Koffman, Problem Solving and Program Design in C.
- Brain W.Kernighan & Dennis Ritchie, C Programming Language, PHI

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs**

Part A/Question: <QUIZ/VIVA> <25> Marks
Part B/Question: <PRACTICAL PERFORMANCE> <25> Marks

Pandit Deendayal Petroleum University					School of Technology					
16HS109T					**Professional Ethics and Human Value**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
1	**0**	**0**	**1**	**1**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- Identify the core values that shape the ethical behaviour of an Engineer.
- Awareness on professional ethics and human values.
- To know their role in technological development.
- To appreciate the rights of others.
- Improved communication and learn to work in group.
- Learn to understand and discuss on issues of social interest.

Unit 1: Human Values **[5 hrs]**

Morals, Values and Ethics - Integrity - work Ethic - Service Learning - Civic Virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Co-operation - Commitment - Empathy - Self-Confidence - Character - Spirituality

Unit 2: Engineering Ethics **[4 hrs]**

Sense of 'Engineering Ethics' - Variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Models of Professional Roles & Professionalism - theories about right action - Self-interest - customs and religion - uses of ethical theories.

Unit 3: Engineering as experimentation **[4 hrs]**

Engineers as responsible experimenters - Research ethics -Codes of ethics - Industrial Standard - Balanced outlook on law - the challenger case study.

Unit 4: Safety, risk and Global issues **[5 hrs]**

Safety and risk - assessment of safety and risk - Risk benefit analysis and reducing risk - Threat of Nuclear power - Collegiality and loyalty - respect for authority - Confidentiality - conflicts of interest - professional rights - employees' rights - Intellectual Property rights (IPR) - discrimination. Multinational corporations - Business ethics - Environmental ethics - Role in Technological Development - Weapons development - consulting engineers - engineers as expert witnesses and advisors-Ethics.

Total 18 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Find the core values that shape the ethical behaviour of an Engineer.
CO2: Students will get aware of the professional ethics and human values.
CO3: Develop and understand their role in technological development.
CO4: Simplify to the rights of others.
CO5: Perceive improved communication with activities and learning to work in group.
CO6: Discuss on issues of social interest and make opinions based on logical reasoning.

TEXT/REFERENCE BOOKS

1. A Textbook on Professional Ethics and Human Value by Prof. R. S. Nagaarazan, New Age International Limited Publisher, Chennai. 2006
2. A Text book on Professional Ethics and Human Values by M. Govindarajan, S. Natarajan, V. S. Senthilkumar, PHI Learning Pvt. Ltd., 2013.
3. A Text book on Professional Ethics and Human Values by Dinesh Babu, Firewall Media, 2007

HSC ------					NCC/NSS/SPORTS					
Teaching Scheme					Examination Scheme					
					Theory			Practical		
L	T	P	C	Hrs/Week	MS	ES	IA	LW	*Participation and Attendance	Total Marks
0	0	2	1	2	* Continuous Evaluation			--	100	100

COURSE OBJECTIVES

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
- To develop youth leadership in the students.
- To induce social consciousness among students through various camps and 'Shibir' activities.
- To develop skills and physical fitness among students through indoor & outdoor sports, field & track events.

National Cadet Corps (NCC):

Introduction to NCC, Aims and objectives, Structure and organization, NCC Song, Incentives, National Integration and Awareness, Drill, saluting, Personality Development & Leadership, Disaster Management, Social Awareness & Community Development, Health & Hygiene, Adventure camps, Environment Awareness and Conservation, Obstacle Training, Armed forces, Map reading, Field Craft & Battle Craft, Introduction to Infantry Weapons & Equipment, Weapon Training (During camps), Participation into Republic and Independence day ceremonial parades,

National Service Scheme (NSS):

Importance and role of youth leadership, Life competencies, Youth development programmes and youth 'shibir', Health, hygiene and sanitation, Youth health, lifestyle, first aid, youth and yoga

Sports:

Importance of sports/games in life, Physical fitness, Introduction to various games and sports, field and track events, Physical training, exercises, running, walking, jogging, Teaching of different sports/games, track & field events , demonstration, practice, skills and correction, Introduction to Yoga & Meditation.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Understand** the importance of Nation building and individual contribution to the same.
CO2 – **Integrate** physical fitness and mental wellbeing
CO3 – **Discover** grassroots challenges of community
CO4 – **Creating** societal impact
CO5 – **Maintain** discipline and team spirit
CO6 – **Upholding** the value of one for all and all for one

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: --**

* All registered students will be evaluated based on his/her attendance during the NCC/NSS/Sports sessions and participation to camps and other activities.

Note: Registration to NCC course in semester 01 will be based on availability of vacancy in the unit under which NCC platoon is registered.

Once registered for any of NCC/SPORTS/NSS in first semester, student cannot change to other course in second semester.

Semester-II

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR

SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B. TECH. IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester II			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Mathematics – II	3	1	0	4	4	25	50	25	--	--	100
2		Element of Civil Engineering & Solid Mechanics	4	0	0	4	4	25	50	25	-	-	100
3		Element of Civil Engineering & Solid Mechanics - Lab	0	0	2	1	2	--	--	--	25	25	50
4		Elements of Electrical Engineering	3	0	0	3	3	25	50	25	-	-	100
5		Elements of Electrical Engineering - Lab	0	0	2	1	2	--	--	--	25	25	50
6		Engineering Physics	3	0	0	3	3	25	50	25	--	--	100
7		Engineering Physics Lab	0	0	2	1	2	--	--	--	25	25	50
8		Workshop Practice	0	0	2	1	2	25	50	25	--	--	100
9		Engineering Graphics-Lab	0	0	4	2	4	--	--	--	25	25	50
10		Computer Programming II	0	0	2	1	2	--	--	--	50	50	100
11		Environmental Studies	3	0	0	3	3	25	50	25	--	--	100
12		Communication Skills – I	0	0	2	1	2	--	--	--	50	50	100
13		NCC/NSS/Sports	0	0	2	1	2	--	--	--	100		100
14		Civic services and Social Internship (Summer Break)	0	0	0	1	0	--	--	--			100
		Total	16	1	18	27	35						1200

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam

20MA103T					MATHEMATICS - II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To be able to apply the calculus of complex functions to construct analytic functions.
- To be able to compute residues and apply them to evaluate contour integrals.
- To be able to formulate and solve various engineering problems using the methods of solving ODEs.
- To study the properties of Laplace transforms and apply them to solve ODEs.

UNIT 1 COMPLEX DIFFERENTIATION **10 Hrs.**

Limit, Continuity, Differentiability of function of complex variable, Analytic function, Cauchy-Euler equation (in Cartesian and polar coordinates), Harmonic function and its significance, Singularities, Taylor's series, Mapping (translation, rotation and inversion), bilinear transformation, Conformal mapping, Applications of Conformal mapping.

UNIT 2 COMPLEX INTEGRATION AND APPLICATIONS **10 Hrs.**

Definition of a Complex line integral, Contour integrals, Cauchy- Goursat theorem, Cauchy integral theorem, Cauchy Integral formula (CIF), CIF for derivatives, Calculation of residues, Cauchy Residue theorem, Applications of residues to evaluate real definite integrals.

UNIT 3 ORDINARY DIFFERENTIAL EQUATIONS WITH APPLICATIONS **10 Hrs.**

Differential equations of first order and higher degree, Higher order differential equations with constant coefficients, Rules for finding C.F. and P.I., Method of variation of parameters, Cauchy and Legendre's linear equations, Linear differential equations of second order with variable coefficients; Simultaneous linear equations with constant coefficients, Applications of higher order differential equations in solving engineering problems.

UNIT 4 LAPLACE TRANSFORMS **10 Hrs.**

Piecewise continuous functions and exponential functions, Definition, Existence and Properties of Laplace transforms, Heaviside function, Inverse Laplace transform, Properties of inverse Laplace transforms, Convolution theorem, Applications of Laplace Transforms in solving differential equations.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify the use of various special functions in engineering aspects.
CO2 – Illustrate the ability to handle mathematical models, to describe physical phenomena, using suitable techniques.
CO3 – Apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution in context with theory.
CO5 – Appraise mathematical problems from real to complex domain.
CO6 – Create a mathematical model of engineering interest.

TEXT/REFERENCE BOOKS

- R.V. Churchill and J. W. Brown, Complex variables and applications, McGraw-Hill, 7th Ed., 2003
- J. M. Howie, Complex analysis, Springer-Verlag, 1st Ed., 2003.
- R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd Ed., 2007.
- Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th Ed., 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: 10 questions 3 marks each	30 Marks (40 min)
Part B: 5 questions 6 marks each	30 Marks (50 min)
Part C: 5 questions 8 marks each	40 Marks (90 min)

					Element of Civil Engineering and Solid Mechanics					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
4	**-**	**-**	**4**	**4**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES.

- To introduce and explain the basics scope of engineering.
- To understand different types of force systems and apply them to practical engineering application.
- To develop understanding of the basic concepts related to tensile, compressive and shear stresses in engineering components.
- To discuss the basic principles of torsion in shafts, shear force and bending moment in beams, Deflection in springs, Columns and Struts.

UNIT 1 INTRODUCTION TO CIVIL ENGINEERING & MECHANICS **14 Hrs.**

Basics and scope of Civil Engineering- Introduction to Civil Engineering- Branches of Civil Engineering- Application of Civil Engineering in other domain different types residential of buildings- green building and smart building.
Introduction to Engineering Mechanics- Resolution of forces- Varignon's – couples- Lami's theorem-
Centroid and Moment of Inertia- Determination of moment of inertia of simple planar laminas like rectangle- triangle- quarter-semi-circle and circle. Theorems of perpendicular and parallel axis-polar moment of inertia- radius of gyration.

UNIT 2. SIMPLE AND COMPOUND STRESSES AND STRAIN **14 Hrs.**

Introduction to stresses and strain – Stress-strain diagram- Elastic constants -relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses. Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure

UNIT 3 SFD- BMD AND STRESSES IN BEAM **12 Hrs.**

Types of beams- Cantilever, Simply supported, Overhanging: Shear Force and Bending Moment Diagrams Theory of simple bending – bending stress and shear stress in beams. Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method.

UNIT 4 TORSION AND COLUMNS **12 Hrs.**

Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends – Stresses in helical springs. Theory of columns – Long column and short column – Euler's formula – Rankine's formula - Secant formula - beam column.

Total 52 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 –**Describe** the basics and scope of civil engineering, role of civil engineer and subbranches of civil engineering.
CO2 -**Compute** the stress and strain developed due to applied load in any structural member and solve the principal stress & strain at a point of stressed member.
CO3 – **Calculate** the shear force & bending moment diagram under various loading & support condition.
CO4 - **Analyze** bending and shear stresses in the different layers of the beam for various loadings.
CO5 - **Determine** the torsion equation & pure torsion
CO6 - **Explain** the loaded structural members for deflection.

TEXT/REFERENCE BOOKS

- N.H Dubey, Engineering Mechanics-Statics and Dynamics, Tata McGraw Hill Private limited
- R. S. Khurmi, Engineering Mechanics, S. Chand Publication
- S.S. Bhavikatti Elements of Civil Engineering (IV Edition) , Vikas Publishing House Pvt. Ltd., New Delhi.
- Ferdinand P Beer and E Russel Johnson , Mechanics for Engineers (Statics & Dynamics) McGraw
- Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996
- S. B. Junarkar and Dr. H. J. Shah, Mechanics of Structures, 27th Revised and Enlarged, Charotar Publication.
- Beer and Johnston, Mechanics of Materials, McGraw Hill International

END SEMESTER EXAMINATION QUESTION PATTERN

Max. Marks: 100	**Exam Duration 3 Hrs.**
Part A: 4 Question from unit-1 – 5 Marks Each	20 Marks
Part B: 8 Numerical Questions from unit 2 to unit 4 – 10 Marks Each	80 Marks

					Elements of Civil Engineering & Solid Mechanics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- To conduct standard tests on construction steel under static load.
- To conduct standard tests on metals under impact load
- To conduct standard tests of flexure and compression on wooden items.
- To conduct standard tests of crushing, impact and abrasion on bricks and tiles.

LIST OF EXPERIMENTS

1. Tension test on mild steel
2. Compression test of ms bar/cost iron
3. Bending test on wooden beam / Steel bars
4. Shear test on steel bar
5. Hardness test
6. Charpy impact test
7. Izod impact test
8. Compression test of on bricks
9. Flexural test on clay roof tiles

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Define** the standard tests of mild steel under tension, compression & shear.
CO2 – **Compute** and use the Charpy impact testing machine to evaluate the performance of metal under impact load.
CO3 – **Compute** Rockwell hardness testing machine to determine the hardness of metals
CO4 – **Illustrate** modulus of rupture of timber and steel bar.
CO5 – **Determine** the compressive and bending strength of clay items.
CO6 – **Explain** the crushing, impact and abrasion values of bricks.

R**EFERENCES:**

- S. B. Junarkar and Dr. H. J. Shah, Mechanics of Structures, 27th Revised and Enlarged, Charotar Publication.
- Beer and Johnston, Mechanics of Materials, McGraw Hill International

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3Hrs**

Part A : Lab Work – Continuous Assessment 50 Marks
Part B : Lab Exam and Viva 50 Marks

20EEXXXX					Elements of Electrical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES:

- To impart knowledge on DC and AC circuits.
- To learn construction, working principles and characteristics of transformer and induction machines.
- To introduce students to various means for electrical safety and protection of electrical installations.
- To impart knowledge on electric wiring and illumination for domestic and industrial applications.

UNIT 1: DC CIRCUITS **10 Hrs.**

Electrical circuit elements (R, L and C), voltage and current sources, dependent and independent sources, Ohms Law, temperature co-efficient of resistance, Kirchhoff current and voltage laws, voltage and current divider circuit, Thevenin and Norton Theorems and their equivalents, maximum power transfer and superposition theorems, nodal and mesh analysis, star-delta transformation, Time domain analysis/natural response of first order RL and RC Circuit

UNIT 2: AC CIRCUITS **10 Hrs.**

Generation of AC voltage, representation of sinusoidal waveforms, rms values of different sinusoidal waveforms, Rectangular and Polar representation of phasor, Sinusoid representation in time and frequency domain. of Analysis of single-phase ac series circuits consisting of R, L, C, RL, RC, RLC combinations, instantaneous, average power and reactive power, complex power and power factor. AC parallel circuit and its solution in admittance form, resonance in AC series circuit and parallel circuit. Polyphase circuits, star and delta representation of polyphase circuit, power measurement in polyphase circuit

UNIT 3: TRANSFORMERS AND INDUCTION MACHINES **10 Hrs.**

Magnetic material and its B-H characteristic, Faraday's Law of Electromagnetic Induction **Transformers:** ideal transformer, emf equation for transformer, working of practical transformer on no-load and load **Induction Machine:** Types of induction motor, production of rotating magnetic field from 3-phase supply, operation of three phase induction motor, starting and running torque, Torque-slip characteristics of induction motor, Power Stages in IM

UNIT 4: ELECTRICAL INSTALLATION, SAFETY AND PROTECTION **10 Hrs.**

Fuse, MCB, ELCB, MCCB, underground cables. Domestic and Industrial Wiring. Types of lamps, illumination schemes and lumen requirement for domestic and industrial applications, Earthing and it schemes. Electrical safety rules, electric shock and first aid, energy conservation methods, elementary calculation of energy consumptions, tariffs

Max Hrs: 40

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Analyze electrical circuits using network theorems.
CO2 – Compare the behavior of R, L and C and their combinations in AC circuits.
CO3 – Analyze balanced polyphase systems in star and delta configuration
CO4 – Understand the construction, working and basic characteristics of transformer and induction machines
CO5 – Recognize the importance of protective devices and electrical safety measures
CO6 – Carry out domestic and industrial electrification

TEXT/REFERENCE BOOKS

- J. Bird, "Electrical Circuit Theory and Technology", Routledge, Tailor and Francis Group, Sixth Edition, 2017.
- D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
- B. L. Theraja, "Electrical Technology", Vol. 1, S. Chand Publication, New Delhi
- Surjit Singh, "Electrical Estimating and Costing", Dhanpat Rai and Co.

20EEXXXX					Elements of Electrical Engineering Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To gain practical knowledge on DC and AC circuits
- To learn operation of electrical instruments and electrical machines
- To develop skills to implement electric wiring

LIST OF EXPERIMENTS

1. Introduction to elements of electrical engineering laboratory and to study different electrical measuring instruments.
2. To validate Ohm's law with linear resistors and find power dissipation in resistor.
3. To implement voltage divider and current divider circuit.
4. To validate Thevenin and Norton theorem for DC circuit.
5. To validate Superposition and Maximum Power Transfer theorem for DC circuit.
6. To obtain transient response of RL and RC circuit.
7. To evaluate performance of AC series circuit.
8. To evaluate performance of AC parallel circuit.
9. To analyse resonance condition in AC circuit.
10. To establish relation between line and phase quantities in star and delta connected polyphase system.
11. To measure power in polyphase system.
12. To perform load test on 1-phase transformer.
13. To perform load test on 3-phase transformer.
14. To obtain current time characteristic for domestic protective devices.
15. To carry out domestic electric wiring.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Operate basic electrical measuring instruments

CO2 – Simulate the basic electrical circuits and obtain results based on electrical laws and network theorem

CO3 – Understand the performance of AC circuit with different connection of R, L and C

CO4 – Formulate star and delta configuration of polyphase system and measure power in polyphase system

CO5 – Operate transformer and induction machines and evaluate its performance

CO6 – Understand the basic wiring and operation of protective devices for domestic application

20SC102					Engineering Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	Viva	
3	0	0	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand basic concepts of quantum mechanics and solve the Schrödinger equation for various cases.
- To understand basics concepts of electric and magnetic properties of solids.
- To develop the fundamental understanding of optoelectronic devices.
- To understand the heat transfer mechanism in solids and fluids.

UNIT 1 Introduction to Quantum Mechanics 12 Hrs.

Inadequacies in Classical Physics, Wave Nature of Matter, Heisenberg's Uncertainty Principle and its applications, zero point energy, Basic Postulates and Formalism of QM: Energy, Momentum and Hamiltonian Operators. Time-independent Schrodinger Wave Equation for Stationary States. Properties and interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions, Application of time-independent Schrödinger equation for various potentials.

UNIT 2 Electronic theory of Solids 10 Hrs.

Elements of crystallography; lattice vibrations of solids; Bloch Theorem and Origin of energy bands, band structure of conductors, type of semiconductors, Free Electron Theory of metals, Wiede-mann Franz Law, Kronig-Penny model, Hall effect. Magnetism and its origin, magnetization and susceptibility, dia-para-ferro-magnetism. Ferromagnetism, Nano magnets and magneto resistance, hard disk drive storage technology. Phenomenology of Superconductors, Meissner effect, BCS theory - high temperature superconductors.

UNIT 3 OPTICS, LASER AND OPTO-ELECTRONICS 08 Hrs.

Optics: Introduction, division of amplitude, thin film interference, Applications of interference, Laser: The Einstein coefficients, Spontaneous and stimulated emission, Optical amplification and population inversion, meta stable state, optical resonator, the principle of pumping scheme, laser beam characteristics. Types of LASER, Injection Laser Diode (ILD). Quantum Cascade Laser, Comparison between ILD and QCL. Applications of lasers.

UNIT 4 THERMAL PHYSICS 10 Hrs.

Laws of thermodynamics -basic concepts, closed and open systems-first law. Heat transfer-thermal expansion of solids and liquids –Conduction in solids – the rmal conductivity- Forbe's method, Lees' disc method, conduction through compound media, formation of ice on ponds, thermal insulation and its applications. Thermal Convection - properties of radiant heat, sea and land breeze. Thermal Radiation – emission and absorption radiation, emissive power, black body radiation – Kirchoff's, Stefan's laws, wien's law, Newton's law of cooling.

Max. 40 Hrs.

COURSE OUTCOMES

CO1 – identify and understand the experimental results which require conceptualization of quantum theory.
CO2 – Interpret the solution of Schrödinger equation to obtain physical information about the system.
CO3 - Identify basic concepts in semiconductors, superconductors and magnetism and apply it in engineering applications.
CO4 - To understand concepts of optical interference and LASER, analyse the lasing characteristics to apply in different laser diodes and other applications
CO5 - To understand concepts of thermal physics in terms of laws and modes of heat transfer.
CO6 - To apply knowledge of concepts of engineering physics to solve real world problems.

TEXT/REFERENCE BOOKS

- N. Zettili, Quantum Mechanics: Concepts and applications, Willey Publications
- Kittel, Charles. Introduction to Solid State Physics. John Wiley and Sons.
- W.D. Callister and David Rethwisch, Materials Science & Engineering -An Introduction, 9th edn.,
- Heat and Thermodynamics BrijLal, N. Subrahmanyam, S. Chand, Limited, 2001.
- Optics by Ajay Ghatak, Tata macgraw hill publishing.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks

20SC102P					Engineering Physics Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To understand the working of various electrical, mechanical and optical instruments in the laboratory.
- To gain practical knowledge in Physics through experiments.
- To understand basics concepts of Physics and be able to apply in performing the experiments.

List of Experiments

1. Introduction to Oscilloscope.
2. Study of Interference using Newton's Ring experiment.
3. Determination of thermal conductivity of different solids.
4. Experiment with solar collector.
5. Experimental to determine linear thermal expansion coefficient of solid bodies.
6. Experiment on reflection of Ultrasonic waves.
7. Experiments with heat pump.
8. Determining Plank's constant and Inverse square law.
9. Experiments on diffraction with He-Ne Laser Kit.
10. Study of Hall Effect.
11. Determining semiconductor energy band gap using four probe method.
12. Experiment to study forced oscillations.
13. Study of charging and discharging of capacitive plates.
14. Study of Bio-Savart's Law
15. Experiments on Fiber Optics.
16. Study of Photoconductivity.
17. Determining e/m by Thomson's method.
18. Study of Polarization of light using LASER.
19. Millikan's oil drop experiment.
20. Study of Holography.

** Any 10 experiments will be conducted relevant to theory course.

COURSE OUTCOMES

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

CO1 - Apply and analyze the concepts of electricity and magnetism.
CO2 - Understand the interaction of light waves and its propagation in different media.
CO3 - Demonstrate and implement the phenomenon of resonance
CO4 - Investigate the electrical properties of a given semiconductor device
CO5 - Examine the charge transport mechanism in different conductors
CO6 - Design and analyze the light propagation for communication application using fibre optics

TEXT/REFERENCE BOOKS

- Ghatak, Optics, 3rd edition, Tata McGraw Hill (2005).
- Kittel, Knight and Ruderman, Mechanics - Berkeley Physics Course, Vol. 1, Tata McGraw-Hill.
- Avadhanulu, A text book of engineering Physics, S. Chand & Company, Ltd.
- Brij Lal, N. Subrahmanyam, Heat and Thermodynamics, S. Chand & Company, Ltd
- Halliday, Resnick, Walker, Fundamentals of Physics (Wiley)

Evaluation

Max. Marks: 100

Continuous evaluation	50 marks
End semester examination and Viva-voce	50 marks

16ME104P					Workshop Practices		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To impart the machining skills in students.
- To develop a skills in precision, safety at work place, team working with right attitude.
- To prepare a job by using ability to design and model different prototypes.

UNIT-I METROLOGY

Semi-Precision tools: Rules and scales, try square. Inside/Outside Calipers, Depth gages etc. Precision Tools: Micrometers, Vernier calipers, Bevel Protractor, Dial indicator, Gage blocks, Surface plates etc.

UNIT-II CARPENTRY SHOP

Timber, Seasoning and Preservation, Plywood and Ply boards, Carpentry Tools, Engineering applications. Different Joints

UNIT-III BENCH WORK AND FITTING

Introduction to the familiarization with tools and their uses, Hammers, Hacksaws, choice of blades & sawing techniques, Files with their classification; According to their longitudinal shape & cross section, classification based on cuts; teeth; length of the file, Care of files and hand tool safety rules Vices & their classification, Other hand tools; scribers, chisels, scrapers, center, punch, surface gauge, Universal cribbing block, Trammel, Screw drivers, Drills, Spanners, Pliers, Taps, Dies, Reamers, Screw drivers etc, Fitting Processes : Marking, Chipping, Sawing, Filing, Scrapping, Drilling, Internal Threading (or Trapping), External Threading (or Dieing), Reaming, welding, soldering, brazing

UNIT-IV TIN SMITHY – SURFACE DEVELOPMENT

Shearing and Bending of sheets, Making simple products by Tin Smithy practice.

List of Experiments:

1. Introduction to Workshop and safety.
2. Experiment on measurement of linear, angular and curved dimensions of the object.
3. Fitting job: Detailed drawing of work piece, use of fitting tools and job preparation.
4. Hands on experience on welding, brazing and soldering.
5. Carpentry job: Detailed drawing of work piece, use of carpentry tools and job preparation.
6. Sheet metal job: Detailed drawing of work piece, use of sheet metal working tools and job preparation.
7. Plumbing job: Internal/External threading, piping network using Tees, Elbows, Reducer, Bends etc

COURSE OUTCOMES

CO1: Define fundamentals and principles cutting and enhance the machining skills in students.

CO2: Apply principles of machining and develop a skills in dignity of labour, precision, safety at work place, team working and development of right attitude.

CO3: Analyse the effect design and model different prototypes in carpentry.

CO4: Examine the effect and create and develop ability to design and model different basic prototypes in trade of fitting.

CO5: Determine the effect and create and develop ability to design and model different basic prototypes in trade of tin smithy.

CO6: Evaluate the performance of different machining and cutting processes such as fitting, carpentry, plumbing etc.

<Course Code>					Engineering Graphics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	4	-	-	-	50	50	100

COURSE OBJECTIVES

- To learn fundamental of engineering drawing and standards used in drawing
- To enable the students with various concepts of projections and standards related to technical drawings.
- To demonstrate and communicate ideas using orthographic (2D) & isometric projection (3D) methods
- To help students to use CAD software to solve engineering problems

UNIT 1 **10 Hrs.**

Introduction to Engineering Graphics – Importance and applications, drawing instruments & accessories, lettering, types of lines, dimensioning methods, basic geometric drawing.
Computer Aided Engineering Drawing: Introduction to CAD, use of softwares in drawing, CAD software user interface, commands, menus and toolbars.

UNIT 2 **14 Hrs.**

Orthographic Projection – Introduction to projection, types of projection, 1st angle and 3rd angle projection, 2D sketch, sketch entities and tools – origin, points, lines, arcs, polygons, fillets and chamfer, trim, extend and offset, projections from pictorial view, orientation of views, sections and sectional views.

UNIT 3 **14 Hrs.**

Isometric Projection - Construction of isometric views from orthographic projections, approach to modelling, moving from 2D to 3D, creating 3D models using CAD features, assembly of components and exploded views.
Projection of Solids - Classification of solids, projections of solids like cylinder, cone, pyramid and prism with its inclination to reference plane, concept of development of lateral surfaces, intersection of solids.

UNIT 4 **14 Hrs.**

Drafting – Drafting standards, drawing views, alignment of drawing views, dimensions and tolerances, symbols, comments and annotations, computer aided drafting, drawing sheet and title block.
Tolerance - Introduction to limits, fits and tolerances, standardized representation of threads, fasteners, welds, bearings and springs, dimensional and geometric tolerances, surface finish symbols.

Total 52 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of engineering graphics and **remember** the basic rules of dimensioning and labelling.
CO2 - Develop the ability to learn fundamental of CAD software and its use to solve engineering problems.
CO3 - Comprehend the concept of projection and use it to **represent** the views on reference planes.
CO4 - Apply the technical communication skill for 3-dimensional geometries in the form of 3D models using isometric projection.
CO5 - Analyse the orientation of geometrical bodies with respect to reference planes and **evaluate** the intricate details of solid using sectioning and development of lateral surfaces.
CO6 - Create drawing sheet by **organizing** drawing views and **applying** necessary dimensions and tolerances.

TEXT/REFERENCE BOOKS

- R Hanifan, "Perfecting Engineering and Technical Drawing", Springer International Publishing Switzerland
- Bethune, J. D., "Engineering Design and Graphics with SolidWorks 2019, 1st edition", Macromedia Press
- K Morling, "Geometric and Engineering Drawing", Elseveir Insights
- DM Kulkarni, "Engineering Graphics with AutoCAD", Easter Economy Edition
- Agrawal, B. & Agrawal C. M., "Engineering Drawing", Tata McGraw Hill Publishers
- P.J. Shah, "Engineering Graphics", S. Chand Publishing
- David C Planchard, "Engineering Graphics with SOLIDWORKS 2019: A Step-by-Step Project Based Approach'', SDC Publications.

<Course Code>					Computer Programming-II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To impart the basic concepts of Python Programming language.
- To be familiar with data structures available in Python.
- To understand testing and debugging in Python.
- To draw different kinds of plots using for scientific research.

INTRODUCTION TO PYTHON

The basic elements of Python, Branching programs, Strings and Input, Iteration

FUNCTION, SCOPING AND ABSTRACTION

Functions and Scoping, Specifications, Recursion, Global variables, Modules, Files

TESTING AND DEBUGGING

Testing, Debugging

STRUCTURED TYPES, MUTABILITY AND HIGHER-ORDER FUNCTIONS

Tuples, Lists and Mutability, Functions as Objects, Strings, Tuples and Lists, Dictionaries

EXCEPTIONS AND ASSERTIONS

Handling exceptions, Exceptions as a control flow mechanism, Assertions

SOME SIMPLE ALGORITHMS AND DATA STRUCTURES

Search Algorithms, Sorting Algorithms, Hashtables

PLOTTING

Plotting using PyLab and extended examples

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Understand the basic concept of programming with python.
CO2- Understand the basics of creating applications.
CO3- Apply various data structures available in Python in solving computational problems.
CO4- Create robust applications for solving computational problems using the Python.
CO5- Test and debug applications written using the Python.
CO6- Draw different kinds of plots using PyLab and generating series.

TEXT/REFERENCE BOOKS

- John V Guttag. “Introduction to Computation and Programming Using Python”, Prentice Hall of India.
- Allen Downey, Jeffrey Elkner and Chris Meyers "How to think like a Computer Scientist, Learning with Python", Green Tea Press.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs**

Part A/Question: <QUIZ/VIVA> <25> Marks
Part B/Question: <PRACTICAL PERFORMANCE> <25> Marks

					ENVIRONMENTAL STUDIES					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Understanding about Bird's eye view of Environment.
- Understanding of multidisciplinary aspect of environment.
- Understanding of pollutions and their effects on environment.
- Understanding about various environment pollution control strategies.

UNIT 1 Bird's Eye view to Environment 08Hrs.

Environmental Studies – Its importance and Multidisciplinary nature; Ecosystem and its various types, factors affecting the functioning of an ecosystem; Biodiversity – its importance, threats and conservation; Natural Resources – Forest, Water, Mineral, Energy, Minerals, Food; Review of State of India's Environment.

UNIT 2 Multi-scale Environmental Pollution 10 Hrs.

Concept of Clean Environment, Introduction to various environmental standards – air, water, soil, noise, heat. Causes and Effects of Air Pollution, Water Pollution, Soil Pollution, Solid Waste (organic and Inorganic) Pollution, Hazardous Waste Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Radioactive Pollution; Pollution across Indian cities – case studies; Introduction to man-made disasters like floods, heat waves, landslides, etc.

UNIT 3 Environmental Pollution Control Strategies 12 Hrs.

Multi-approaches (role of research, technology, policy, planning & implementation, legislation & judiciary, incentives & business) for reducing various types of pollution; Case studies of Pollution control strategies; Review of the Central and State Government's policies and mechanisms for managing various natural resources and controlling the various types of pollutions (including Swacch Bharat Abhiyan), Global Initiatives for environmental management; Indian Culture and Traditional Wisdom for managing environment

UNIT 4 Social Issues and the Environment 09 Hrs.

Concept of sustainability and Sustainable Development, Environmental Sustainability Index, Environmental Ethics, Public awareness and people's participation (bottlenecks and solutions), Consumerism and Waste products, Introduction to Carbon Footprint & Water Footprint, Green Buildings, Green Business (profitability in managing environment)

TOTAL 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:
CO1- Understand the various facets of environment.
CO2- Understand of multidisciplinary aspects of environment.
CO3- Understand about the different types of pollutions.
CO4- Understand the effects of pollution on human health, plants, materials and environment.
CO5- Understand about the various environment pollution control strategies.
CO6- Understand about various concepts of sustainable development.

TEXT/REFERENCE BOOKS:

- Bharucha Erach, Textbook for Environmental Studies, UGC New Delhi.
- Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd, Ahmedabad 380013, India.
- Clark, R. S., Marine Pollution, Clanderson Press Oxford.
- Daniel B. Botkin & Edwards A. Keller, Environmental Science, Wiley INDIA edition.
- Hawkins R. E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay.
- Miller T. G. Jr., 2006. Environmental Science, Clengage Learning, India.
- Odum E. P. 1971. Fundamentals of Ecology, W. B. Saunders Co, USA.
- Wagner K. D., 1998. Environmental Management, W. B. Saunders Co, USA.

END SEMESTER EXAM PAPER SCHEME (Max Marks: 100)

Part A	4 Questions of 10 Marks each. 1 Question from every unit.	40
Part B	6 Questions of 10 Marks each. 3 Questions from Unit 3 & 4 each	60

20HSXXXP					Communication Skills – I (Semester I/II) (First Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Understand of the fundamental elements of communication in English language.
- Know and understand different practices of verbal and non-verbal communication with inputs to improve basic language skills.
- Students are expected to be better equipped in the following areas:
  - **Listening:** Understanding basic content in lectures and common everyday situations
  - **Speaking:** Correct expression in the English language at a basic level
  - **Reading:** Understanding, retaining, and critically analyzing technical/non-technical content
  - **Writing:** Using appropriate vocabulary, grammar, effective paragraph construction, writing in day-to-day scenarios, including digital platforms

UNIT 1 **21 hrs**

Structure of English Language, Academic, Research and Technical Vocabulary, Phonetics and Accent

UNIT 2 **3 hrs**

Listening Skills, Note Taking and Note Making, Collective note-taking and note-making on digital platforms

UNIT 3 **3 hrs**

Reading, Reading Comprehension, Speed Reading

UNIT 4 **3 hrs**

The art of introducing oneself, Public speaking and articulation

Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Confidence to listen, speak, read and write in English.
CO2 Being able to produce something new with the help of inputs.
CO3 Learning to critically analyze.
CO4 Preparing reports/critique with the help of collected data.
CO 5 Having a multi-dimensional/disciplinary perspective and approach.
CO6 Better improved and sharpened skills to present, convince and persuade to be an effective and successful professional.

TEXT/REFERENCE BOOKS

- Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
- Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
- Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
- Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
- Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tool	Marks	Assignments
Lab Work	50	• Listening and Questionnaire – 15 • Grammar Worksheet – 20 • Short Story/Essay (750 – 1000 words) – 05 • Reading Comprehension – 10
Lab Exam/Viva	50	• Wordsworth – 10 • Narrating a Story along with Self Introduction/Speech – 15 • Reading Aloud – 05 • Vocabulary/Phonetics – 20

HSC ----					NCC/NSS/SPORTS					
Teaching Scheme					Examination Scheme					
					Theory			Practical		
L	T	P	C	Hrs/Week	MS	ES	IA	LW	*Participation and Attendance	Total Marks
0	0	2	1	2	* Continuous Evaluation			--	100	100

COURSE OBJECTIVES

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
- To develop youth leadership in the students.
- To induce social consciousness among students through various camps and 'Shibir' activities.
- To develop skills and physical fitness among students through indoor & outdoor sports, field & track events.

National Cadet Corps (NCC):

Introduction to NCC, Aims and objectives, Structure and organization, NCC Song, Incentives, National Integration and Awareness, Drill, saluting, Personality Development & Leadership, Disaster Management, Social Awareness & Community Development, Health & Hygiene, Adventure camps, Environment Awareness and Conservation, Obstacle Training, Armed forces, Map reading, Field Craft & Battle Craft, Introduction to Infantry Weapons & Equipment, Weapon Training (During camps), Participation into Republic and Independence day ceremonial parades,

National Service Scheme (NSS):

Importance and role of youth leadership, Life competencies, Youth development programmes and youth 'shibir', Health, hygiene and sanitation, Youth health, lifestyle, first aid, youth and yoga

Sports:

Importance of sports/games in life, Physical fitness, Introduction to various games and sports, field and track events, Physical training, exercises, running, walking, jogging, Teaching of different sports/games, track & field events , demonstration, practice, skills and correction, Introduction to Yoga & Meditation.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Understand** the importance of Nation building and individual contribution to the same.
CO2 – **Integrate** physical fitness and mental wellbeing
CO3 – **Discover** grassroots challenges of community
CO4 – **Creating** societal impact
CO5 – **Maintain** discipline and team spirit
CO6 – **Upholding** the value of one for all and all for one

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: --**

* All registered students will be evaluated based on his/her attendance during the NCC/NSS/Sports sessions and participation to camps and other activities.

<Course Code>					Civic & Social Service Internship					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
			01	21 days	--	--	--	--	--	100

COURSE OBJECTIVES

- To develop a holistic view of social work and social welfare in the community, with special emphasis on the role of different agencies like Govt. departments and NGOs in human services.
- To enlighten and sensitize students on various types of problems of the people and their diversified cultural background.
- To understand the agency as an organization, its structure, functions, activities and sources of funding.
- To understand and make a commitment to the basic humanistic values and principles of social work practice in a secular democratic society.
- To develop an understanding of the application of the methods of social work practice in the field.
- To develop an understanding of the opportunities in working with diverse populations.
- To develop the self –awareness necessary to assess one's own values, attitudes, feelings, strengths, limitations, and interests and performance.
- To inspire young technocrats to become change makers

UNIT 1: Overview of Civic and Social Service Sector
UNIT 2: Understanding of NGO/Civic Body/Government Body Management and their functioning
UNIT 3: Study of Individual organizational and government projects and schemes where students are interning
UNIT 4: Field visits

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Become sensitized workforce of enlightened Engineers and Managers who are socially concerned and willing to positively contribute to the society
CO2- Acquire desired work habits and attitudes with the sense of social responsibility and think innovatively to find solutions
CO3- Understand the role of different NGO/civic/government bodies in the service of citizens
CO4- Imbibe basic humanistic values and principles of social work practice in a secular democratic society
CO5- To assess one's own values, attitudes, feelings, strengths, limitations, interests and performance through opportunities of working with diverse populations
CO6- Obtain experiential learning via internship and be sensitive towards issues of modern-day citizenship and democracy

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Part A: NGO evaluation 50 Marks
Part B: Internal faculty 50 Marks

Semester-III

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR

SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B. TECH. IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester III			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Discrete Mathematical Structures	3	1	0	4	4	25	50	25	--	--	100
2		Data Structure and Algorithms	3	0	0	3	3	25	50	25	-	-	100
3		Data Structure and Algorithms Lab	0	0	2	1	2	--	--	--	25	25	50
4		Fundamentals of Signal Processing and Communication	3	0	0	3	3	25	50	25	-	-	100
5		Object Oriented Concepts & Programming	2	0	0	2	2	25	50	25	--	--	100
6		Object Oriented Concepts & Programming Lab	0	0	2	1	2	--	--	--	25	25	50
6		Digital Logic Design and HDL	3	0	0	3	3	25	50	25	-	-	100
7		Digital Logic Design and HDL Lab	0	0	2	1	2	--	--	--	25	25	50
8		OE-1	3	0	0	3	3	25	50	25	-	-	100
		Total	17	1	6	21	24						750

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LE – Lab Exam, LW – Lab Work, OE- Open Elective

20MA206T					Discrete Mathematical Structure					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the concept of sets, relations, functions and logic.
- To study Combinatorics as an analytical method for problem solving.
- To apply graph theory-based modelling and applying the same to solve real life problems.
- To explain the basics of algebraic structures.

UNIT 1 SETS, RELATIONS, FUNCTIONS AND LOGIC **10 Hrs.**

Finite and Infinite sets, Countable and Uncountable sets, Mathematical Induction, Functions and Relations, Types of Relation, Partial Ordered Relations, Hasse diagram and Lattice. Propositions - Simple and Compound. Basic logical operators. Implication. Truth tables. Tautologies, Contradictions and Contingency. Valid arguments and Fallacy.

UNIT 2 COMBINATORICS **10 Hrs.**

Recursive functions, Recurrence relations, Solutions of recurrence relations (Direct Method and by using Generating Function), Counting principles, Permutation, Combination, Derangement, inclusion-exclusion principle, Pigeon hole principle, Extended Pigeon hole principle.

UNIT 3 GRAPH THEORY AND ITS APPLICATIONS **12 Hrs.**

Graphs and related definitions, Sub graphs, Homomorphism and Isomorphism, Paths and Connectivity. Bipartite graph. Eulerian graph and Konigsberg Bridge problem. Hamiltonian graph. Labeled and weighted graphs. Graph coloring. Four color problem. Planar Graphs. Digraphs and related definitions. Trees. Algebraic expressions and Polish notation. Sequential representation. Adjacency matrix. Shortest path Algorithms (Dijkstra), Binary trees, Strongly and weakly connected graphs, Powers of the adjacency matrix, Floyd-Warshall algorithm, Application of Graph theory in real-life applications.

UNIT 4 ALGEBRAIC STRUCTURES **08 Hrs.**

Group, Semi group, Monoids, Properties of a Group, Composition table for finite Group, Order of a group, Order of its elements, Cyclic Group, Generator, Lagrange's Theorem. Ring, Properties of Rings, Integral Domain, Field.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify structures of algebraic nature, prove and use their properties.
CO2 – Understand the basic concepts of sets, relations, functions, logic and be able to determine their properties.
CO3 – Identify and apply the basic techniques of Combinatorics and Counting.
CO4 – Apply Graph theory in related areas such as minimal-path problems and network flow problems.
CO5 – Defend and point out fallacious reasoning and propositions.
CO6 – Construct and solve recurrence relations that arise in counting problems including problems of determining the time complexity of recursively defined algorithms.

TEXT/REFERENCE BOOKS

- Seymour Lipschutz, Marc Lipson, Discrete Mathematics, Schaum's Series, McGraw-Hill Education, 3rd Ed., 2009.
- Kenneth Rosen, Discrete Mathematics and Its Applications, McGraw Hill Education, 7th Ed., 2017.
- Bernard Kolman, Robert Busby, Sharon C. Ross, Discrete Mathematical Structures, Pearson, 6th Ed., 2018.
- Thomas Koshy, Discrete Mathematics with Applications, Academic Press Inc., 2004.
- Ralph P. Gramaldi, Discrete and Combinatorial Mathematics, 5th Ed, Pearson, 2006.
- C.L. Liu, D.P. Mohapatra, Elements of Discrete Mathematics: A Computer Oriented Approach, McGraw Hill Education, 4th Ed., 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: 10 questions 2 marks each	20 Marks (40 min)
Part B: 5 questions 6 marks each	30 Marks (50 min)
Part C: 5 questions 10 marks each	50 Marks (90 min)

<Course Code>					Data Structure & Algorithms					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart the basic concepts of data structures and algorithms.
- To understand concepts about searching and sorting techniques
- To understand basic concepts about stacks, queues, lists, trees and graphs.
- To enable them to write algorithms for solving problems with the help of fundamental data structures

UNIT 1 INTRODUCTION TO DATA STRUCTURE **10 Hrs.**

Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.

UNIT 2 STACKS AND QUEUES **10 Hrs.**

ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

UNIT 3 LINKED LISTS AND TREES **10 Hrs.**

Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

UNIT 4 SORTING, HASHING AND GRAPHS **09 Hrs.**

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Max. 39 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – List data structure as per problem domain.

CO2 – Recognize and describe features of data structures.

CO3 – Practice data structure for popular applications.

CO4 – Understand complexity of data structure and algorithms.

CO5 – Compare and select suitable data structure for the given application.

CO6 – Design application using data structure algorithm.

TEXT/REFERENCE BOOKS

- Ellis Horowitz, Sartaj Sahni. Fundamentals of Data Structures. Computer Science Press.
- Mark Allen Weiss, Addison . Algorithms, Data Structures, and Problem Solving with C++. Wesley Publishing Company.
- R.G. Dromey. How to Solve it by Computer. 2nd Edition. Pearson Education.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Data Structure and Algorithms Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To impart the basic concepts of data structures and algorithms.
- To understand concepts about searching and sorting techniques
- To understand basic concepts about stacks, queues, lists, trees and graphs.
- To enable them to write algorithms for solving problems with the help of fundamental data structures

Laboratory Sessions would be based on following topics:

1. Creation, deletion, display of singly linked list of integers.
2. Sorting related experiments
3. Searching related experiments
4. Using stack operations to convert a given infix expression into its postfix Equivalent and its implementation.
5. Binary Trees - Binary Tree Traversal
6. Graphs.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – List data structure as per problem domain.

CO2 – Recognize and describe features of data structures.

CO3 – Practice data structure for popular applications.

CO4 – Understand complexity of data structure and algorithms.

CO5 – Compare and select suitable data structure for the given application.

CO6 – Design application using data structure algorithm.

TEXT/REFERENCE BOOKS

- Ellis Horowitz, Sartaj Sahni. Fundamentals of Data Structures. Computer Science Press.
- Mark Allen Weiss, Addison . Algorithms, Data Structures, and Problem Solving with C++. Wesley Publishing Company.
- R.G. Dromey. How to Solve it by Computer. 2nd Edition. Pearson Education.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Fundamentals of Signal Processing and Communication					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce mathematical tools for analysis of continuous time signals and LTI systems.
- Understand basic principles of communication systems.
- Create foundation for digital signal processing.

UNIT-1 CONTINUOUS TIME SIGNALS AND SYSTEMS 09 Hrs.

Signal – Definition, Examples, Classifications, Continuous time signals: Energy, power, periodicity, Signal operations, Elementary Signals, System - Definition, Classification, Continuous time LTI systems: Convolution integral and unit impulse response, Interconnections, stability and causality.

UNIT-2 FOURIER ANALYSIS AND CORRELATION OF SIGNALS 12 Hrs.

Exponential Fourier series and Fourier transform, Signal spectra, Dirichlet conditions, Important Properties. Frequency analysis of LTI systems, Signal distortions, Distortionless transmission, Ideal vs. practical filters, Parseval's relation, Essential bandwidth, Time correlation of signals, Spectral densities, Relation between convolution and time correlation.

UNIT-3 FUNDAMENTALS OF COMMUNICATION SYSTEMS 10 Hrs.

Baseband and carrier communication, AM Schemes modulation and detection – DSBFC, DSBSC, SSB, VSB, QAM, Angle Modulation and Demodulation, Wideband and narrowband FM, Principles and working of super heterodyne receiver: sensitivity and selectivity, Noise types, Signal to noise ratio (SNR), Noise factor and noise figure, Noise modeling, PSD of white noise and narrow band noise, Performance comparison of AM and FM schemes.

UNIT-4 FOUNDATION FOR DIGITAL SIGNAL PROCESSING 08 Hrs.

Sampling and Sampling theorem, Reconstruction, Aliasing, Discrete time elementary signals, Discrete time LTI system and unit impulse (sample) response, Convolution sum, Linear constant co-efficient difference equation representation, Stability and causality, Discrete time vs. digital signal processing, Concept of quantization, A to D and D to A conversion, Future study.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember properties of signals, systems, and principles of various modulation and demodulation methods.
CO2: Understand mathematical representation of signals, systems, modulated signals and detection techniques.
CO3: Apply mathematical concepts to model behaviour of LTI systems, modulation and demodulation of signals.
CO4: Analyze signals and systems in time and frequency domain to obtain various parameters.
CO5: Evaluate properties of LTI systems and performance of communication systems.
CO6: Design a block diagram level elementary communication and signal processing system.

TEXT/REFERENCE BOOKS

- Alan V.Oppenheim, Alan S.Willsky with S. Hamid Nawab, Signals & Systems, Pearson Education.
- B. P. Lathi, Signal Processing and Linear System, Berkeley Cambridge Press.
- B.P.Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press.
- P. Chakrabarti, Analog and Digital Communication, Dhanpat Rai & Co.
- J. G.Proakis, D. G.Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, PHI.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

20ICXXXX					Object Oriented Concepts and Programming					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce software development using object oriented approach.
- Use of a version control system, an automated build process.
- Learn an appropriate framework for automated unit and integration tests.

5 Hrs.

UNIT 1 FOUNDATIONS

Genealogy of Object oriented languages, program structure, abstract data types and their specification, implement an ADT, Concrete state space, concrete invariant, abstraction function, implementing operations

UNIT 2 CONCEPTS **7 Hrs.**

Abstraction, Encapsulation, classes and objects, polymorphism, Inheritance-single, multilevel, hierarchical, hybrid, super classes, interclass relationships, class members, constructors, destructors

UNIT 3 DESIGN **7 Hrs.**

Unified Modelling language (UML), Use case diagrams, scenarios, class diagram, the iterator pattern, Model-view-controller pattern, Commands as methods and as objects, Implementing OO language features

UNIT 4 PRACTICE **7 Hrs.**

Iterative and incremental development styles, design of class hierarchies, refactoring, Memory Management, Generic types and collections, Graphical Programming, Software development Process

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to:

CO1: List use cases for object oriented programming.
CO2: Recognize and describe essential features of object-oriented programming language.
CO3: Practice class, object interaction and object state transition diagrams.
CO4: Analyze OOP model for engineering problems.
CO5: Evaluate different code fragments for the problem.
CO6: Design applications using OOP.

TEXT/REFERENCE BOOKS

- Freeman S., Pryce N., Growing Object-Oriented Software Guided by Tests, Addison-Wesley, (1st Ed.) 2009.
- Weisfeld M., The Object-Oriented Thought Process, Addison-Wesley Professional (4th Ed.), 2013,
- Fowler M., UML Distilled, Addison-Wesley (3rdEd), 2003.
- Balagurusamy E., Object-Oriented Programming with C++. McGraw Hill India (7th Ed), 2017

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Part B Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.	80 to 60 Marks

20ICXXXX					Object Oriented Concepts and Programming Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Introduce software development using object oriented approach.
- Use of a version control system, an automated build process.
- Learn an appropriate framework for automated unit and integration tests.

Laboratory sessions would be based on following topics:

FOUNDATIONS

- Program structure
- Implement an ADT
- Abstraction function, implementing operations

CONCEPTS

- Abstraction, Encapsulation, classes and objects,
- Polymorphism, Inheritance-single, multilevel, hierarchical, hybrid, Super classes, interclass relationships
- Constructors, destructors

DESIGN

- Unified Modelling language (UML), Use case diagrams, scenarios,
- Commands as methods and as objects,
- Implementing OO language features

PRACTICE

- Design of class hierarchies, Memory Management,
- Graphical Programming
- Software development Process

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, student will be able to:
CO1: List use cases for object oriented programming.
CO2: Recognize and describe essential features of object-oriented programming language.
CO3: Practice class, object interaction and object state transition diagrams.
CO4: Analyze OOP model for engineering problems.
CO5: Evaluate different code fragments for the problem.
CO6: Design applications using OOP.

TEXT/REFERENCE BOOKS

- Freeman S., Pryce N., Growing Object-Oriented Software Guided by Tests, Addison-Wesley, (1st Ed.) 2009.
- Weisfeld M., The Object-Oriented Thought Process, Addison-Wesley Professional (4th Ed.), 2013.
- Fowler M., UML Distilled, Addison-Wesley (3rdEd), 2003.
- Balagurusamy E., Object-Oriented Programming with C++. McGraw Hill India (7th Ed), 2017.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development	25 Marks

<Course Code>					Digital Logic Design and HDL					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES:

- To learn the fundamentals of digital logic circuits and digital number systems.
- To be able to analyze and design digital combinational-logic and sequential-logic circuits.
- To implement digital combinational-logic and sequential-logic circuits, using Verilog HDL.

UNIT-1: INTRODUCTION TO DIGITAL NUMBER SYSTEMS AND DIGITAL LOGIC/GATES 7 Hrs.

Introduction: Digital Systems; Data representation and coding; Noise Margins; Basic logic operations, truth-tables and logic gates; Number Systems and Codes: Positional number system; Binary; octal and hexadecimal number systems; Methods of base conversions; Binary; octal and hexadecimal arithmetic; Representation of signed numbers; Fixed-point numbers; Binary coded decimal codes; Gray codes; Error detection and correction codes - parity check codes and Hamming codes.

UNIT-2: DIGITAL COMBINATIONAL-LOGIC CIRCUITS AND VERILOG HDL 14 Hrs.

Boolean Algebra & Simplification of Boolean Algebra: Basic postulates and fundamental theorems of Boolean algebra; Standard representation of logic functions; The Map Method; SOP and POS forms; Simplification of Boolean functions using K-map and Quine-McCluskey tabular methods; Synthesis of combinational logic circuits. Digital Combinational-Logic modules: Decoders; encoders; multiplexers; demultiplexers, combinational shifters, and their applications; Parity circuits and comparators; Arithmetic modules- adder; sub-tractor, basic multiplier, ALU; Design examples. Introduction to Verilog Hardware Description Language (HDL): Types of modelling: Gate-level modelling, Data-flow modelling; Behavioural modelling; Basic constructs and syntax of Verilog language, related to hierarchical and modular modelling; Concept of test-bench and incorporating delays in test-bench; Verilog implementation of combinational circuits/modules.

UNIT-3: DIGITAL SEQUENTIAL-LOGIC CIRCUITS 13 Hrs.

Basic sequencing elements - latches and flip-flops: SR-latch; D-latch; D flip-flop; JK flip-flop; T flip-flop;
Definitions of (synchronous) Moore and Mealy Finite State Machines (FSM) – state diagram, state table, state assignment; Analysis and implementation of FSM using D flip-flops, JK flip-flops and T flip-flops; Design examples of FSM; Various Registers - and Counters; Application examples. Verilog implementation of sequencing elements (latch and flip-flops) using behavioural modelling; Verilog implementation of sequential-logic circuits and RTL structures.

UNIT-4: INTRODUCTION TO MEMORY AND PROGRAMMABLE LOGIC CIRCUITS 5 Hrs.

Introduction to basic sub-blocks of memory; Programmable Logic Devices: PLAs and their applications; Sequential PLDs.

Max. 39 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:
CO1- Understand the basics of number systems, Boolean algebra and standard digital logic gates.
CO2- Analyze the functionality of digital combinational-logic and sequential-logic circuits.
CO3- Design digital combinational-logic and sequential-logic circuits, at the module/schematic-level.
CO4- Write codes in Verilog HDL, using structural, dataflow, and behavioral modeling.
CO5- Implement digital combinational-logic circuits, using Verilog HDL.
CO6- Build digital sequential-logic circuits and RTL structures, using Verilog HDL.

TEXT/REFERENCE BOOKS:

- M. Morris Mano and Michael Ciletti, "Digital Design: With a Introduction to the Verilog HDL", 5th edition, Pearson.
- Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata McGraw Hill.
- Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd edition, Prentice Hall.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Digital Logic Design And HDL Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To learn the fundamentals of digital logic circuits and digital number systems.
- To be able to analyze and design digital combinational-logic and sequential-logic circuits.
- To implement digital combinational-logic and sequential-logic circuits, using Verilog HDL (Hardware Description Language).

Laboratory Sessions would be based on following topics:

- Digital data representation and coding; Basic logic operations, truth-tables and logic gates; Number Systems and Codes: Positional number system; Binary; octal and hexadecimal number systems and arithmetic; Representation of signed numbers; Fixed-point numbers; Binary coded decimal codes; Gray codes.
- Standard representation of logic functions; The Map Method; SOP and POS forms; Simplification of Boolean functions using K-map and Quine-McCluskey tabular methods; Synthesis of combinational logic circuits.
- Digital Combinational-Logic modules: Decoders; encoders; multiplexers; demultiplexers, combinational shifters, and their applications; Parity circuits and comparators; Arithmetic modules- adder; sub-tractor, basic multiplier, ALU; Design examples.
- Introduction to Verilog Hardware Description Language (HDL): Types of modelling: Gate-level modelling, Data-flow modelling; Behavioural modelling; Basic constructs and syntax of Verilog language, related to hierarchical and modular modelling; Concept of test-bench and incorporating delays in test-bench; Verilog implementation of combinational circuits/modules.
- Basic sequencing elements - latches and flip-flops: SR-latch; D-latch; D flip-flop; JK flip-flop; T flip-flop.
- Synchronous Moore and Mealy Finite State Machines (FSM) – state diagram, state table, state assignment; Analysis and implementation of FSM using D flip-flops, JK flip-flops and T flip-flops; Design examples of FSM; Various Registers - and Counters; Application examples.
- Verilog implementation of sequencing elements (latch and flip-flops) using behavioural modelling; Verilog implementation of sequential-logic circuits and RTL structures.
- Programmable Logic Devices: PLAs and their applications; Sequential PLDs.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:
CO1- Understand the basics of number systems, Boolean algebra and standard digital logic gates.
CO2- Analyze the functionality of digital combinational-logic and sequential-logic circuits.
CO3- Design digital combinational-logic and sequential-logic circuits, at the module/schematic-level.
CO4- Write codes in Verilog HDL, using structural, dataflow, and behavioral modeling.
CO5- Implement and simulate digital combinational-logic circuits, using Verilog HDL.
CO6- Build and simulate digital sequential-logic circuits and RTL structures, using Verilog HDL.

TEXT/REFERENCE BOOKS:

- M. Morris Mano and Michael Ciletti, "Digital Design: With a Introduction to the Verilog HDL", 5th edition, Pearson.
- Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata McGraw Hill.
- Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd edition, Prentice Hall.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

Semester-IV

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR
SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B TECH IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester IV			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Analog Circuit Design	3	0	0	3	3	25	50	25	--	--	100
2		Analog Circuit Design Lab	0	0	2	1	2	--	--	--	25	25	50
3		Data Base Management Systems	2	0	0	2	2	25	50	25	-	-	100
4		Data Base Management Systems Lab	0	0	2	1	2	--	--	--	25	25	50
5		Computer Organization & Design	2	0	0	2	2	25	50	25	--	--	100
6		Computer Organization & Design Lab	0	0	2	1	2	--	--	--	25	25	50
7		Digital Signal Processing	3	0	0	3	3	25	50	25	-	-	100
8		Digital Signal Processing Lab	0	0	2	1	2	--	--	--	25	25	50
9		OE-2	3	0	0	3	3	25	50	25	--	--	100
10		Industry 4.0	2	0	0	2	2	25	50	25	--	--	100
11		Industry 4.0 Lab	0	0	2	1	2	--	--	--	50	50	100
12		Communication Skills - II	0	0	2	1	2	--	--	--	50	50	100
13		Industrial Orientation (3 weeks-summer break)	0	0	0	1	0	--	--	--	--	--	100
		Total	15	0	12	22	27						1100

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LE – Lab Exam, LW – Lab Work, OE – Open Elective

<Course Code>					Analog Circuits Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

- To study and design BJT amplifiers.
- To analyse BJT, FET and MOSFET and their frequency response.
- To understand the OPAMP and its Applications.
- To apply ADC and DAC to develop real life circuit.

UNIT 1 Amplifier Analysis **08Hrs.**

Bias Stabilization Techniques for BJT, Thermal Stability. Small signal Analysis of BJT and FET amplifiers. High frequency model of BJT.

UNIT 2 Multistage and Feedback Amplifier **10 Hrs.**

Multistage Amplifiers: cascaded amplifier, RC coupled amplifier. Concept of Feedback in amplifiers - advantages and disadvantages –Types of Feedback Topologies, Effect on gain, impedance and bandwidth.

UNIT 3 OPAMP and its Applications **12 Hrs.**

Review of OPAMP, Clipping and clamping circuits, Schmitt trigger, monostable and astable multivibrators, triangular wave generator, precision rectifiers, log and antilog amplifiers, sample and hold circuit, peak detector, Active filters (1st 2nd order butterworth), 555 timer IC, Application of 555 in mostable, Bistable and Astable multivibrator.

UNIT 4 A/D and D/A Converters **9 Hrs.**

Analog To Digital and Digital To Analog Converters: Digital to Analog Conversion, R-2R ladder type DAC, Weighted resistor type DAC, Analog to Digital Conversion, Counter type A/D Converter, Flash type A/D converter, Dual slope A/D converter, Successive approximation ADC, Use of Sample and Hold circuit in ADC.

Some of the above topics would be covered through the associated laboratory course.

Maximum 39 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember the fundamentals of BJT, digital systems, & OPAMP.
CO2: Understand the concepts of analog sub-systems.
CO3: Apply the concepts of BJT, OPAMP, and ADC/DAC in different circuits.
CO4: Analyse the behaviour of analog and digital circuits.
CO5: Evaluate different electronic circuits related to analog.
CO6: Design electronics circuits using BJT, OPAMP and ADC//DAC.

TEXT/REFERENCE BOOKS

- J. Millman, C. Halkias and C. Parikh, “Integrated Electronics”, Tata McGraw Hill.
- R. A. Gayakwad, “Opamp and Linear Integrated Circuits” PHI.
- Boylestad and Nashlesky, “Electronic Devices and Circuit Theory”, PHI.
- Salivahanan, “Electronic Devices and Circuits”, Tata McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.(10 to 20 marks each)	80 to 60 Marks

<Course Code>					Analog Circuit Design Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To analyse BJT, FET and MOSFET devices and their frequency response.
- To study the design aspect of amplifiers using BJT.
- To critically analyse the OPAMP circuits to study its Applications.
- To develop circuits using ADC and DAC.

Laboratory Sessions would be based on following topics:

BJT, FET, MOSFET:

- Device characterization
- BJT amplifier design.

MULTISTAGE AMPLIFIER DESIGN:

- Study of different coupling mechanism
- Frequency response of multistage amplifier
- Effect of feedback

OPAMP CIRCUITS AND APPLICATIONS

- Clipping and clamping circuits
- Schmitt trigger, monostable and astable multivibrators, triangular wave generator,
- Precision rectifiers, log and antilog amplifiers, sample and hold circuit, peak detector,
- Active filters (1st 2nd order butterworth)
- Timer IC based circuits

ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS

- R-2R ladder type DAC, Weighted resistor type DAC,
- Counter type A/D Converter, Flash type A/D converter, Dual slope A/D converter, Successive approximation ADC,
- Use of Sample and Hold circuit in ADC.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Describe the behavior of BJT, FET and MOSFET.
CO2- Understand the frequency response of single and multistage amplifier.
CO3- Identify the basics aspects of single stage and multistage amplifier design.
CO4- Use OPAMP in simple circuit applications.
CO5- Apply Timer IC for real life applications.
CO6- Design a circuits for different application using A/D and D/A converters.

TEXT/REFERENCE BOOKS:

- J. Millman, C. Halkias and C. Parikh, “Integrated Electronics”, Tata McGraw Hill.
- R. A. Gayakwad, “Opamp and Linear Integrated Circuits” PHI.
- Boylestad and Nashlesky, “Electronic Devices and Circuit Theory”, PHI
- Salivahanan, “Electronic Devices and Circuits”, Tata McGraw Hill.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks:25 **Exam Duration:2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Database Management Systems					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To learn fundamental concepts of Database management system.
- To study various Database design models and normalization concepts.
- To apply the above concepts to optimal Database design for various applications.
- To carry out data retrieval and manipulation using SQL.

UNIT 1 INTRODUCTION AND DATABASE MODELS 6 Hrs.

Advantages of Database system applications, Three levels of the architecture. ER-Model, Relational Data Model

UNIT 2 SQL 7 Hrs.

Basics of SQL, DDL, DML, DCL, Primary key, foreign key, unique, not null, check, IN operator, Functions, set operations, sub-queries, correlated subqueries, Use of group by, having,

UNIT 3 NORMALIZATION 7 Hrs.

Importance of a good schema design, Problems encountered with bad schema designs, dependency theory - functional dependencies, Minimal covers, 1NF, 2NF, 3NF and BCNF.

UNIT 4 TRANSACTIONS, QUERY PROCESSING, SECURITY 6 Hrs.

ACID properties, Concurrency control, measures of query cost, selection operation, sorting, join. Security: Discretionary and Mandatory Access Control; Audit Trails; Multi-Level Security;

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to
CO1- Understand need of database management systems.
CO2- Explain database models.
CO3- Apply SQL commands in database systems.
CO4- Analyse normalization techniques in database systems.
CO5- Determine security levels in database systems.
CO6- Create database systems for real time problems.

TEXT/REFERENCE BOOKS

- A Silberschatz, H F Korth and S Sudarshan, "Database System Concepts", McGRAW Hill.
- C. J. Date, A. Kennan, and S. Swamynathan, "An Introduction to Database Systems", Pearson Education
- Ramez Elmasri and Shamkant B Navathe, "Fundamentals of Database Systems", Addison Wesley

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Database Management Systems Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To learn fundamental concepts of Database management system.
- To study various Database design models and normalization concepts.
- To apply the above concepts to optimal Database design for various applications.
- To carry out data retrieval and manipulation using SQL.

Laboratory Sessions would be based on following topics:

INTRODUCTION AND DATABASE MODELS, SQL, NORMALIZATION, TRANSACTIONS, QUERY PROCESSING, SECURITY

- Installation of relational database management system e.g MYSQL
- Introduction to SQL, DDL, DML, DCL, database and table creation, alteration, defining constraints, primary key, foreign key, unique, not null, check, IN operator
- Study and use of inbuilt SQL functions - aggregate functions, Built-in functions numeric, date, string functions
- Study, write and use the set operations, sub-queries, correlated subqueries in SQL
- Study and use of group by, having, order by features of SQL
- Study different types of join operations, Exist, Any, All and relevant features of SQL
- Study and apply Database Normalization techniques
- Analysis of query cost, creating indices and evaluating their effect on query evaluation plans and cost

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1- Understand need of database management systems.
CO2- Explain database models.
CO3- Apply SQL commands in database systems.
CO4- Analyzed normalization techniques in database systems.
CO5- Determine security levels in database systems.
CO6- Create database systems for real time problems.

TEXT/REFERENCE BOOKS

- A Silberschatz, H F Korth and S Sudarshan, "Database System Concepts", McGRAW Hill.
- C. J. Date, A. Kennan, and S. Swamynathan, "An Introduction to Database Systems", Pearson Education.
- Ramez Elmasri and Shamkant B Navathe, "Fundamentals of Database Systems", Addison Wesley.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Computer Organization and Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- Understand the functional organization and integration of the building blocks (Memory, Registers, ALU, Control, I/O, etc.) of the micro-computer architecture
- Develop an Instruction Set Architecture
- Learn assembly language programming

UNIT-1: OVERVIEW OF DIGITAL SEQUENTIAL CIRCUITS AND IMPLEMENTATION 4 Hrs.

Review of digital logic circuits: Tri-state based multiplexing for bus; Sequential circuits (counters and registers) and Moore Finite State Machines (FSM): Various methods of implementation of FSM: implementation based on Decoders and OR gates, implementation based on two-level Multiplexors, implementation based on ROM.

UNIT-2: INTRODUCTION TO COMPUTER ORGANIZATION 8 Hrs.

Basic structure of micro-computer / Central Processing Unit (CPU); Concept of control bus, address bus and data bus. Concept of Instruction Set Architecture. Understanding the building blocks of micro-computer: Data memory, Instruction Memory, Register Set, Address decoding, Arithmetic-logic Unit (ALU), timing pulse generator, Program Counter (PC), Stack Memory and stack pointers, I/O registers, control unit, etc. Design of control unit: Hardwired Control (MUX based and FSM based), Microprogrammed Control (ROM based). Design a simple RISC/CISC processor using a digital logic simulation tool.

UNIT-3: INSTRUCTION SET ARCHITECTURE AND ASSEMBLY LANGUAGE PROGRAMMING 8 Hrs.

RISC and CISC Architectures; Harvard and von Neumann Architectures; Instruction format; Addressing Modes; Instruction Set for an example microprocessor (8085/AVR/MIPS/etc.) covering these category of instructions: Data Transfer; Arithmetic; Logical; Branching; Subroutine; Stack; Basic I/O and Interrupt; Assembly language programming.

UNIT-4: BASICS OF MEMORY ORGANIZATION AND PIPELINING 6 Hrs.

Introduction to memory hierarchies and organization; Cache; Introduction to Pipelining: Arithmetic Pipeline; Instruction Pipeline;

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Describe the building blocks of the micro-computer, such as: the ALU, registers, control unit, memory and I/O unit.
CO2- Identify the basics aspects of pipelining and memory organization.
CO3- Organize the blocks of the micro-computer, and create a basic functional architecture.
CO4- Write simple programs in assembly language, utilizing the instruction set architecture.
CO5- Apply the knowledge of digital logic, to implement some of the building blocks of the micro-computer, especially, control unit, ALU, registers, PC, timing pulse generator.
CO6- Design a processor or micro-computer, based on simple instruction set.

TEXT/REFERENCE BOOKS:

- M. Morris Mano, "Computer System Architecture", Pearson Education
- Yale N. Patt, Sanjay J. Patel, "Introduction to Computing Systems", McGraw Hill
- R.S.Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085A", Penram International
- David A Patterson and John L. Hennessy, "Computer Organization and Design", Morgan Kaufmann

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs.

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Computer Organization and Design Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- Understand the functional organization and integration of the building blocks (Memory, Registers, ALU, Control, I/O, etc.) of the micro-computer architecture
- Develop an Instruction Set Architecture
- Learn assembly language programming

Laboratory Sessions would be based on following topics:

OVERVIEW OF DIGITAL SEQUENTIAL CIRCUITS AND IMPLEMENTATION

- Sequential circuits (counters and registers)
- Moore Finite State Machines (FSM): Various methods of implementation of FSM: implementation based on Decoders and OR gates, implementation based on two-level Multiplexors, implementation based on ROM.

INTRODUCTION TO COMPUTER ORGANIZATION

- Basic structure of micro-computer / Central Processing Unit (CPU); Concept of Instruction Set Architecture. Understanding the building blocks of micro-computer: Data memory, Instruction Memory, Register Set, Address decoding, Arithmetic-logic Unit (ALU), timing pulse generator, Program Counter (PC), Stack Memory and stack pointers, I/O registers, control unit, etc.
- Design of control unit: Hardwired Control (MUX based and FSM based), Microprogrammed Control (ROM based).
- Design a simple RISC/CISC processor using a digital logic simulation tool.

INSTRUCTION SET ARCHITECTURE AND ASSEMBLY LANGUAGE PROGRAMMING

- RISC and CISC Architectures; Harvard and von Neumann Architectures;
- Instruction format; Addressing Modes; Instruction Set for an example microprocessor (8085/AVR/MIPS/etc.) covering these category of instructions: Data Transfer; Arithmetic; Logical; Branching; Subroutine; Stack; Basic I/O and Interrupt; Assembly language programming.

BASICS OF MEMORY ORGANIZATION AND PIPELINING

- Introduction to memory hierarchies and organization; Cache;
- Introduction to Pipelining: Arithmetic Pipeline; Instruction Pipeline;

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Describe the building blocks of the micro-computer, such as: the ALU, registers, control unit, memory and I/O unit.
CO2- Identify the basics aspects of pipelining and memory organization.
CO3- Organize the blocks of the micro-computer, and create a basic functional architecture.
CO4- Write simple programs in assembly language, utilizing the instruction set architecture.
CO5- Apply the knowledge of digital logic, to implement some of the building blocks of the micro-computer, especially, control unit, ALU, registers, PC, timing pulse generator.
CO6- Design a processor or micro-computer, based on simple instruction set.

TEXT/REFERENCE BOOKS:

- M. Morris Mano, "Computer System Architecture", Pearson Education
- Yale N. Patt, Sanjay J. Patel, "Introduction to Computing Systems", McGraw Hill
- R.S.Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085A", Penram International
- David A Patterson and John L. Hennessy, "Computer Organization and Design", Morgan Kaufmann

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Digital Signal Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce mathematical ideas for analysis of discrete time signals and systems.
- Understand methodology to analyze, design and implement various digital filters.
- Understand need and development of efficient algorithms for various DSP tasks.

UNIT-1 ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS 10 Hrs.

Introduction to DSP, A review of Sampling Theorem, Discrete Time Signals and Systems, Z-transform, ROC and Properties, Poles- Zeros, Inverse z-transform, LTI System Analysis using Z-transform, Discrete Time Fourier Transform (DTFT) and Important Properties, Frequency Response of Discrete Time Systems, Correlation of Discrete Time Signals, Parseval's relation, Energy and Power Spectral Density.

UNIT-2 DIGITAL FILTERS: DESIGN AND STRUCTURES 12 Hrs.

Ideal Digital Filters, Practical Filters: Stability and Causality, FIR and IIR Filters, Linear Phase and Implications, Filter Design Steps, Design of Linear Phase FIR Filters, Window Method, IIR Filter Design, Pole-Zero Placement Method, Overview of Laplace Transform and Analog Filter Design, Analog Filter Standard Frequency Responses and Design Equations, IIR Filter Coefficients from Analog Filter, Bilinear Transformation, Basic Structures for FIR and IIR Systems implementation, Direct, Transposed Cascade and Parallel form Structures, Effects of Co-efficient Quantization.

UNIT-3 DFT AND FFT ALGORITHMS 10 Hrs.

Effect of periodicity and discretization on spectra of a signal, Sampling of DTFT, DFT and IDFT, Important Properties of DFT, Linear and Circular Convolution, Application of DFT in Linear Filtering, Efficient Computation of DFT, Radix2 FFT Algorithms, Geortzel Algorithm.

UNIT-4 DIGITAL SIGNAL PROCESSORS AND DEVELOPMENT TOOLS **07 Hrs.**

Need and Features of Digital Signal Processors, Harvard and Modified Harvard Architecture, Pipelining, Multiplier-Accumulator (MAC) Unit, Circular Buffer, Fixed and Floating point DSP Processors, Audio-Video Codecs and Interfacing, Hardware and Software Development Tools for DSP, Recent Trends in DSP Based System Design, Application of DSP and its implementation on DSP processors.

Max. 39 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember properties of discrete time signals and systems in Z-domain and frequency domain.
CO2: Understand concepts and complexity of digital signal processing techniques.
CO3: Apply concepts to realize discrete time systems and digital signal processing algorithms.
CO4: Analyze discrete time systems, algorithms and digital filters.
CO5: Evaluate performance of discrete time systems and digital signal processing algorithms.
CO6: Design and implement practical applications using software and hardware development tools.

TEXT/REFERENCE BOOKS

- Digital Signal Processing: Principles, Algorithm & Application, Proakis, Manolakis, Pearson Education.
- Digital Signal processing-A Practical Approach, Emmanuel Ifeacher,, Barrie W..Jervis, Pearson Education.
- Discrete Time Signal Processing, Allen V. Oppenheim, Ronald W. Schafer, Prentice Hall.
- Digital Signal Processors: Architectures, Implementations, and Applications, Sen M.Kuo, Woon-Seng S.Gan, Pearson education India.
- Digital Signal Processors, Architecture, programming and applications, B.Venkatramani, M Bhaskar, Mc-Graw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Digital Signal Processing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To impart knowledge of flow process of digital signal processing.
- To implement digital signal processing algorithms on software and hardware platforms.
- To evaluate performance of digital signal processing systems and algorithms.

Laboratory Sessions would be based on following topics but not limited to:

1. Discrete time signal generation
2. Z domain and frequency domain analysis of discrete time signals and systems
3. Design and implementations of FIR and IIR filters
4. Application of DFT-FFT in linear filtering
5. Simulation of discrete time systems for speech and audio applications
6. Implementation of digital signal processing algorithms on various platforms.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember representation of discrete time signals and systems in Z-domain and frequency domain.
CO2: Understand the methodologies to utilize digital signal processing techniques practically.
CO3: Apply concepts to realize discrete time systems and digital signal processing algorithms practically.
CO4: Analyze and report the behaviour of discrete time systems and digital signal processing algorithms.
CO5: Evaluate and report performance of discrete time systems and digital signal processing algorithms.
CO6: Design and implement practical applications using software and hardware development tools.

TEXT/REFERENCE BOOKS

- Digital Signal Processing: Principles, Algorithm & Application, Proakis, Manolakis, Pearson Education.
- Digital Signal processing-A Practical Approach, Emmanuel Ifeacher,, Barrie W..Jervis, Pearson Education.
- Discrete Time Signal Processing, Allen V. Oppenheim, Ronald W. Schafer, Prentice Hall.
- Digital Signal Processors: Architectures, Implementations, and Applications, Sen M.Kuo, Woon-Seng S.Gan, Pearson education India.
- Digital Signal Processors, Architecture, programming and applications, B.Venkatramani, M Bhaskar, Mc-Graw Hill.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: simulation and designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

Course Code					Industry 4.0					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To interpret the core elements and basic technologies of Industry 4.0.
- To understand how the core elements and technologies of Industry 4.0 are interconnected .
- To develop a holistic approach to improve processes and products with Industry 4.0.

UNIT I: INDUSTRY 4.0 – CONCEPTS & TERMINOLOGIES **08 Hrs.**

Industry 4.0, Smart business model, Technology road-map, Sensing & actuation, Communication, Internet of things (IoT), Cyber Physical Systems and Next Generation Sensors, Visualization, Cloud Computing.

UNIT II: SMART WORLD & SUSTAINABLE ENVIRONMENT **08 Hrs.**

Sensors and their integration, Renewable Energy System, Hybrid Energy System, Smart Grid, Smart Metering, Communication Protocols, 5G Technology, Smart Agriculture, Smart Infrastructure, Physiological Sensors, Human Machine Interface.

UNIT III: SMART MANUFACTURING **08 Hrs.**

Automation Systems, Additive Manufacturing, Micro-Electro-Mechanical Systems (MEMS), Smart Factories and Interconnection, Advanced Robotics – Autonomous and Swarm, Self-Propelled Vehicles, Drones–Unmanned Aerial Vehicle (UAV), 3d Printing, Spacecrafts.

UNIT IV: TRANSFORMING TECHNOLOGIES IN BIOENGINEERING **08 Hrs.**

Establishment of Smart Biotechnology Factory, Artificial Intelligence in Bioprocess Technology, 3D Bio Printing for Tissue Engineering, Simulation Tools, RSM and Box Model, Cyber Physical System based Telemedicine, Real Time Biosensors, Bio nanotechnology, biofuel.

Total Hours 32 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Understand the core elements and basic technologies for Industry 4.0.
CO2 Apply the different computational techniques and algorithms for realizing Industry 4.0.
CO3 Transform the traditional business approach by integrating the data and intelligence.
CO4 Develop the traditional industries with intelligent and automated machines.
CO5 Utilize data and intelligence for the development of Smart World.
CO6 Understand the concept, significance and means to achieve sustainable development.

TEXT/REFERENCE BOOKS

- Ustundag Alp, and Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer,First Edition, 2018.
- Kaushik Kumar, Divya Zindani, and J. Paulo Davim, Digital Manufacturing and Assembly Systems in Industry 4.0., CRC Press, Taylor & Francis First Edition, 2019.
- Antonella Petrillo, Raffaele Cioffi, and Fabio De Felice, Digital Transformation in Smart Manufacturing., IntechOpen Publisher, First Edition, 2018.
- J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama and N. Jenkins, Smart Grid: Technology and Applications, John Wiley and Sons Ltd., First Edition, 2012.
- Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, First Edition, 2016.
- Ibrahim Garbie, Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0, Springer, First Edition, 2016.

Course Code					Industry 4.0 Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

List of Experiments

1. Basic computations using Python programming.
2. Use simulations to understand the performance/behavior of a system by (i) creating a computational environment that mimics the real world, (ii) generating (synthetic) or loading data from sources, and (iii) testing the hypothesis
3. Introduction to MATLAB programming and SIMULINK
4. 3D printing of Airfoil through rapid prototyping 3D printer
5. Dynamic simulation of drone (unmanned air vehicle) through MATLAB/SIMULINK
6. ANSYS simulation of bending of a beam in an earthquake resist-building
7. Introduction to Arduino Embedded platform.
8. Design of line follower autonomous vehicle.
9. Design of smart meter for recording the electricity consumption
10. Design of smart lighting with the help of proximity sensors.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Understand the concept of Industry 4.0 and its significance.
CO2 Understand the resource requirements for the implementation of Industry 4.0.
CO3 Learn the Simulation Packages for Industry 4.0.
CO4 Explore the concept of Smart Infrastructure through simulation studies.
CO5 Inspect embedded platform applications for Industry 4.0.
CO6 Synthesise the solution for the given Industry 4.0 related problem.

Pandit Deendayal Petroleum University **School of Technology**

20HSXXXP					Communication Skills – II (Semester – III/IV) (Second Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2	--	--	--	50	50	100

COURSE OBJECTIVES

- Understand of the fundamental elements of communication in English language.
- Know and understand different practices of verbal and non-verbal communication with inputs to improve basic language skills.
- Students are expected to be better equipped in the following areas:
  - **Listening:** Understanding basic content in lectures and common everyday situations
  - **Speaking:** Correct expression in the English language at a basic level
  - **Reading:** Understanding, retaining, and critically analyzing technical/non-technical content
  - **Writing:** Using appropriate vocabulary, grammar, effective paragraph construction, writing in day-to-day scenarios, including digital platforms

UNIT 1	7 hrs
Technical Writing, Report Writing, Creating Lab Journals and Manuals, Portfolio of Critical Writing and Creative Writing, Essay, Story-writing, etc.	
UNIT 2	**7 hrs**
Summarizing, Writing Reviews (Books/Articles/Movies/websites), Reading Skills (Advanced)	
UNIT 3	**7 hrs**
Digital Literacy, Emails, Creating e-content, Editing and proofreading online, Using grammar and spell check software, Using plagiarism checkers	
UNIT 4	**9 hrs**
Group Discussion, Resume Writing, Interview Skills	
	Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Confidence to listen, speak, read and write in English
CO2 Being able to produce something new with the help of inputs
CO3 Learning to critically analyze
CO4 Preparing reports/critique with the help of collected data
CO 5 Having a multi-dimensional/disciplinary perspective and approach
CO6 Better improved and sharpened skills to present, convince and persuade to be an effective and successful professional

TEXT/REFERENCE BOOKS

- Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
- Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
- Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
- Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
- Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tool	Marks	Assignments
Lab Work	50	• Essay/Journal Writing – 10 • Report Writing – 10 • Creating e-content – 10 • Blog Writing – 10 • Review Writing - 10
Lab Exam/Viva	50	• Mock Interview – 15 • Group Discussion – 15 • Cover Letter/Curriculum - 20

<Course Code>					Industrial Orientation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	1	3 weeks summer break	--	--	--	--	100	100

COURSE OBJECTIVES

- To explore and experience the working environment of the industry.
- To learn about the different departments in an industry.
- To relate classroom learning with functioning of an industry.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 Remember the academic concepts to solve industrial problems.
CO2 Understand the working of different industrial departments.
CO3 Map classroom learnings to industry processes.
CO4 Analyse different solutions for industrial problems.
CO5 Evaluate the impact of solution.
CO6 Apply principles of management, teamwork, ethics, and communicate effectively in a professional environment for lifelong learning.

Semester - V

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR

SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B TECH IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester V			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Operating System	3	0	0	3	3	25	50	25	-	-	100
2		Operating System Lab	0	0	2	1	2	--	--	--	25	25	50
3		RF Engineering	3	0	0	3	3	25	50	25	-	-	100
4		RF Engineering Lab	0	0	2	1	2	--	--	--	25	25	50
5		Digital Communication	3	0	0	3	3	25	50	25	-	-	100
6		Digital Communication Lab	0	0	2	1	2	--	--	--	25	25	50
7		CE-1 Theory	2	0	0	2	2	25	50	25	-	-	100
8		CE-1 Lab	0	0	2	1	2	--	--	--	25	25	50
9		CE-2 Theory	2	0	0	2	2	25	50	25	--	--	100
10		CE-2 Lab	0	0	2	1	2	--	--	--	25	25	50
11		OE-3	3	0	0	3	3	25	50	25	-	-	100
		Total	18	0	6	21	24						750

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LE- Lab Exam, LW- Lab work, OE – Open Elective

The ICT department may offer electives from below basket, based on availability of expertise/faculty

Subject Code	**CE: Core Elective (1 and 2)**	**Credit**	**L-T-P**	**Subject Code**	**CE: Core Elective (1 and 2)**	**Credit**	**L-T-P**
	Information Security	2	2-0-0		Information Security Lab	1	0-0-2
	Energy Efficient Computing and Communication	2	2-0-0		Energy Efficient Computing and Communication Lab	1	0-0-2
	Building blocks of CPS	2	2-0-0		Building blocks of CPS Lab	1	0-0-2
	Theory of Automata and Computation	2	2-0-0		Theory of Automata and Computation Lab	1	0-0-2
	Probability and Statistics for Data Science	2	2-0-0		Probability and Statistics for Data Science Lab	1	0-0-2

	Computer based Financial System Analysis	2	2-0-0		Computer based Financial System Analysis lab	1	0-0-2

<Course Code>					Operating System					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart the Operating System role in the overall computer system.
- To study the operations performed by OS as a resource manager.
- To understand the scheduling policies of OS, the different memory management techniques, page replacement algorithms, the concepts of Deadlock, input/output, storage, file management and different system calls.

UNIT 1 PROCESS MANAGEMENT **09 Hrs.**

Introduction-Operating system, OS Operations, Process Management, Memory Management, Storage Management, Protection and Security, System calls, Process and Threads.

UNIT 2 SYNCHRONIZATION **10 Hrs.**

Process Scheduling-Basic concepts and algorithms, Thread scheduling, Process Synchronization algorithms, Mutual exclusion, Test Set Locks, Semaphores-Binary, Counting.

UNIT 3 DEADLOCKS **10 Hrs.**

Deadlocks- Deadlock Avoidance, Deadlock Detection, and Recovery from Deadlock.

UNIT 4 MEMORY AND FILE MANAGEMENT **10 Hrs.**

Memory Management and Virtual Memory-Contiguous Memory Allocation, Segmentation, Paging. Virtual Memory Management - Background, Demand Paging, Copy-on-Write, Page Replacement, Page Replacement Algorithms, Allocation of Frames, Thrashing. Storage Management-File System- Concept of a File, System calls for file operations, I/O device management, interface, device drivers.

Max. 39 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Apply concepts of process management for the improvement of system performance.

CO2 – Understand and solve synchronization problems.

CO3 – Assess about minimization of turnaround time, waiting time and response time; and also maximization of throughput by keeping CPU as busy as possible.

CO4 – Analyze important parameters for memory management to handle memory optimally.

CO5 – Judge efficacy of Page replacement algorithms.

CO6 – Design and create new techniques for process, synchronization, memory and file management.

TEXT/REFERENCE BOOKS

- Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, Wiley.
- W. Stallings, Operating Systems – Internals and Design Principles, Prentice Hall.
- Sumitabha Das, Unix Concepts and Applications, TMH.
- Andrew S Tanenbaum, Modern Operating Systems, PHI.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Operating System Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To impart the Operating System role in the overall computer system.
- To study the operations performed by OS as a resource manager.
- To understand the scheduling policies of OS, the different memory management techniques, page replacement algorithms, the concepts of Deadlock, input/output, storage, file management and different system calls.

Laboratory Sessions would be based on following topics:

1. Shell scripting.
2. CPU Scheduling algorithms.
3. File organization techniques, File allocation methods.
4. System calls.
5. Banker's algorithm for Dead Lock Avoidance and Prevention.
6. Page Replacement algorithms, Memory management techniques like paging and segmentation.
7. Pipes, Dining Philosopher problem using Semaphores.
8. Inter process communication, I/O device management, interface, device drivers.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Apply concepts of process management for the improvement of system performance.

CO2 – Understand and solve synchronization problems.

CO3 – Assess about minimization of turnaround time, waiting time and response time; and also maximization of throughput by keeping CPU as busy as possible.

CO4 – Analyze important parameters for memory management to handle memory optimally.

CO5 – Judge efficacy of Page replacement algorithms.

CO6 – Design and create new techniques for process, synchronization, memory and file management.

TEXT/REFERENCE BOOKS

- Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, Wiley.
- W. Stallings, Operating Systems – Internals and Design Principles, Prentice Hall.
- Sumitabha Das, Unix Concepts and Applications, TMH.
- Andrew S Tanenbaum, Modern Operating Systems, PHI.

END SEMESTER LABORATORY EXAMINATION PATTERN	25 Marks
Max. Marks: 25	**Exam Duration: 2 Hrs.**
The laboratory exam would be conducted in the Lab, and students would be provided one or more	

<Course Code>					RF Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To Impart electromagnetic and transmission line concepts.
- To learn the radiating body behavior for wireless communication system.
- To introduce the wave propagation mechanism in different modes.
- To elaborate and familiarize the different modern RF technologies.

UNIT 1 ELECTROMAGNETICS **10 Hrs.**

Maxwell's equations, pointing theorem, uniform plane wave and reflection, plane wave propagation in free space and lossless & lossy media. Transmission line: Types of transmission lines, transmission line equation and solution, reflection and transmission coefficients, standing wave and standing wave ratio, line impedance, Smith chart, impedance matching. Waveguides, waveguide Tees, bands, corners, twists, posts, irises, directional couplers, Faraday's rotation, circulator and isolator, Introduction, modes (TEM, TEmn, TMmn) and field pattern in medium, S-parameters.

UNIT 2 RADIATING SYSTEMS **09 Hrs.**

Basics: Radiation Mechanism and Current Distribution, Fundamental Parameters related to antenna (Radiation Pattern, Radiation Power Density, Directivity, Gain, Beam width, Bandwidth, Polarization, Radiation Efficiency, Antenna Efficiency, Far Field Radiation. Antenna Array: Two Element Array N-Element Linear Array with uniform amplitude and spacing, Broadside and End-Fire Arrays, N-Element 2D Array. Microstrip antenna: Introduction to strip line and microstrip lines, Advantages and limitations, feeding techniques, introduction to rectangular microstrip antenna, RMSA and CMSA design, filters design using microstrip line.

UNIT 3 RADAR AND WAVE PROPAGATION **08 Hrs.**

Introduction (basic principle and types) to radar, radar range equation, maximum unambiguous range, pulse & MTI radars blind speed, radar resolution. Modes of wave propagation, Ground Wave Propagation, Sky wave propagation, Definitions for Virtual height, MUF and Skip distance, Multi-hop propagation, Space wave propagation..

UNIT 4 MODERN RF TECHNOLOGIES **12 Hrs.**

RFID, NFC technology and their interfacing with IoT, RF Energy harvesting for WSN & IoT, 5G Technology, Antenna Design for 5G, MU-MIMO and Massive MIMO for5G Radios, study of effect of RF on flora fauna and human being.

Max. 39 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remembering the fundamentals of RF Engineering.
CO2: Understanding effect and outcome of RF waves.
CO3: Applying the transmission medium, and radiating elements.
CO4: Analyzing the behaviour of wave in different transmission conditions.
CO5: Evaluating different RF Technologies.
CO6: Design RF subsystems.

TEXT/REFERENCE BOOKS

- Samuel Y. Liao, "Microwave Devices and Circuits", Pearson Education, 3rd edition, 2012.
- C. A. Balanis, "Antenna theory: analysis and design", John Wiley and sons, 3rd Edition, 2005.
- M. L. Skolnik, "Introduction to Radar Systems", Mc Graw Hill, 3rd edition, 2016.
- K. D. Prasad, "Antenna and wave Propagation", Satya Prakashan, 3rdedition, 2009.
- M. Kulkarni, "microwave and radar engineering", Umesh Publication, 3rd edition, 2008.
- Rodriguez, Jonathan, "Fundamentals of 5G mobile networks" John Wiley & Sons, 2015.
- Hueber, Gernot, and Ali M. Niknejad, "Millimeter-wave Circuits for 5G and Radar" Cambridge University Press, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.(10 to 20 marks each)	80 to 60 Marks

<Course Code>					RF Engineering Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To study different RF components
- To observe behaviour of RF sources, MIC components
- To analyse Radar systems
- To design radiating elements

Laboratory Sessions would be based on following topics:

ELECTROMAGNETICS:

- Tube based source characterization
- Semiconductor based source characterization.
- VSWR formation, Return loss measurement, use of Smith Chart

WAVEGUUIDE AND COMPONENTS:

- Modes in rectangular waveguideFrequency and wavelength measurement
- Component characterization

RADIATING SYSTEMS:

- MIC Components characterization
- Rectangular Microstrip Antenna design and frequency response
- Circular Microstrip Antenna design and frequency response

RADAR AND WAVE PROPAGATION

- Antenna array
- Radar application
- Wave propagation study
- RF front end design for 5G
- RFID design

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:
CO1: Use the RF components
CO2: Characterize the RF sources
CO3: Apply concept to study the transmission medium
CO4: Analyze the behavior of Radar and radiating elements
CO5: Evaluate the properties of transmission lines
CO6: Design RF subsystems

TEXT/REFERENCE BOOKS

- Samuel Y. Liao, "Microwave Devices and Circuits", Pearson Education, 3rd edition, 2012.
- C. A. Balanis, "Antenna theory: analysis and design", John Wiley and sons, 3rd Edition, 2005.
- M. L. Skolnik, "Introduction to Radar Systems", Mc Graw Hill, 3rd edition, 2016.
- K. D. Prasad, "Antenna and wave Propagation", Satya Prakashan, 3rdedition, 2009.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks:25 **Exam Duration:1 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Digital Communication					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart basic knowledge of digital modulation and demodulation techniques.
- To Understand coding and multiple access principles.
- Understand basic principles of wireless communication system.

UNIT-1 DIGITAL BASEBAND AND CARRIER COMMUNICATION TECHNIQUES 12 Hrs.

Review of Analog and digital Messages, Low pass sampling, Aliasing, Interpolation, PAM, PPM and PWM, PCM: Quantization, Uniform and non-uniform quantization, Quantization noise, Companding laws, DPCM, DM ADM, and SDM, Time division multiplexing (TDM), Line coding, Pulse shaping, Digital receivers, Regenerative repeaters. Carrier Communication Techniques: ASK, FSK, PSK, QAM, DPSK, MSK, GMSK, M-ary, Coherent and non-coherent detection, Carrier synchronization, Frequency Division Multiplexing (FDM), Noise performance and comparison of digital communication systems

UNIT-2 INFORMATION THEORY AND SOURCE CODING 07 Hrs.

Uncertainty and Information, Average Mutual Information and Entropy, Measure of Information, Source Coding Theorem, Huffman and Shanon-Fano Coding, Uniqueness Property, Channel Models, Channel Capacity, Error free Communication over a Noisy Channel, Information Capacity, Shannon Limit

UNIT-3 ERROR CONTROL CODING (CHANNEL CODING) 10 Hrs.

Selection of Channel Codes, Error Correcting Codes: Linear Block Codes, Hamming Distance, Perfect Codes and Hamming Codes, Low Density Parity Check (LDPC) Codes, Cyclic Codes, Burst Error Correcting and Detecting Code, Introduction to Golay, CRC, BCH, Reed-Solomon, Convolution and Turbo Codes

UNIT-4 WIRELESS CELLULAR SYSTEMS AND MULTIPLE ACCESS TECHNIQUES 10 Hrs.

Introduction to Mobile, Cellular and Personal Wireless Communication Systems, The Cellular Concept – System Design Fundamentals, Frequency Reuse, Channel Assignments, Hand-offs, Interference, Power Control, Grade of Service, Improving Coverage and Capacity, Evolution of Cellular Mobile Systems, Multiple Access Strategies: FDMA,TDMA, CDMA, OFDM, Spread Spectrum Communication Techniques and Applications, Software Defined Radio (SDR) and Model Architecture

Max. 39 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember principles of various digital communication methods.
CO2: Understand digital modulation, detection, coding, digital transmission and access techniques.
CO3: Apply mathematical concepts to model digital communication system.
CO4: Analyze digital communication systems to obtain various parameters like bandwidth, datarate etc.
CO5: Evaluate and compare performance of digital communication systems.
CO6: Design a block diagram level simple digital communication system.

TEXT/REFERENCE BOOKS

- B.P.Lathi, Zhi Ding "Modern Digital and Analog Communication Systems", Oxford University Press.
- P. Chakrabarti, "Analog and Digital Communication", Dhanpat Rai & Co.
- Wayne Tomasi "Electronic Communications Systems", Pearson education India.
- Ranjan Bose, "Information Theory, Coding and Cryptography", PHI.
- T. Rappaport, "Wireless Communications – Principles and Practice",Prentice Hall.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Digital Communication Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To impart knowledge of digital modulation, demodulation and coding techniques.
- To verify performance of various baseband and carrier digital communication systems.
- To compare various digital communication systems and understand their applications.

Laboratory Sessions would be based on following topics but not limited to:

1. PAM, PPM, PWM baseband techniques
2. Sampling, Quantization, PCM and variants
3. Digital carrier communication (ASK, FSK, PSK etc.) techniques
4. TDM techniques and synchronization
5. QAM and FDM Techniques
6. Error detection and correction techniques
7. Noise and BER analysis in various digital communication systems
8. OFDM Techniques
9. Spread spectrum communication

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember principles of various digital communication methods.
CO2: Understand digital modulation, detection, coding, digital transmission and multiplexing techniques.
CO3: Apply theoretical and mathematical concepts to practical digital communication system.
CO4: Analyze and report the characteristics of various modulation, demodulation, multiplexing, synchronization, coding techniques.
CO5: Evaluate and report performance of digital communication systems.
CO6: Design and implement small scale digital communication system using development tools.

TEXT/REFERENCE BOOKS

- B.P.Lathi, Zhi Ding "Modern Digital and Analog Communication Systems", Oxford University Press.
- P. Chakrabarti, "Analog and Digital Communication", Dhanpat Rai & Co.
- Wayne Tomasi "Electronic Communications Systems", Pearson education India.
- Ranjan Bose, "Information Theory, Coding and Cryptography", PHI.
- T. Rappaport, "Wireless Communications – Principles and Practice",Prentice Hall.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Information Security					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the concept of security requirements, security attacks, and security policy.
- To understand the mathematical concepts for cryptographic algorithms.
- To understand the security mechanisms available to protect the data.
- To understand the security analysis of cryptographic algorithms.

UNIT 1 INTRODUCTION AND NUMBER THEORY 07 Hrs.

Basics of Information Security, Classical Ciphers and Cryptanalysis, Introduction to Number Theory.

UNIT 2 SYMMETRIC KEY CRYPTOGRAPHY 07 Hrs.

Feistel Structure, Advanced Encryption Standard, Data Encryption Standard, Modern Block Ciphers, Modes of Operation, Use of Modern Block Ciphers.

UNIT 3 PUBLIC KEY CRYPTOGRAPHY 06 Hrs.

Introduction to Public Key Cryptography, Diffie-Hellman Key Exchange, RSA Cryptosystem.

UNIT 4 HASH FUNCTION AND DIGITAL SIGNATURE 06 Hrs.

Introduction to Hash Function, Introduction to SHA, Message Authentication Code, Digital Signature.

Max. 26 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Define the importance of security policies, basic concepts of cryptography, and cryptanalysis.
CO2- Demonstrate the mathematical concepts for cryptographic algorithms.
CO3- Apply appropriate encryption techniques to secure data in transit across data networks.
CO4- Analyze cryptography algorithms with the knowledge of security requirements and security attacks.
CO5- Evaluate the authentication and hash algorithms as per security requirements.
CO6- Discuss the security analysis of framework and policies applied in real life applications.

TEXT/REFERENCE BOOKS

- William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education
- Atul Kahate, “Cryptography and Network Security”, Tata McGraw-Hill Education
- Behrouz A. Forouzan, “Cryptography and Network Security”, McGraw-Hill Education

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Information Security Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To understand the concept of security requirements, security attacks, and security policy.
- To understand the mathematical concepts for cryptographic algorithms.
- To understand the security mechanisms available to protect the data.
- To understand the security analysis of cryptographic algorithms.

List of Experiments

1. Download and Practice Cryptool.
2. Study and Implement program for Ceaser Cipher with Encryption, Decryption, Brute Force Attack, and Frequency Analysis functions.
3. Study and Implement a program for Transposition (Columnar) Cipher to encrypt and decrypt the message.
4. Study and Implement a program for Rail Fence Transposition Cipher to encrypt and decrypt the message.
5. Study and Implement a program for Vigenère Cipher to encrypt and decrypt the message.
6. Study and Implement a program for 6x6 Playfair Cipher.
7. Study and Implement a program for n-gram Hill Cipher.
8. Use Crypto++ library to implement encryption and decryption functions for different block ciphers.
9. Study and Implement RSA Encryption and Decryption function.
10. Use RSA for generation and verification of digital signature on file.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Define the importance of security policies, basic concepts of cryptography, and cryptanalysis.
CO2- Demonstrate the mathematical concepts for cryptographic algorithms.
CO3- Apply appropriate encryption techniques to secure data in transit across data networks.
CO4- Analyze cryptography algorithms with the knowledge of security requirements and security attacks.
CO5- Evaluate the authentication and hash algorithms as per security requirements.
CO6- Discuss the security analysis of framework and policies applied in real life applications.

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- William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education
- Atul Kahate, “Cryptography and Network Security”, Tata McGraw-Hill Education
- Behrouz A. Forouzan, “Cryptography and Network Security”, McGraw-Hill Education

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Energy Efficient Computing and Communication					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To learn energy efficient computing concepts.
- To study role of energy saving approaches in energy efficient infrastructure.
- To understand about energy efficient communication schemes.
- To analyse energy efficient communication protocols and computing.

UNIT 1 INTRODUCTION TO ENERGY EFFICIENT COMPUTING AND ICT COMPONENTS 6 Hrs.

Energy efficient ICT Fundamentals: Business, IT, and the Environment – energy efficient computing: carbon footprint, power saving, Emerging Low Power Devices (VLSI and FPGA), Green ICT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics

UNIT 2 ENERGY EFFICIENT INFRASTRUCTURE AND MODELLING 8 Hrs.

Buildings, Data Centres, Networks, and Devices, Energy efficient Business Process Management: Modelling, Optimization, and Collaboration – Energy efficient Enterprise Architecture – Environmental Intelligence – Green Supply Chains – Green Information Systems: Design and Development Models. The Role of ICT in the Evolution Towards Smart Grids, Cloud Computing - a Greener Future for ICT

UNIT 3 ENERGY EFFICIENT COMMUNICATION 7 Hrs.

Green Communications for Carbon Emission Reductions: Architectures and Standards, Green Ad Hoc and Sensor Networks, C-RAN: A Green RAN Framework, Energy Savings for Mobile Communication Networks through Dynamic Spectrum and Traffic Load Management, Green Wireless Access Networks, Energy-Efficient Communication Protocols with QoS Guarantees, LPWAN, LoRaWAN, 6LOWPAN

UNIT 4 ANALYSIS OF ENERGY EFFICIENT COMPUTING AND COMMUNICATION 5 Hrs.

Performance evaluation and measurement for energy efficient computing and communication, Environmentally Responsible Business Strategies (ERBS) – Case Study Scenarios for Trial Runs – Case Studies – Applying Green ICT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector

Some of the above topics would be covered through the associated laboratory course.

Max.26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember components of energy efficient computing and communication.
CO2- Understand the role of ICT in energy efficient computing and communication.
CO3- Apply concepts of energy efficiency in computing and communication infrastructure.
CO4- Analyse energy efficient computing and communication schemes and strategies.
CO5- Evaluate performance of energy efficient computing and communication schemes and approaches.
CO6- Create energy efficient computing and communication strategies for industry, society and academic.

TEXT/REFERENCE BOOKS

- Bhuvan Unhelkar, Green IT Strategies and Applications-Using Environmental Intelligence, CRC Press, June 2014.
- Woody Leonhard, Katherine Murray, ―Green Home computing for dummies, August 2012.
- Jinsong Wu, Sundeep rangan, H. Zhang,Green communication: Theoretical Fundamentals, Algorithms, and Applications, CRC Press, 2012.
- Santosh K. Kurinec, Sumeet Walia, Energy Efficient Computing & Electronics Devices to Systems, CRC Press, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Energy Efficient Computing and Communication Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To learn energy efficient computing concepts.
- To simulate energy saving approaches in energy efficient infrastructure.
- To understand about energy efficient communication schemes.
- To implement energy efficient communication protocols and computing.

Laboratory Sessions would be based on following topics:

INTRODUCTION TO ENERGY EFFICIENT COMPUTING AND ICT COMPONENTS

- Energy efficient computing: carbon footprint
- power saving, Emerging Low Power Devices (VLSI and FPGA)
- Green ICT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics

ENERGY EFFICIENT INFRASTRUCTURE AND MODELLING

- Buildings, Data Centres, Networks, and Devices,
- Energy efficient Business Process Management: Modelling, Optimization, and Collaboration – Energy efficient Enterprise Architecture
- Environmental Intelligence – Green Supply Chains – Green Information Systems: Design and Development Models.
- The Role of ICT in the Evolution Towards Smart Grids, Cloud Computing - a Greener Future for ICT

ENERGY EFFICIENT COMMUNICATION

- Green Ad Hoc and Sensor Networks, C-RAN: A Green RAN Framework
- Energy Savings for Mobile Communication Networks through Dynamic Spectrum and Traffic Load Management,
- Green Wireless Access Networks, Energy-Efficient Communication Protocols with QoS Guarantees, LPWAN, LoRaWAN, 6LOWPAN

ANALYSIS OF ENERGY EFFICIENT COMPUTING AND COMMUNICATION

- Performance evaluation and measurement for energy efficient computing and communication
- Environmentally Responsible Business Strategies (ERBS) – Case Study Scenarios for Trial Runs – Case Studies –
- Applying Green ICT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember components of energy efficient computing and communication.
CO2- Understand the role of ICT in energy efficient computing and communication.
CO3- Apply concepts of energy efficiency in computing and communication infrastructure.
CO4- Analyse energy efficient computing and communication schemes and strategies.
CO5- Evaluate performance of energy efficient computing and communication schemes and approaches.
CO6- Create energy efficient computing and communication strategies for industry, society and academic.

TEXT/REFERENCE BOOKS

- Bhuvan Unhelkar, Green IT Strategies and Applications-Using Environmental Intelligence, CRC Press, June 2014.
- Woody Leonhard, Katherine Murray, ―Green Home computing for dummies, August 2012.
- Jinsong Wu, Sundeep rangan, H. Zhang,Green communication: Theoretical Fundamentals, Algorithms, and Applications, CRC Press, 2012.
- Santosh K. Kurinec, Sumeet Walia, Energy Efficient Computing & Electronics Devices to Systems, CRC Press, 2019.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Building Blocks of Cyber Physical Systems					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To learn the fundamentals of cyber physical systems.
- To understand concepts of cyber physical system modelling.
- To explore a wide range of engineering solutions using cyber physical systems.
- To implement applications of CPS.

UNIT 1 INTRODUCTION AND MODELING OF CPS **06 Hrs.**

Introduction to cyber physical systems, continuous dynamics, discrete dynamics, hybrid systems, computation of state machines, concurrent models of computation, introduction to hybrid equations tool box,

UNIT 2 EMBEDDED SYSTEM COMPONENTS FOR CPS **07 Hrs.**

Introduction to design of CPS, sensors and actuators, embedded processors, memory architecture, input and output, multi tasking, scheduling.

UNIT 3 ANALYSIS OF CPS **07 Hrs.**

Invariant and temporal logic, equivalence and refinement, reachability analysis and model checking, quantitative analysis, security and privacy.

UNIT 4 CPS SIMULATIONS **06 Hrs.**

Simulations of CPS in communication networks, Physical systems, CPS interfaces, FSM simulations
The role of CPS in the development of smart cities, healthcare, factory automation and defence systems.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1- Remember different modeling, design, analysis techniques of CPS.
CO2- Understand methodology to execute different real world scenarios using CPS.
CO3-Apply modeling, simulation concepts to existing problems.
CO4-Analyse CPS parameters for the problem.
CO5-Evaluate different CPS models for the problem.
CO6-Create CPS simulation for real world problems.

TEXT/REFERENCE BOOKS

- Edward A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems, A Cyber-Physical Systems Approach", Second Edition, MIT Press, ISBN 978-0-262-53381-2, 2017, available for download.
- Derek Molloy, "Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux", 2016, Wiley.
- Rajeev Alur, "Principles of Cyber-Physical Systems", 2015, MIT Press.ISBN: 9780262029117
- Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, "Cyber-Physical Systems: From Theory to Practice", 2015, CRC Press.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Building Blocks of Cyber Physical Systems Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To learn the fundamentals of cyber physical systems.
- To apply concepts of cyber physical system modelling.
- To simulate a wide range of engineering solutions using cyber physical systems.
- To execute different applications of CPS.

Laboratory Sessions would be based on following topics:

INTRODUCTION AND MODELING OF CPS

- Continuous dynamics
- Discrete dynamics,
- Hybrid systems,
- Computation of state machines, concurrent models of computation, introduction to hybrid equations tool box,

EMBEDDED SYSTEM COMPONENTS FOR CPS

- Sensors and actuators, embedded processors, memory architecture
- Input and output, multi tasking, scheduling.

ANALYSIS OF CPS

- Invariant and temporal logic, equivalence and refinement
- Reachability analysis and model checking, quantitative analysis, security and privacy

CPS SIMULATIONS

- Simulations of CPS in communication networks, Physical systems, CPS interfaces
- FSM simulations
- The role of CPS in the development of smart cities, healthcare, factory automation and defence systems.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember different modeling, design, analysis techniques of CPS.
CO2- Understand methodology to execute different real world scenarios using CPS.
CO3-Apply modeling, simulation concepts to existing problems.
CO4-Analyse CPS parameters for the problem.
CO5-Evaluate different CPS models for the problem.
CO6-Create CPS simulation for real world problems.

TEXT/REFERENCE BOOKS

- Edward A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems, A Cyber-Physical Systems Approach", Second Edition, MIT Press, ISBN 978-0-262-53381-2, 2017, available for download.
- Derek Molloy, "Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux", 2016, Wiley.
- Rajeev Alur, "Principles of Cyber-Physical Systems", 2015, MIT Press.ISBN: 9780262029117
- Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, "Cyber-Physical Systems: From Theory to Practice", 2015, CRC Press.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Theory of Automata and Computation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the central ideas of theoretical computer science from the perspective of formal languages.
- To understand the fundamental concepts of formal languages, grammars and automata theory.
- To understand the Classification of machines by their power to recognize languages.
- Employ finite state machines to solve problems in computing.

UNIT 1 FINITE AUTOMATA AND REGULAR LANGUAGE 7 Hrs.

Introduction to Finite Automata, Regular Expressions, Finite Automata and Regular Expressions, Properties of Regular Languages-Pumping Lemma for Regular Languages

UNIT 2 PUSHDOWN AUTOMATA AND CONTEXT-FREE LANGUAGE 6 Hrs.

Context-Free Grammars, Parse Tress, Ambiguity in Grammars and Languages. Push Down Automata: definition, the Languages of a PDA, Equivalence of PDA's and CFG's.

UNIT 3 LINEAR BOUNDED AUTOMATA AND CONTEXT-SENSITIVE LANGUAGE 7 Hrs.

Normal Forms for Context- Free Grammars, the Pumping Lemma for Context-Free Languages, Chomsky Normal Form. Context–sensitive grammars, linear bounded automata definition.

UNIT 4 TURING MACHINE AND FREE LANGUAGE 6 Hrs.

Turing Machines-Problems That Computers Cannot Solve, Extensions to the basic Turing machine, Restricted Turing Machines, Undecidability and uncountable problems, The Classes P and NP, An NP-Complete Problem.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Define the basic concepts and application of Theory of Computation
CO2 – Understand the concept of abstract machines and their power to recognize the languages.
CO3 – Demonstrate the finite state machines for modelling and solving computing problems
CO4 – Analyse context-free grammar to design pushdown automata
CO5 – Apply this basic knowledge of Theory of Computation to solve computational problems.
CO6 – Design the concepts of Turing machine to understand decidability and undecidability.

TEXT/REFERENCE BOOKS

- Introduction to Automata Theory, Languages, and Computation, John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education.
- Theory of Computer Science – Automata languages and computation, Mishra and Chandrashekaran, PHI.
- Introduction to the Theory of Computation, Michael Sipser, Cengage Learning.
- Introduction to Languages and the Theory of Computation, John C Martin, TMH

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Theory of Automata and Computation Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To understand the central ideas of theoretical computer science from the perspective of formal languages.
- To understand the fundamental concepts of formal languages, grammars and automata theory.
- To understand the Classification of machines by their power to recognize languages.
- Employ finite state machines to solve problems in computing.

Laboratory Sessions would be based on following topics:

FINITE AUTOMATA AND REGULAR LANGUAGE

Finite Automata, Regular Expressions, Finite Automata and Regular Expressions, Properties of Regular Languages- Pumping Lemma for Regular Languages

PUSHDOWN AUTOMATA AND CONTEXT-FREE LANGUAGE

Context-Free Grammars, Parse Tress, Ambiguity in Grammars and Languages. Push Down Automata: definition, the Languages of a PDA, Equivalence of PDA's and CFG's.

LINEAR BOUNDED AUTOMATA AND CONTEXT-SENSITIVE LANGUAGE

Normal Forms for Context- Free Grammars, the Pumping Lemma for Context-Free Languages, Chomsky Normal Form. Context–sensitive grammars, linear bounded automata definition.

TURING MACHINE AND FREE LANGUAGE

Turing Machines-Problems That Computers Cannot Solve, Extensions to the basic Turing machine, Restricted Turing Machines, Undecidability and uncountable problems, The Classes P and NP, An NP-Complete Problem.

Some of the above topics would be covered through the associated theory course

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Define the basic concepts and application of Theory of Computation
CO2 – Understand the concept of abstract machines and their power to recognize the languages.
CO3 – Demonstrate the finite state machines for modelling and solving computing problems
CO4 – Analyse context-free grammar to design pushdown automata
CO5 – Apply this basic knowledge of Theory of Computation to solve computational problems.
CO6 – Design the concepts of Turing machine to understand decidability and undecidability.

TEXT/REFERENCE BOOKS

- Introduction to Automata Theory, Languages, and Computation, John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education.
- Theory of Computer Science – Automata languages and computation, Mishra and Chandrashekaran, PHI.
- Introduction to the Theory of Computation, Michael Sipser, Cengage Learning.
- Introduction to Languages and the Theory of Computation, John C Martin, TMH

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development	25 Marks

<Course Code>					Probability and Statistics for Data Science					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Study probability theory and random variables.
- Learn random processes and applications.
- Explore tools for statistical signal analysis and characterization.

UNIT-1 FUNDAMENTALS OF PROBABILITY THEORY 8 Hrs.

Concept of Probability, Discrete and Continuous Random Variables, Cumulative Distribution Function, Probability Mass Functions and Probability Distribution Functions, Standard Distributions, Mutivariate Random Variables and Joint Distributions, Statistical Independence, Expectations: Mean, Variance and Higher Order Statistics, Covariance, Correlation, Uncorrelated Random Variables, Algebra of Random Variables, Conditional Expectations.

UNIT-2 RANDOM PROCESSES AND SPECTRAL ANALYSIS 7 Hrs.

Random Processes, Classification, Convergence, Central Limit Theorem, Monte Carlo Simulation, Markov Chains, Power Spectral Density, Multiple Random Processes, Transmission of Random Processes Through Linear Systems, Bandpass Random Process, Applications.

UNIT-3 STATISTICAL METHODS 7 Hrs.

Descriptive statistics: PCA and whitening, Frequentist Statistics: Independent and Identically Distributed Sampling, Mean Square Error, Parametric and Non-parametric Estimation, Bayesian Statistics and Estimation, Distributional tests.

UNIT-4 HYPOTHESIS TESTING AND LINEAR REGRESSION 4 Hrs.

Parametric and Non-parametric Testing, Linear Regression Models, Least Square Estimation, Overfitting.
Some of the above topics would be covered through the associated Lab course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1: Outline characteristics of random variables and statistical models.
CO2: Understand classification of random processes, Estimation, Hypothesis and Regression.
CO3: Apply knowledge of probability distributions to estimate data.
CO4: Analyze and compare characteristics of statistical methods.
CO5: Evaluate performance of statistical methods.
CO6: Design a model for data analysis.

TEXT/REFERENCE BOOKS

- Probability and Statistics for Data Science, Carlos Fernandez-Granda, Center for Data Science in NYU.
- Probability and Random Processes, Palaniammal S., Prentice Hall of India.
- Mathematical Methods and Algorithms for Signal Processing, Moon & Stirling, Pearson Indian Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Probability and Statistics for Data Science Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Study probability theory and random variables.
- Learn random processes and applications.
- Explore tools for statistical signal analysis and characterization.

Laboratory Sessions would be based on following topics:

FUNDAMENTALS OF PROBABILITY THEORY

- Concept of Probability, Discrete and Continuous Random Variables.
- Cumulative Distribution Function, Probability Mass Functions and Probability Distribution Functions, Standard Distributions.
- Mutivariate Random Variables and Joint Distributions, Statistical Independence.
- Expectations: Mean, Variance and Higher Order Statistics.
- Covariance, Correlation, Uncorrelated Random Variables, Algebra of Random Variables, Conditional Expectations.

RANDOM PROCESSES AND SPECTRAL ANALYSIS

- Random Processes, Classification, Convergence, Central Limit Theorem.
- Monte Carlo Simulation, Markov Chains.
- Power Spectral Density, Multiple Random Processes, Transmission of Random Processes through Linear Systems, Bandpass Random Process, Applications.

STATISTICAL METHODS

- Descriptive statistics: PCA and whitening, Frequentist Statistics: Independent and Identically Distributed Sampling, Mean Square Error.
- Parametric and Non-parametric Estimation, Bayesian Statistics and Estimation, Distributional tests.

HYPOTHESIS TESTING AND LINEAR REGRESSION

- Parametric and Non-parametric Testing, Linear Regression Models, Least Square Estimation, Overfitting.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Outline characteristics of random variables and statistical models.
CO2: Understand classification of random processes, Estimation, Hypothesis and Regression.
CO3: Apply knowledge of probability distributions to estimate data.
CO4: Analyze and compare characteristics of statistical methods.
CO5: Evaluate performance of statistical methods.
CO6: Design a model for data analysis.

TEXT/REFERENCE BOOKS

- Probability and Statistics for Data Science, Carlos Fernandez-Granda, Center for Data Science in NYU.
- Probability and Random Processes, Palaniammal S., Prentice Hall of India.
- Mathematical Methods and Algorithms for Signal Processing, Moon & Stirling, Pearson Indian Edition.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Computer based Financial System Analysis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce fundamentals of financial systems and mathematical analysis of financial systems.
- Introduce modelling of financial systems using statistical methods.
- Introduce concepts of financial derivatives and pricing.

UNIT-1 BASIC FINANCIAL SYSTEMS AND MATHEMATICS 06 Hrs.

Introduction to financial markets, financial instruments, bonds, stocks and financial derivatives, Time value of money, Annuity and instalments, Markowitz portfolio theory, Risk and return, Two and multi asset portfolio theory, Efficient frontier, Capital Asset Pricing Model (CAPM) and portfolio performance analysis, Calculation of Net Asset Value of a mutual fund, Performance Evaluation using Sharpe's, Treynor's and Jensen's measures.

Note: Use simulation software to understand various financial mathematics concepts

UNIT-2 INTRODUCTION TO ECONOMETRICS AND FINANCIAL DATA MODELLING 07 Hrs.

Modelling and analysing financial and economic systems using statistical methods, Model selection, Time series regression model, Conditional mean model, Conditional variance model, Multivariate model, Markov model.

Note: Use case study to simulate different models

UNIT-3 FUNDAMENTAL AND TECHNICAL ANALYSIS 08 Hrs.

Economic analysis: Macro-economic indicators in the Indian context, Prices with macroeconomic variables in the Indian context; Industry analysis, Company analysis, Stock valuation, Expected direction of movement of a stock price. Technical analysis: Introduction, Price and Volume indicators- Dow theory, Circuit filters, Charts, Patterns, Indicators, Efficient market hypothesis, Concept of efficiency, Implications for investment decisions.

Note: Use case study to simulate different analysis

UNIT-4 INTRODUCTION TO FINANCIAL DERIVATIVES AND HEDGING 05 Hrs.

No arbitrage principle, Pricing of forwards and futures, Properties of options, Derivative pricing by replication in binomial model, Risk-neutral pricing, Black-Scholes option model, Hedging, Stop loss strategy: The Greek Letters: Delta, Gamma and Vega sensitivities.

Note: Use simulation software to understand various financial derivative concepts

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize different financial systems and analysis methods.
CO2: Interpret mathematical representation of simple financial products and systems.
CO3: Apply mathematical and statistical concepts to present simple financial systems.
CO4: Analyze simple financial systems using analysis tools.
CO5: Evaluate basic performance measures of simple financial systems.
CO6: Create model of simple financial systems.

TEXT/REFERENCE BOOKS

- J. Cvitanic, F. Zapatero, Introduction to the Economics and Mathematics of Financial Markets, PHI.
- M. Capinski, T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer.
- Christopher Dougherty, Introductory Econometrics, Oxford University Press.
- Fischer D.E., Jordan R.J., Security Analysis and Portfolio Management, Pearson Education.
- Prasanna Chandra, Investment Analysis and Portfolio Management, TMH Education Private Limited.
- Pindyck, Robert S., Daniel L. Rubinfeld, Econometric Models and Economic Forecasts, McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs.

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Computer based Financial System Analysis Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Introduce fundamentals of financial systems and mathematical analysis of financial systems.
- Introduce modelling of financial systems using statistical methods.
- Introduce concepts of financial derivatives and pricing.

Laboratory Sessions would be based on following topics:

BASIC FINANCIAL SYSTEMS AND MATHEMATICS

- Introduction to financial markets, financial instruments, bonds, stocks and financial derivatives.
- Time value of money, Annuity and instalments, Markowitz portfolio theory, Risk and return, Two and multi asset portfolio theory.
- Efficient frontier, Capital Asset Pricing Model (CAPM) and portfolio performance analysis, Calculation of Net Asset Value of a mutual fund.
- Performance Evaluation using Sharpe's, Treynor's and Jensen's measures.

INTRODUCTION TO ECONOMETRICS AND FINANCIAL DATA MODELLING

- Modelling and analysing financial and economic systems using statistical methods, Model selection.
- Time series regression model, Conditional mean model, Conditional variance model, Multivariate model, Markov model.

FUNDAMENTAL AND TECHNICAL ANALYSIS

- Economic analysis: Macro-economic indicators in the Indian context, Prices with macroeconomic variables in the Indian context.
- Industry analysis, Company analysis, Stock valuation, Expected direction of movement of a stock price.
- Technical analysis: Introduction, Price and Volume indicators- Dow theory, Circuit filters, Charts, Patterns, Indicators, Efficient market hypothesis, Concept of efficiency, Implications for investment decisions.

INTRODUCTION TO FINANCIAL DERIVATIVES AND HEDGING

- No arbitrage principle, Pricing of forwards and futures, Properties of options.
- Derivative pricing by replication in binomial model, Risk-neutral pricing.
- Black-Scholes option model, Hedging, Stop loss strategy: The Greek Letters: Delta, Gamma and Vega sensitivities.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize different financial systems and analysis methods.
CO2: Interpret mathematical representation of simple financial products and systems.
CO3: Apply mathematical and statistical concepts to present simple financial systems.
CO4: Analyze simple financial systems using analysis tools.
CO5: Evaluate basic performance measures of simple financial systems.
CO6: Create model of simple financial systems.

TEXT/REFERENCE BOOKS

- J. Cvitanic, F. Zapatero, Introduction to the Economics and Mathematics of Financial Markets, PHI.
- M. Capinski, T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer.
- Christopher Dougherty, Introductory Econometrics, Oxford University Press.
- Fischer D.E., Jordan R.J., Security Analysis and Portfolio Management, Pearson Education.
- Prasanna Chandra, Investment Analysis and Portfolio Management, TMH Education Private Limited.
- Pindyck, Robert S., Daniel L. Rubinfeld, Econometric Models and Economic Forecasts, McGraw Hill.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

Semester - VI

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR

SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B TECH IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester VI			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Embedded Systems	3	0	0	3	3	25	50	25	--	--	100
2		Embedded Systems Lab	0	0	2	1	2	--	--	--	25	25	50
3		Artificial Intelligence Systems	3	0	0	3	3	25	50	25	--	--	100
4		Artificial Intelligence Systems Lab	0	0	2	1	2	--	--	--	25	25	50
5		Computer Communication and Networking	3	0	0	3	3	25	50	25	--	--	100
6		Computer Communication and Networking Lab	0	0	2	1	2	--	--	--	25	25	50
7		CE-3 (Theory)	2	0	0	2	2	25	50	25	--	--	100
8		CE-3 (Lab)	0	0	2	1	2	--	--	--	25	25	50
9		CE-4 (Theory)	2	0	0	2	2	25	50	25	--	--	100
10		CE-4 (Lab)	0	0	2	1	2	--	--	--	25	25	50
11		OE-4	3	0	0	3	3	25	50	25	--	--	100
12		Communication Skills - III	0	0	2	1	2				50	50	100
13		Industrial Training/ IEP (6 weeks-summer break)	0	0	0	2	0						100
		Total	16	0	12	24	28						1050

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LE – Lab Exam, LW – Lab Work, OE – Open Elective

The ICT department may offer electives from below basket, based on availability of expertise/faculty

Subject Code	**Core Elective 3,4,5,6,7**	**Credit**	**L-T-P**	**Subject Code**	**Core Elective 3,4,5,6,7**	**Credit**	**L-T-P**
	Machine Learning	2	2-0-0		Machine Learning Lab	1	0-0-2
	Natural Language Processing	2	2-0-0		Natural Language Processing Lab	1	0-0-2
	Big Data Analytics and Computing	2	2-0-0		Big Data Analytics and Computing Lab	1	0-0-2
	Deep and Reinforcement Learning	2	2-0-0		Deep and Reinforcement Learning Lab	1	0-0-2

	Introduction to GPU based computing	2	2-0-0		Introduction to GPU based computing Lab	1	0-0-2
	Computer Vision	2	2-0-0		Computer Vision Lab	1	0-0-2
	Fundamentals of Quantum Computing	2	2-0-0		Fundamentals of Quantum Computing Lab	1	0-0-2
	Wireless Sensor Networks	2	2-0-0		Wireless Sensor Networks Lab	1	0-0-2
	Edge and Fog Computing	2	2-0-0		Edge and Fog Computing Lab	1	0-0-2
	Intelligent Sensors and Actuators for IoT	2	2-0-0		Intelligent Sensors and Actuators for IoT Lab	1	0-0-2
	Cloud Architecture and Services	2	2-0-0		Cloud Architecture and Services Lab	1	0-0-2
	Image Processing	2	2-0-0		Image Processing Lab	1	0-0-2
	Statistical Signal Processing	2	2-0-0		Statistical Signal Processing Lab	1	0-0-2
	Real Time Operating System	2	2-0-0		Real Time Operating System Lab	1	0-0-2
	Bio Inspired Computing	2	2-0-0		Bio Inspired Computing Lab	1	0-0-2
	5G Networks	2	2-0-0		5G Networks Lab	1	0-0-2
	High-Speed Computing Structures using FPGA	2	2-0-0		High-Speed Computing Structures using FPGA Lab	1	0-0-2
	Cognitive & Software Defined Radio	2	2-0-0		Cognitive & Software Defined Radio Lab	1	0-0-2
	Speech Signal Processing	2	2-0-0		Speech Signal Processing Lab	1	0-0-2

Pandit Deendayal Petroleum University					School of Technology					
<Course Code>					Embedded Systems					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES:

- To understand microcontroller based embedded system
- To be able to program (settings for) the on-chip modules/functionalities and GPIOs
- To be able to write programs for interfacing of external devices (sensors and actuators)

UNIT-1: INTRODUCTION TO EMBEDDED SYSTEMS 5 Hrs.

Introduction to microcontroller (μC), and embedded system (ES): Digital sub-components; Characteristics and functionalities; Classification; Type of architectures (RISC vs. CISC) and memories (FLASH,SRAM,EEPROM); Aspects related to ES design and μC selection; Programming software/IDE (tool chain); Applications of ES.

UNIT-2: MICRO-CONTROLLER ARCHITECTURE AND ASSEMBLY LANGUAGE PROGRAMMING 12 Hrs.

An example microcontroller (AVR/PIC/∫C-51/ARM/etc.): μC architecture, pin diagram and basic connections – clock, reset, brown-out, etc.; General register set; Special function registers; On-chip memories; General Purpose Inputs and Outputs (GPIOs); Instruction Set and Assembly language programing: Data transfer, arithmetic, logic and branch instructions, addressing Modes; Basic programming concepts: Looping, branching, memory-access, time-delays, using assembly instructions; Stack and related operations; Subroutines and interrupts.

UNIT-3: MICRO-CONTROLLER PROGRAMMING IN EMBEDDED C 12 Hrs.

Programming the on-chip modules/capabilities of the microcontroller using Embedded C: GPIOs, Timers/Counters, Waveform generation, EEPROM, ADC, Interrupt functionalities, Watchdog timer.

Basics of parallel and serial communication; Programming the serial communication modules: USART, Serial Peripheral Interface (SPI), I2C Inter-integrated Circuit (I2C).

UNIT-4: PROGRAMMING AND INTERFACING OF SENSORS AND ACTUATORS 10 Hrs.

Interfacing of I/O devices, LED and switches, 4x4 Keypad, 16x2 LCD, Motor drivers and opto-couplers, Stepper Motor, Servo Motor, DC Motors, Relays, Buzzers, Proximity sensor, temperature sensor, DAC, RTC. Basic programming for wireless modules: Bluetooth, Wifi, Zigbee.

Some of the above topics would be covered through the associated laboratory course.

Max. 39 Hrs.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Describe the basic components/functionalities, and architecture of microcontroller based embedded system.

CO2- Write simple programs using assembly language, and summarize the instruction set architecture for microcontroller.

CO3- Apply the syntax and constructs of the C language, to write Embedded C programs.

CO4- Analyze the functionality of on-chip modules/capabilities of the microcontroller: timers/counters, interrupts, basic communication protocols, EEPROM, ADC, waveform generator.

CO5- Comprehend and demonstrate the working of external input-output devices (interfacing of sensors and actuators) to the microcontroller.

CO6- Develop simple embedded system, utilizing Embedded C programming for interfacing input-output devices with the microcontroller and/or the related on-chip modules.

TEXT/REFERENCE BOOKS:

- Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Naimi. "AVR Microcontroller and Embedded Systems: Using Assembly and C", (2015), Pearson India.
- Raj Kamal, "Embedded Systems: Architecture, Programming, and Design", 2nd Edition, Tata McGraw-Hill

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs.

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

Pandit Deendayal Petroleum University					School of Technology					
<Course Code>					Embedded Systems Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To understand microcontroller based embedded system.
- To be able to program (settings for) the on-chip modules/functionalities and GPIOs.
- To be able to write programs for interfacing of external devices (sensors and actuators).

Laboratory Sessions would be based on following topics:

- Microcontroller architecture: General register set; Special function registers; On-chip memories; General Purpose Inputs and Outputs (GPIOs).
- Instruction Set Architecture of microcontroller and Assembly language programing: Data transfer, arithmetic, logic and branch instructions, addressing Modes; Basic programming concepts: Looping, branching, memory-access, time-delays, using assembly instructions; Stack and related operations; Subroutines and interrupts.
- Programming the on-chip modules/capabilities of the microcontroller using Embedded C (or similar language and IDE tools): GPIOs, Timers/Counters, Waveform generation, EEPROM, ADC, Interrupt functionalities.
- Basics of parallel and serial communication; Programming the serial communication modules: USART, Serial Peripheral Interface (SPI), I2C Inter-integrated Circuit (I2C).
- Interfacing of I/O devices, LED and switches, Joystick, 4x4 Keypad, 16x2 LCD, Touch-screen display, 7-Segment and LED push-button shields, RFID receivers and tags, Motor drivers and opto-couplers, Stepper Motor, Servo Motor, DC Motors, Relays, Buzzers, Proximity sensor, temperature sensor, Heart-rate sensor, distance sensor, Accelerometer, level-converters, RTC. Basic programming for wireless modules: Bluetooth, Wifi, Zigbee, RF transceiver.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Describe the basic components/functionalities, and architecture of microcontroller based embedded system.

CO2- Write simple programs using assembly language using IDE, and summarize the instruction set architecture for microcontroller.

CO3- Apply the syntax and constructs of the C language, to write Embedded C programs using IDE

CO4- Analyze and inspect the functionality of on-chip modules/capabilities of the microcontroller: timers/counters, interrupts, basic communication protocols, EEPROM, ADC, waveform generator.

CO5- Comprehend and demonstrate the working of external input-output devices (interfacing of sensors and actuators) to the microcontroller.

CO6- Develop small-scale embedded system for real world application, using input-output devices with the microcontroller and/or the related on-chip modules, utilizing IDE.

TEXT/REFERENCE BOOKS:

- Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Naimi. "AVR Microcontroller and Embedded Systems: Using Assembly and C", 2015 Edition, Pearson India.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Artificial Intelligence System					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Learn the fundamentals of Artificial Intelligence.
- Learn to represent knowledge and making inference.
- Know the various methods of Neural Networks and their working.
- Study the basic of planning and expert systems.

UNIT 1 SEARCH **10 Hrs.**

Philosophy, fundamental nature of intelligence, Terminologies of AI, what is data, Present state of AI, Definitions, Uninformed Search, Informed Search, Local Search, Genetic Algorithms, Adversarial Search, Constraint Satisfaction Problems

UNIT 2 KNOWLEDGE AND INFERENCE **10 Hrs.**

Knowledge Representation- Syntax, semantics, Bayesian networks - sampling, learning and inference, Decision Theory-Markov Decision Processes

UNIT 3 PLANNING AND LEARNING **10 Hrs.**

Classical planning, planning under uncertainty, value iteration and policy, planning algorithms, refinement planning, Neural Network, Back Propagation

UNIT 4 TRENDS IN AI SYSTEM DESIGN **09 Hrs.**

Overview of New Generation of GPUs, Hardware Accelerators (TPUs), Open Source Frameworks, Applications of AI in Data Science and IoT, Case studies on next generation of AI applications

Max. 39 Hrs.

Some of the above topics would be covered through the associated Lab course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the artificial intelligence system.

CO2: Understand various methods of achieving intelligence.

CO3: Implement the neural network architectures.

CO4: Analyse features of high dimensional data.

CO5: Evaluate the performance of various hardware platforms.

CO6: Design and create optimization models, neural networks for intelligence system.

TEXT/REFERENCE BOOKS

- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016
- Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
- Artificial Intelligence and Expert Systems Development by D W Rolston-Mc Graw hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Artificial Intelligence System Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Understand problem solving through search.
- Understand and implement learning algorithms using Neural Networks.
- Design an AI model and evaluate its performance.

Laboratory Sessions would be based on following topics:

SEARCH

- Informed Search, Local Search, Genetic Algorithms, Adversarial Search, Constraint Satisfaction Problems

KNOWLEDGE AND INFERENCE

- Bayesian networks, learning and inference, Decision Theory, Markov Decision Processes

PLANNING AND LEARNING

- planning under uncertainty, value iteration and policy, planning algorithms, refinement planning, Neural Network, Back Propagation

TRENDS IN AI SYSTEM DESIGN

- Open Source Frameworks, Implementation of AI algorithm for IoT devices, Case studies on next generation of AI applications

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1: Recognize the artificial intelligence system.
CO2: Understand various methods of achieving intelligence.
CO3: Implement the neural network architectures.
CO4: Analyse features of high dimensional data.
CO5: Evaluate the performance of various hardware platforms.
CO6: Design and create optimization models, neural networks for intelligence system.

TEXT/REFERENCE BOOKS

- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
- Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
- Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly, 2017.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Computer Communication and Networking					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the communication network design.
- Study the state-of-the-art in network protocols, architectures.
- Learn the design and implementation of network applications.
- Understand about working of different protocols.

UNIT 1 Introduction and application layer **7 Hrs.**

Introduction: Nuts and Bolts, Performance parameters: throughput, delay, etc., Layered Architecture (OSI and TCP/IP),Applications: Network application Design, Socket Programming, Client-server applications, Echo and Chat applications, FTP,DNS, Peer to Peer file sharing application, use of computer networks and ethics

UNIT 2 Data link and physical layers **11 Hrs.**

Data link layer: Introduction, Media access protocols (ALOHA, CSMA based) , Ethernet 802.3, Token, ring 802.5, Reliability Issue: sliding window, Internetworking and Routing: Best effort Service, Virtual Circuits, IP Addressing, introduction to physical layer services, different types of modulation schemes, multiplexing and demultiplexing techniques

UNIT 3 Network layer **10 Hrs.**

Internetworking and Routing: Routing Issues, Distance Vector and Link State routing, Intra and Inter Autonomous System Routing (OSPF, RIP, BGP), Broadcast and Multicast Routing Issues

UNIT 4 Transport Layer **11 Hrs.**

Transport Layer: End to end delivery issues, Reliable data transfers, Congestion Control, Traffic engineering and Quality of service, TCP, UDP, Advanced Topics: QoS over IP, IPV6, Infrastructure-less networks: wireless ad hoc and sensor networks, and Internet of Things (IoT), Green computer networking

Max. 39 Hrs.

Some of the above topics would be covered through the associated laboratory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember concepts of protocol design at different layers.
CO2- Understand design and implementation of different protocols.
CO3- Apply computer networking concepts to solve problems.
CO4- Analyse computer networking protocols at different layers.
CO5- Evaluate performance of different Computer network protocols.
CO6- Create computer networking applications.

TEXT/REFERENCE BOOKS

- James Kurose and Keith Rose, “Computer Networking: A Top Down Approach”, Pearson Education.
- Larry L Peterson and Bruce S Davie, “Computer Networks: A Systems Approach”, Elsevier.
- Andrew S Tanenbaum, “Computer Networks”, Pearson Education.
- Behrouz A Forouzan, “Data Communication and Networking”, McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Computer Communication and Networking Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To understand the communication network design.
- To understand state-of-the-art in network protocols, architectures.
- To learn the design and implementation of network applications.

Laboratory Sessions would be based on following topics:

1. LAN cable and static routing
2. Socket Programming- client-server elements of a few network applications e.g. Echo client and server, Time client and server, Online Quiz and Buzzer Application, etc
3. DHCP and Wireshark/ Packet Tracer
4. DNS and Wireshark/ Packet Tracer
5. HTTP and Wireshark/ Packet Tracer
6. TCP and UDP and Wireshark/ Packet Tracer
7. Virtual LAN and Wireshark/ Packet Tracer
8. OSPF and BGP
9. NS2/NS3 installation and communication between two nodes
10. TCP/UDP connections and their performance analysis

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember concepts of functionality of layered network architecture.
CO2- Understand various types of network topologies, network devices and their functions within a network.
CO3- Apply computer networking concepts to solve problems.
CO4- Analyse computer networking scenarios using network simulator tools.
CO5- Evaluate different computer network protocols practically.
CO6- Create computer networking applications and scenarios.

TEXT/REFERENCE BOOKS

- James Kurose and Keith Rose, “Computer Networking: A Top Down Approach”, Pearson Education.
- Larry L Peterson and Bruce S Davie, “Computer Networks: A Systems Approach”, Elsevier.
- Andrew S Tanenbaum, “Computer Networks”, Pearson Education.
- Behrouz A Forouzan, “Data Communication and Networking”, McGraw Hill.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

Pandit Deendayal Petroleum University **School of Technology**

20HSXXXP					Communication Skills – III (Semester V/VI) (Third Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To strengthen the communication skills of professionals to make them ready for the modern workplace.
- To fine tune their professional skills and expertise using communication skills.
- To participate in the life long learning process with confidence and certainty.

UNIT 1 **10 hrs**

- Writing research proposals
- Writing technical projects

UNIT 2 **15 hrs**

- The Art of Presentation

- *Sapiens: A Brief History of Humankind* (2011), Yuval Noah Harari
- *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations* (2016), Thomas L. Friedman
- (Presentation in teams of 4 students each, not more than two from the same branch, with a view to promote cross-disciplinary research)

UNIT 3 **5 hrs**

- Uploading portfolios on SlideShare
  - ✓ Uploading Video modules

Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Demonstrate enhanced communications skills for enhanced team work for a better result.
CO2 Apply critical analysis for innovative thinking and well-rounded perspectives in different settings and contexts.
CO3 Analysis of situations to identify opportunities for professional and career growth through strong communication skills.
CO4 High competence of oral, written and visual communication skills for a workplace ready professional.
CO5 Realization and application of communication skills and language processes for multiple perspectives and interdisciplinary approach in profession.
CO6 Improved communication skills for improved research, organizational, and critical thinking and perspective.

TEXT/REFERENCE BOOKS

- Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
- Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
- Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
- Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tool	Marks	Assignments
Lab Work	50	• Business Proposal – 15 • Research Project Proposal – 15 • Reviews on the two books – 20
Lab Exam/Viva	50	• Presentation on the reviews of the two books (Intra Branch) – 15 • Presentation on a technical topic (Inter Branch) – 15 • Slideshare/Video Modules (Prescribed Texts) – 20

<Course Code>					Industrial Training/ International Exposure Program					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	2	6 weeks summer break	--	--	--	--	100	100

COURSE OBJECTIVES

1. Exposure to the work culture of an organization.
2. Understand verticals, products and services of an organization.
3. Develop necessary technical and soft skills.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	Remember the academic concepts to solve problems.
CO2	Understand the functioning of different departments in an organization.
CO3	Map classroom learnings to organization processes.
CO4	Analyze different solutions for problems.
CO5	Study the impact of the solutions/services of an organization towards society, environment, infrastructure, energy, and economy.
CO6	Develop technical knowledge and apply principles of teamwork, ethics, communication effectively in a professional environment for lifelong learning.

Semester - VII

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR

SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B TECH IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester VII			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Internet of Things	2	0	0	2	2	25	50	25	--	--	100
2		Internet of Things Lab	0	0	2	1	2	--	--	--	25	25	50
3		Digital CMOS VLSI Circuits	2	0	0	2	2	25	50	25	--	--	100
4		Digital CMOS VLSI Circuits Lab	0	0	2	1	2	--	--	--	25	25	50
5		CE-5 (Theory)	2	0	0	2	2	25	50	25	--	--	100
6		CE-5 (Lab)	0	0	2	1	2	--	--	--	25	25	50
7		CE-6 (Theory)	2	0	0	2	2	25	50	25	--	--	100
8		CE-6 (Lab)	0	0	2	1	2	--	--	--	25	25	50
9		CE-7 (Theory)	2	0	0	2	2	25	50	25	--	--	100
10		CE-7 (Lab)	0	0	2	1	2	--	--	--	25	25	50
11		Mini Project	0	0	6	3	6				There will be three reviews (30 %, 30 %, 40 %)		100
		Total	10	0	16	18	26						850

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LW- Lab work, LE- Lab Exam

The department may offer electives from below basket, based on availability of expertise/faculty

Subject Code	**Core Elective 3,4,5,6,7**	**Credit**	**L-T-P**	**Subject Code**	**Core Elective 3,4,5,6,7**	**Credit**	**L-T-P**
	Machine Learning	2	2-0-0		Machine Learning Lab	1	0-0-2
	Natural Language Processing	2	2-0-0		Natural Language Processing Lab	1	0-0-2
	Big Data Analytics and Computing	2	2-0-0		Big Data Analytics and Computing Lab	1	0-0-2
	Deep and Reinforcement Learning	2	2-0-0		Deep and Reinforcement Learning Lab	1	0-0-2
	Introduction to GPU based computing	2	2-0-0		Introduction to GPU based computing Lab	1	0-0-2
	Computer Vision	2	2-0-0		Computer Vision Lab	1	0-0-2
	Fundamentals of Quantum Computing	2	2-0-0		Fundamentals of Quantum Computing Lab	1	0-0-2
	Wireless Sensor Networks	2	2-0-0		Wireless Sensor Networks Lab	1	0-0-2

	Edge and Fog Computing	2	2-0-0		Edge and Fog Computing Lab	1	0-0-2
	Intelligent Sensors and Actuators for IoT	2	2-0-0		Intelligent Sensors and Actuators for IoT Lab	1	0-0-2
	Cloud Architecture and Services	2	2-0-0		Cloud Architecture and Services Lab	1	0-0-2
	Image Processing	2	2-0-0		Image Processing Lab	1	0-0-2
	Statistical Signal Processing	2	2-0-0		Statistical Signal Processing Lab	1	0-0-2
	Real Time Operating System	2	2-0-0		Real Time Operating System Lab	1	0-0-2
	Bio Inspired Computing	2	2-0-0		Bio Inspired Computing Lab	1	0-0-2
	5G Networks	2	2-0-0		5G Networks Lab	1	0-0-2
	High-Speed Computing Structures using FPGA	2	2-0-0		High-Speed Computing Structures using FPGA Lab	1	0-0-2
	Cognitive & Software Defined Radio	2	2-0-0		Cognitive & Software Defined Radio Lab	1	0-0-2
	Speech Signal Processing	2	2-0-0		Speech Signal Processing Lab	1	0-0-2

<Course Code>					Internet of Things					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- To impart knowledge about components of IoT Architecture and platforms of IoT.
- To Interface I/O devices, sensors & communication modules.
- To develop real life IoT based projects.

UNIT-1: INTRODUCTION **5 Hrs.**

Introduction to IoT, technology evolution, IoT Architectures, resource management, Communication protocols, Standards and regulations.

UNIT-2: TECHNOLOGY FOR IoT **6 Hrs.**

Programming for IoT, different frameworks, Virtualization concepts, Embedded platforms, Cloud based deployment, distributed data analysis.

UNIT-3: SECURITY FOR IoT **9 Hrs.**

Security issues in the Internet of Things, Robustness and Reliability, High risk issues, Approaches and New Paradigms, authentication for devices, different methods of securing the Internet of Things (IoT).

UNIT-4: IoT APPLICATION **6 Hrs.**

Applied Internet of Things, Vehicle technology, smart cities, smart agriculture, IoT based industrial processes, Cloud-Based Smart supply chain Management, Programming Raspberry Pi with Python, Other IoT Devices, IoT Physical Servers and Cloud Offerings. Case Studies Illustrating IoT Design, Data Analytics for IoT Data Aggregation for the IoT.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1 – Understand internet of Things and technological aspects.

CO2 – Understand the architecture and its relation with available resources.

CO3 – Interpret Interface I/O devices, sensors & communication modules.

CO4 – Understand various security aspects for IoT.

CO5 – Compare different frameworks for implementation.

CO6 – Design solutions of problems which require IoT as a platform.

TEXT/REFERENCE BOOKS:

- Pethuru Raj and Anupama C. Raman. The Internet of Things: Enabling Technologies, Platforms, and Use Cases. CRC Press.
- Adrian McEwen. Designing the Internet of Things. Wiley publications.
- Vijay Madisetti, Arshdeep Bahga. Ïnternet of Things: A Hands on Approach. University Press.
- Raj Kamal. Internet of Things: Architecture and Design. McGraw Hill

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Internet of Things Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To impart knowledge about components of IoT Architecture and platforms of IoT.
- To Interface I/O devices, sensors & communication modules.
- To develop real life IoT based projects.

Laboratory Sessions would be based on following topics:

OVERVIEW OF IoT ARCHITECTURES

- Resource management
- Communication protocols

INTRODUCTION TO IoT TECHNOLOGY COMPONENT

- Programming concepts for IoT
- Frameworks study
- Embedded and Virtualization

IoT SECURITY

- Device authentication
- Securing methods for the Internet of Things (IoT)

IoT APPLICATION

- Solution development for different domain problems
- Associated data analytics

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1 – Understand internet of Things and technological aspects.

CO2 – Understand the architecture and its relation with available resources.

CO3 – Interpret Interface I/O devices, sensors & communication modules.

CO4 – Understand various security aspects for IoT.

CO5 – Compare different frameworks for implementation.

CO6 – Design solutions of problems which require IoT as a platform.

TEXT/REFERENCE BOOKS:

- Pethuru Raj and Anupama C. Raman. The Internet of Things: Enabling Technologies, Platforms, and Use Cases. CRC Press.
- Adrian McEwen. Designing the Internet of Things. Wiley publications.
- Vijay Madisetti, Arshdeep Bahga. İnternet of Things: A Hands on Approach. University Press.
- Raj Kamal. Internet of Things: Architecture and Design. McGraw Hill

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Digital CMOS VLSI Circuits					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- To understand the characteristics and concepts related to the design of digital CMOS VLSI circuits/gates.
- To explore various CMOS logic styles, and design CMOS VLSI circuits/gates at the transistor-level and layout-level.
- To analyze the performance/power of digital CMOS VLSI circuits/gates.

UNIT-1: INTRODUCTION TO DIGITAL CMOS VLSI 6 Hrs.

Trends in VLSI/Semiconductor industry, related to technology (Moore's) scaling; ITRS Roadmap; Overview of semiconductor devices inherent in the MOSFET: Drain-Body and Source-Body PN junctions, Metal-semiconductor contacts, MOS Capacitor; IV characteristics of P-channel and N-channel planar MOSFETs; Non-ideal effects; Basic steps of CMOS fabrication process/technology.

UNIT-2: DESIGN OF DIGITAL CMOS VLSI STANDARD AND COMPOUND GATES 7 Hrs.

Static CMOS inverter and its VTC characteristics; Resistive Load NMOS inverter and its VTC characteristics; Pseudo NMOS inverter and its VTC characteristics; Design and transistor sizing of standard gates (NAND, NOR, EXOR, tri-state INV) and compound gates.

UNIT-3: PERFORMANCE AND POWER ANALYSES OF DIGITAL CMOS VLSI GATES/CIRCUITS 7 Hrs.

RC modelling and Elmore delay analysis of gates (pattern dependent delay analysis); Sutherland's logical effort method of delay estimation and sizing of cascaded paths/gates; Static and dynamic Power of gates; Euler Diagram/Paths for layout of gates, stick diagrams, Lambda rules (DRC) and layouts of gates; Design, simulate and analyze digital CMOS VLSI gates using SPICE and EDA tools.

UNIT-4: CMOS LOGIC STYLES 6 Hrs.

Pass-transistor tree based logic gates (and similar other logic styles – CPL, transmission gates, DPL, etc); Pseudo-NMOS logic; CVLS logic; Dynamic logic (domino, NP domino, Zipper); Hybrid logic style and examples (Full-Adder, MUX, XOR).

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

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

CO1- Identify the pros and cons, and the trends related to scaling of the CMOS VLSI technology.
CO2- Understand the characteristics, sub-parts, and the regions of operation of the MOSFET, and use their I-V equations.
CO3- Design digital CMOS VLSI standard gates and compound gates, at the transistor –level.
CO4- Estimate the performance/power of digital CMOS VLSI standard and compound gates.
CO5- Analyze and compare various digital CMOS logic styles and gates/circuits.
CO6- Create layouts of digital CMOS VLSI standard gates and compound gates, based on Lambda rules.

TEXT/REFERENCE BOOKS:

- Neil Weste, David Harris, Ayan Banerjee, "CMOS VLSI design: A circuits and systems perspective", 3rd Edition, Pearson.
- Sung-Mo Kang, Yusuf Leblebici , "CMOS Digital Integrated Circuits", 3rd Edition, Tata McGraw Hill.
- Robert F. Pierret, "Semiconductor Device Fundamentals", 1st Edition, Pearson.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs.

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Digital CMOS VLSI Circuits Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To understand the characteristics and concepts related to the design of digital CMOS VLSI circuits/gates.
- To explore various CMOS logic styles, and design CMOS VLSI circuits/gates at the transistor-level and layout-level.
- To analyze the performance/power of digital CMOS VLSI circuits/gates.

Laboratory Sessions would be based on following topics:

INTRODUCTION TO DIGITAL CMOS VLSI

- Trends in VLSI/Semiconductor industry, related to technology (Moore's) scaling; ITRS Roadmap;
- Overview of semiconductor devices inherent in the MOSFET: Drain-Body and Source-Body PN junctions, Metal-semiconductor contacts, MOS Capacitor;
- IV characteristics of P-channel and N-channel planar MOSFETs; Non-ideal effects; Basic steps of CMOS fabrication process/technology.

DESIGN OF DIGITAL CMOS VLSI STANDARD AND COMPOUND GATES

- Static CMOS inverter and its VTC characteristics; Resistive Load NMOS inverter and its VTC characteristics; Pseudo NMOS inverter and its VTC characteristics;
- Design and transistor sizing of standard gates (NAND, NOR, EXOR, tri-state INV) and compound gates.

PERFORMANCE AND POWER ANALYSES OF DIGITAL CMOS VLSI GATES/CIRCUITS

- RC modelling and Elmore delay analysis of gates (pattern dependent delay analysis); Sutherland's logical effort method of delay estimation and sizing of cascaded paths/gates;
- Static and dynamic Power of gates;
- Euler Diagram/Paths for layout of gates, stick diagrams, Lambda rules (DRC) and layouts of gates; Design, simulate and analyze digital CMOS VLSI gates using SPICE and EDA tools.

CMOS LOGIC STYLES

- Pass-transistor tree based logic gates (and similar other logic styles – CPL, transmission gates, DPL, etc);
- Pseudo-NMOS logic; CVLS logic; Dynamic logic (domino, NP domino, Zipper); Hybrid logic style and examples (Full-Adder, MUX, XOR).

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

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

CO1- Identify the pros and cons, and the trends related to scaling of the CMOS VLSI technology.
CO2- Understand the characteristics, sub-parts, and the regions of operation of the MOSFET, and use their I-V equations.
CO3- Design digital CMOS VLSI standard gates and compound gates, at the transistor –level.
CO4- Estimate the performance/power of digital CMOS VLSI standard and compound gates.
CO5- Analyze and compare various digital CMOS logic styles and gates/circuits.
CO6- Create layouts of digital CMOS VLSI standard gates and compound gates, based on Lambda rules.

TEXT/REFERENCE BOOKS:

- Neil Weste, David Harris, Ayan Banerjee, "CMOS VLSI design: A circuits and systems perspective", 3rd Edition, Pearson.
- Sung-Mo Kang, Yusuf Leblebici , "CMOS Digital Integrated Circuits", 3rd Edition, Tata McGraw Hill.
- Robert F. Pierret, "Semiconductor Device Fundamentals", 1st Edition, Pearson.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Mini Project						
Teaching Scheme					Examination Scheme						
L	T	P	C	Hrs/Week	Theory			Practical			Total Marks
					MS	ES	IA	Continuous Evaluation	Mid-term Evaluation	End-term Evaluation	
0	0	6	3	6	--	--	--	30	30	40	100

COURSE OBJECTIVES:

- To provide an opportunity to solve real-world problems using ICT tools.
- To provide an opportunity for life and domain skill enhancement.
- To make ready the students for the academia/research/industry and for the society at large.

The scope of the Mini Project: The students are expected to work on topic in any of the ICT related areas. The mini project can be based on novel ideas and their implementation, an extensive survey of technology or methods, development of proof of concepts. Thus, students are expected to use acquired skills or develop new skills while working under the supervision of industry or academic mentor within the stipulated time frame.

COURSE OUTCOMES:

At the end of this course students will be able to:
CO1: Recognize the real-world problem.
CO2: Understand the problem and its technological significance.
CO3: Implement and analyze existing feasible solutions using available tools.
CO4: Design and create a solution using science, technology, engineering, and mathematical principles.
CO5: Study the impact of the proposed solution towards, society, environment, infrastructure, energy, and economy
CO6: Apply principles of management, finance, teamwork, ethics, and communicate effectively in a professional environment, for lifelong learning.

EVALUATION:

The evaluation will be based on continuous (30%), mid-term presentation (30%), end-term presentation (40%).

<Course Code>					Machine Learning					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce principles, algorithms, and applications of Machine Learning from mathematically motivated perspective.
- Work with different machine learning paradigms.
- Learn tools to apply machine learning algorithms to real data and performance evaluation.

UNIT 1 FUNDAMENTALS AND REGRESSION **05 Hrs.**

Convex optimization, Statistical Decision Theory, Linear Regression, Subset selection, PCA, Linear Discriminant Analysis (LDA)

UNIT 2 CLASSIFICATION **06 Hrs.**

Multiclass Classification, KNN, Neural Network, Back Propagation, Parameter estimation, Support Vector, logistic regression

UNIT 3 IMPROVING CLASSIFICATION **09 Hrs.**

Boosting, Bagging, Ensemble methods, Gradient boosting, Random Forests, HMM, Belief propagation

UNIT 4 CLUSTERING **06 Hrs.**

Clustering- Partitioning, Hierarchical, Density based, Gaussian Mixture Model, Expectation Maximization, K- Means clustering

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: List machine learning algorithm for the problem domain.
CO2: Compare different machine learning algorithms for the problems.
CO3: Carryout machine learning technique for classification and decision problems.
CO4: Analyze important parameters and structure of the machine learning algorithms.
CO5: Judge efficacy of machine learning algorithm.
CO6: Design and apply machine learning algorithm.

TEXT/REFERENCE BOOKS

- Simon Haykin, Neural Networks and Learning Machines, Third Edition, Paper Back, Pearson India.
- Ethem Alpaydin, Introduction to Machine Learning, Third edition, PHI, 2015.
- Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning. Springer. 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Machine Learning Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Introduce principles, algorithms, and applications of Machine Learning from mathematically motivated perspective.
- Work with different machine learning paradigms.
- Learn tools to apply machine learning algorithms to real data and performance evaluation.

Laboratory Sessions would be based on following topics:

FUNDAMENTALS AND REGRESSION
Convex optimization, Statistical Decision Theory, Linear Regression, Subset selection, PCA, Linear Discriminant Analysis (LDA)

CLASSIFICATION
Multiclass Classification, KNN, Neural Network, Back Propagation, Parameter estimation, Support Vector, logistic regression

IMPROVING CLASSIFICATION
Boosting, Bagging, Ensemble methods, Gradient boosting, Random Forests, HMM, Belief propagation

CLUSTERING
Clustering- Partitioning, Hierarchical, Density based, Gaussian Mixture Model, Expectation Maximization, K- Means clustering

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES
On completion of the course, student will be able to
CO1: List machine learning algorithm for the problem domain.
CO2: Compare different machine learning algorithms for the problems.
CO3: Carryout machine learning technique for classification and decision problems.
CO4: Analyze important parameters and structure of the machine learning algorithms.
CO5: Judge efficacy of machine learning algorithm.
CO6: Design and apply machine learning algorithm.

TEXT/REFERENCE BOOKS

- Simon Haykin, Neural Networks and Learning Machines, Third Edition, Paper Back, Pearson India
- Ethem Alpaydin, Introduction to Machine Learning, Third edition, PHI, 2015
- Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning. Springer. 2001

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development	25 Marks

<Course Code>					Natural Language Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- To understand the structure of natural language for processing.
- To understand the concepts of linguistic rules and machine learning approaches for classification.
- To study the various applications of NLP- machine translation, sentiment analysis, summarization.

UNIT-1: OVERVIEW OF NLP **5 Hrs.**

Basics of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition, Language Structure and Analyzer - Overview of language, requirement of computational grammar. Words and their Analysis. Tokenization. Stemming. Morphological Analysis. POS tagging.

UNIT-2: CORPUS AND DATASETS **6 Hrs.**

Corpus, need for corpus, corpus analysis, types of data attributes, Categorical or qualitative data attributes, Numeric or quantitative data attributes, different file formats for corpora, dataset preparation for NLP applications.

UNIT-3: SENTENCE STRUCTURE AND PROCESSING 7 **Hrs.**

NLP components, understanding, Morphological analysis, syntactic analysis, Semantic analysis, ambiguity handling, pragmatic analysis, Handling corpus-raw text, sentences, pre-processing.

UNIT-4: FEATURE EXTRACTION AND ADVANCED ALGORITHMS **8 Hrs.**

Parsers and parsing, POS tagging and POS taggers, Name entity recognition, n-grams, bag of words, semantic tools and resources, probabilistic theory for NLP, TF-IDF, Vectorization, Encoders and decoders, normalization, Recall word embedding, Algorithms used by neural networks, Rule-Based System for NLP, Machine Learning for NLP Problems, Deep learning for NLP, case studies.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1 – Process the Natural Language based on structure.

CO2 – Perform Tokenization, Stemming, POS tagging for processing the language.

CO3 – Apply machine learning and linguistic rules for classification related problems.

CO4 – Develop parsers and shallow parser for different languages.

CO5 – Build various applications of NLP- machine translation.

CO6 – Classify sentiments from different data sets.

TEXT/REFERENCE BOOKS:

- Bird, Steven, Ewan Klein, and Edward Loper. Natural language processing with Python: analyzing text with the natural language toolkit. O'Reilly Media, Inc., 2009.
- Thanaki, Jalaj. Python natural language processing. Packt Publishing Ltd, 2017.
- Jurafsky, Daniel, and James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics, Prentice Hall, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Natural Language Processing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To understand the structure of natural language for processing.
- To understand the concepts of linguistic rules and machine learning approaches for classification.
- To study the various applications of NLP- machine translation, sentiment analysis, summarization.

Laboratory Sessions would be based on following topics:

- To work with Text Files, PDF FILES with Python
- pattern searching in text Utilizing regular Expressions
- Ultra-fast tokenization
- Stemming and Lemmatization
- Understand Vocabulary Matching
- Use Part of Speech Tagging to automatically process raw text files
- Visualize POS and NER
- Text Classification
- Learn about Non-negative Matrix Factorization
- Use different algorithms
- Sentiment Analysis
- Use Deep Learning in NLP

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, student will be able to:

CO1 – Process the Natural Language based on structure.

CO2 – Perform Tokenization, Stemming, POS tagging for processing the language.

CO3 – Apply machine learning and linguistic rules for classification related problems.

CO4 – Develop parsers and shallow parser for different languages.

CO5 – Build various applications of NLP- machine translation.

CO6 – Classify sentiments from different data sets.

TEXT/REFERENCE BOOKS:

- Bird, Steven, Ewan Klein, and Edward Loper. Natural language processing with Python: analyzing text with the natural language toolkit. O'Reilly Media, Inc., 2009.
- Thanaki, Jalaj. Python natural language processing. Packt Publishing Ltd, 2017.
- Jurafsky, Daniel, and James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics, Prentice Hall, 2000.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

20ICXXXX					Big Data Analytics and Computing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Know the big data characteristics and challenges.
- Learn the tools and techniques of collection, integration, processing and storage of big data.
- Understand real applications which uses big data.

UNIT 1 BIG DATA PROGRAMMING TOOLS **6 Hrs.**

Hadoop – Hadoop ecosystem, Moving Data in and out, Hadoop Distributed File System, Hive Architecture, Hive QL, Map Reduce scripts, HBase concepts, Indexing, Yarn

UNIT 2 LARGE SCALE DATA PROCESSING **7 Hrs.**

Spark - core, Data analysis, Spark SQL, Spark Streaming, Machine Learning library, GraphX, NoSQL, Use of NoSQL

UNIT 3 DATABASE **6 Hrs.**

MongoDB, Server tools, MongoDB through Java script, Principles of schema design, Queries on databases, MongoDB query language

UNIT 4 REAL APPLICATIONS OF BIG DATA **7 Hrs.**

Spatial-temporal data, financial data, multimedia data, health care data, social media, scientific data

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to:

CO1: List big data characteristics and challenges.
CO2: Understand essential features of the programming tools.
CO3: Practice big data programming tools.
CO4: Analyse computing problems for given application.
CO5: Evaluate computing based solution.
CO6: Design applications using big data analytics.

TEXT/REFERENCE BOOKS

- Kuan-Ching Li, Hai Jiang, Laurence T. Yang, and Alfredo Cuzzocrea. Big Data: Algorithms, Analytics, and Applications. Chapman & Hall/CRC Big Data Series, ISBN 9781482240559, 2015.
- Thomas Erl, Wajid Khattak, and Dr. Paul Buhler. Big Data Fundamentals: Concepts, Drivers & Techniques. The Prentice Hall Service Technology Series, ISBN-13: 978-0134291079, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs
Part A Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Part B Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.	80 to 60 Marks

20ICXXXX					Big Data Analytics and Computing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Know the big data characteristics and challenges.
- Learn the tools and techniques of collection, integration, processing and storage of big data.
- Understand real applications which uses big data.

Laboratory sessions would be based on following topics:

BIG DATA PROGRAMMING TOOLS

- Hadoop – Hadoop ecosystem, Moving Data in and out,
- Hadoop Distributed File System
- Hive Architecture
- Hive QL, Map Reduce script

LARGE SCALE DATA PROCESSING

- Spark - core, Data analysis,
- Spark SQL, Spark Streaming,
- Machine Learning library, GraphX
- NoSQL, Use of NoSQL

DATABASE

- MongoDB, Server tools,
- MongoDB through Java script,
- Queries on databases, MongoDB query language

REAL APPLICATIONS OF BIG DATA

Spatial-temporal data, financial data, multimedia data, health care data, social media, scientific data

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: List big data characteristics and challenges.
CO2: Understand essential features of the programming tools.
CO3: Practice big data programming tools.
CO4: Analyze computing problems for given application.
CO5: Evaluate computing based solution.
CO6: Design applications using big data analytics.

TEXT/REFERENCE BOOKS

- Kuan-Ching Li, Hai Jiang, Laurence T. Yang, and Alfredo Cuzzocrea. Big Data: Algorithms, Analytics, and Applications. Chapman & Hall/CRC Big Data Series, ISBN 9781482240559, 2015.
- Thomas Erl, Wajid Khattak, and Dr. Paul Buhler. Big Data Fundamentals: Concepts, Drivers & Techniques. The Prentice Hall Service Technology Series, ISBN-13: 978-0134291079, 2016

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development	25 Marks

<Course Code>					Deep Reinforcement Learning					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Building optimal Deep Neural Networks.
- Work with different RL paradigms and understanding of Deep RL.
- Learn tools and estimate optimal policy and value function.

UNIT 1 INTRODUCTION TO RL AND CNN **05 Hrs.**

Introduction to Reinforcement learning, Introduction to Neural Network, CNN, CNN Architectures, Network tuning, Hyper parameters optimization, transfer learning.

UNIT 2 RECURRENT NEURAL NETWORKS **06 Hrs.**

Introduction, Training RNNs -Loss and BPTT, RNN Architectures, LSTM, Deep RNNs, Bi-RNNs

UNIT 3 REINFORCEMENT LEARNING **09 Hrs.**

Markov Decision Processes-Value Function and policies, Dynamic Programming-Bellman Equations, Monte Carlo methods, Temporal-difference prediction and control-SARSA, Q learning, n-step TD, Approximation methods

06 Hrs.

UNIT 4 DEEP REINFORCEMENT LEARNING

Value-based Deep RL: Q-network, Policy-based Deep RL: REINFORCE, Asynchronous Methods for Deep RL, Advantage Actor-Critic (A2C), Model-based Deep RL, Case study: RL in classic Game

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: List deep learning architectures for the problem domain.

CO2: Compare different algorithms for the given problems.

CO3: Carryout RL technique for classification, text prediction, estimating optimal policy, and value function.

CO4: Analyse important parameters and structure of the RL algorithms.

CO5: Judge efficacy of RL algorithms.

CO6: Design and create RL algorithm for specific domain.

TEXT/REFERENCE BOOKS

- Richard Sutton and Andrew Barto, Reinforcement Learning: An Introduction, 2nd ed, MIT Press, Cambridge, MA, 2018
- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Deep Reinforcement Learning Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Building optimal Deep Neural Networks.
- Work with different RL paradigms and understanding of Deep RL.
- Learn tools and estimate optimal policy and value function.

Laboratory Sessions would be based on following topics:

NEURAL NETWORKS
Neural Network, CNN, CNN Architectures, Network tuning, Hyper parameters optimization, transfer learning.

RECURRENT NEURAL NETWORKS
Training RNNs -Loss and BPTT, RNN Architectures, LSTM, Deep RNNs, Bi-RNNs

REINFORCEMENT LEARNING
Markov Decision Processes-Value Function and policies, Dynamic Programming-Bellman Equations, Monte Carlo methods, Temporal-difference prediction and control-SARSA, Q learning, n-step TD, Approximation methods

DEEP REINFORCEMENT LEARNING
Value-based Deep RL: Q-network, Policy-based Deep RL: REINFORCE, Asynchronous Methods for Deep RL, Advantage Actor-Critic (A2C), Model-based Deep RL, Case study: RL in classic Game

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES
On completion of the course, student will be able to
CO1: List deep learning architectures for the problem domain.
CO2: Compare different algorithms for the given problems.
CO3: Carryout RL technique for classification, text prediction, estimating optimal policy, and value function.
CO4: Analyze important parameters and structure of the RL algorithms.
CO5: Judge efficacy of RL algorithms.
CO6: Design and create RL algorithm for specific domain.

TEXT/REFERENCE BOOKS

- Richard Sutton and Andrew Barto, Reinforcement Learning: An Introduction, 2nd ed, MIT Press, Cambridge, MA, 2018
- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016

END SEMESTER LABORATORY EXAMINATION PATTERN
Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development	25 Marks

<Course Code>					Introduction to GPU based computation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the advantage of GPU over CPU.
- Recognize fundamentals of parallel computing.
- Setup GPU programming environment.
- Know various frameworks and their implementation in GPU environment.
- Use CUDA: Parallel computing platform.

UNIT 1 INTRODUCTION TO COMPUTATION PLATFORMS 05 Hrs.

CPU vs GPU based computation, Technical requirements, Parallelization and Amdahl's Law, Using Amdahl's Law, The Mandelbrot set, Code Profiling

UNIT 2 GPU PROGRAMMING ENVIRONMENT 06 Hrs.

Environment settings, hardware details, GPU drivers, Setting up a programming environment, GCC, IDE, and graphical dependencies, software tools, CUDA toolkit, Python environment, scripts.

UNIT 3 IMPLEMENTATION FRAMEWORK 09 Hrs.

Kernels, Threads, Blocks, and Grids, Threads, blocks, and grids, Thread synchronization and intercommunication, Using shared memory, The parallel prefix algorithm, The naive parallel prefix algorithm, Streams, Events, Contexts, and Concurrency, Manual context creation, Host-side multiprocessing and multithreading, Multiple contexts for host-side concurrency

UNIT 4 TOOLS AND APPLICATIONS 06 Hrs.

Using the CUDA Libraries with Scikit-CUDA, Installing Scikit-CUDA, Basic linear algebra with cuBLAS, cuBLAS functions, measuring GPU performance, Fast Fourier transforms, convolution, Singular value decomposition (SVD), Principal Component Analysis (PCA)

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the potential of GPU over CPU.

CO2: Understand the architecture of GPU and its working process.

CO3: Implement computational model and algorithms in CUDA / GPU environment.

CO4: Analyze the high dimensional data on GPU platforms.

CO5: Evaluate of performance of similar architecture for GPU vs CPU.

CO6: Create a hybrid architecture for efficient computing.

TEXT/REFERENCE BOOKS

- Tuomanen, Brian. Hands-On GPU Programming with Python and CUDA: Explore high-performance parallel computing with CUDA. Packt Publishing Ltd, 2018.
- Chapman, Barbara, ed. Parallel Computing: From Multicores and GPU's to Petascale. Vol. 19. IOS Press, 2010.
- Couturier, Raphaël, ed. Designing scientific applications on gpus. CRC Press, 2013.
- Cai, Yiyu, and Simon See, eds. GPU computing and applications. Singapore: Springer, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Introduction to GPU based computation Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Understand the advantage of GPU over CPU.
- Recognize fundamentals of parallel computing.
- Setup GPU programming environment.
- Know various frameworks and their implementation in GPU environment.
- Use CUDA: Parallel computing platform.

Laboratory Sessions would be based on following topics:

COMPUTATION PLATFORMS

CPU vs GPU based computation, Technical requirements, Parallelization and Amdahl's Law, Using Amdahl's Law, The Mandelbrot set, Code Profiling

GPU PROGRAMMING ENVIRONMENT

Environment settings, hardware details, GPU drivers, Setting up a programming environment, GCC, IDE, and graphical dependencies, software tools, CUDA toolkit, Python environment, scripts.

IMPLEMENTATION FRAMEWORK

Kernels, Threads, Blocks, and Grids, Threads, blocks, and grids, Thread synchronization and intercommunication, Using shared memory, The parallel prefix algorithm, The naive parallel prefix algorithm, Streams, Events, Contexts, and Concurrency, Manual context creation, Host-side multiprocessing and multithreading, Multiple contexts for host-side concurrency

TOOLS AND APPLICATIONS

Using the CUDA Libraries with Scikit-CUDA, Installing Scikit-CUDA, Basic linear algebra with cuBLAS cuBLAS functions, measuring GPU performance, Fast Fourier transforms, convolution, Singular value decomposition (SVD), Principal Component Analysis (PCA)

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the potential of GPU over CPU.
CO2: Understand the architecture of GPU and its working process.
CO3: Implement computational model and algorithms in CUDA / GPU environment.
CO4: Analyze the high dimensional data on GPU platforms.
CO5: Evaluate of performance of similar architecture for GPU vs CPU.
CO6: Create a hybrid architecture for efficient computing.

TEXT/REFERENCE BOOKS

- Tuomanen, Brian. Hands-On GPU Programming with Python and CUDA: Explore high-performance parallel computing with CUDA. Packt Publishing Ltd, 2018.
- Chapman, Barbara, ed. Parallel Computing: From Multicores and GPU's to Petascale. Vol. 19. IOS Press, 2010.
- Couturier, Raphaël, ed. Designing scientific applications on gpus. CRC Press, 2013.
- Cai, Yiyu, and Simon See, eds. GPU computing and applications. Singapore: Springer, 2015.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration:2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Computer Vision					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Insight into image and video formation design, modelling and analysis.
- Ability to work with features well above the pixel level.
- Learn tools and apply computer vision algorithms to problems.

UNIT 1 LOW LEVEL VISION **06 Hrs.**

Camera Calibration, Color Models, Linear Filters, Image Pyramids, Image Features, Texture.

UNIT 2 MID-LEVEL VISION **07 Hrs.**

Segmentation - Clustering, Graphs, Hough Transform, EM Algorithm, Motion Segmentation, Tracking, Particle Filter.

UNIT 3 HIGH LEVEL VISION **07 Hrs.**

Classification, Object Detection, Object Recognition, HMM, Parsing People, Kinematic Tracking.

UNIT 4 APPLICATIONS **06 Hrs.**

Intelligent Transportation, Medical Image Processing, Surveillance.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – List computer vision algorithms for specific domain.
CO2 – Compare different vision approaches for the problem.
CO3 – Apply computer vision techniques for the problem.
CO4 – Analyze important parameters for computer vision algorithms and fine tune them for the problem.
CO5 – Judge efficacy of the algorithms.
CO6 – Design and create algorithms for computer vision applications.

TEXT/REFERENCE BOOKS

- Simon Prince, Computer Vision: Models, Learning, and Interface, Cambridge University Press, 1/e.
- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Computer Vision Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- Insight into image and video formation design, modelling and analysis.
- Ability to work with features well above the pixel level.
- Learn tools and apply computer vision algorithms to problems.

Laboratory Sessions would be based on following topics:

LOW LEVEL VISION

- Linear Filters
- Image Pyramids
- Image Features

MID-LEVEL VISION

- Segmentation
- Tracking

HIGH LEVEL VISION

- Classification
- Detection

APPLICATIONS

- Medical Image Processing
- Surveillance

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1 – List computer vision algorithms for specific domain.

CO2 – Compare different vision approaches for the problem.

CO3 – Apply computer vision techniques for the problem.

CO4 – Analyze important parameters for computer vision algorithms and fine tune them for the problem.

CO5 – Judge efficacy of the algorithms.

CO6 – Design and create algorithms for computer vision applications.

TEXT/REFERENCE BOOKS:

- Simon Prince, Computer Vision: Models, Learning, and Interface, Cambridge University Press, 1/e.
- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development. 25 Marks

<Course Code>					Wireless Sensor Networks					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- To understand fundamentals of sensor network systems.
- To learn the design of MAC and transport layer protocols for Adhoc networks.
- To explore tools and technologies for wireless sensor networks.
- To understand the concepts of sensor network security and routing protocols.

UNIT-1: OVERVIEW OF WIRELESS SENSOR NETWORKS 04 Hrs.

Introduction to sensor nodes and networks, design constraints and challenges, Driving Applications, Single-Node Architecture, Network Architecture, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT-2: MAC PROTOCOLS FOR WIRELESS SENSOR NETWORKS 07 Hrs.

MAC Protocols and design issues for Wireless Sensor Networks, Design goals of a MAC Protocol, Classifications of MAC Protocols, Contention – Based Protocols, Contention – Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

UNIT-3: ROUTING PROTOCOLS FOR WIRELESS SENSOR NETWORKS 07 Hrs.

Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table – Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols, Proactive Routing, Introduction to NS2/NS3.

UNIT-4: TRANSPORT LAYER, SECURITY PROTOCOLS AND SENSOR NETWORK SIMULATION 08 Hrs.

Introduction, Issues and goals in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks and Other Transport Layer Protocol, Security in Ad Hoc Wireless Networks, Network Security Requirements, Security Provisioning, Network Security Attacks, Key Management, Secure Routing in Ad Hoc Wireless Networks, Sensor network platforms and tools, NS2/NS3 based network simulations.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1 – Understand and explain the concept of wireless sensor networks and their applications.

CO2 – Recognize typical node and network architectures.

CO3 – Analyze energy efficient protocol design.

CO4 – Design and simulate sensor network protocol for different environment.

CO5 – Evaluate measurements of protocol performance in wireless sensor networks.

CO6 – Understand security issues in wireless sensor networks.

TEXT/REFERENCE BOOKS:

- Ad-Hoc Wireless Networks: Architectures and Protocols – C. Siva Ram Murthy and B.S. Manoj, PHI.
- Holger Karl & Andreas Willig, Protocols And Architectures for Wireless Sensor Networks. John Wiley.
- Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks- Technology, Protocols, and Applications. John Wiley.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs.

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Wireless Sensor Networks Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To understand fundamentals of sensor network systems.
- To learn the design of MAC and transport layer protocols for Adhoc networks.
- To explore tools and technologies for wireless sensor networks.
- To understand the concepts of sensor network security and routing protocols.

Laboratory Sessions would be based on following topics:

OVERVIEW OF WIRELESS SENSOR NETWORKS

- Node design
- Network design
- Gateway Concepts.

MAC PROTOCOLS FOR WIRELESS SENSOR NETWORKS

- MAC Protocols design.

ROUTING PROTOCOLS FOR WIRELESS SENSOR NETWORKS

- Designing a Routing Protocol for Ad Hoc Wireless Networks
- Introduction to tool based simulations.

SENSOR NETWORK SIMULATION

- Security Provisioning,
- Tool based network simulations.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1 – Understand and explain the concept of wireless sensor networks and their applications.

CO2 – Recognize typical node and network architectures.

CO3 – Analyze energy efficient protocol design.

CO4 – Design and simulate sensor network protocol for different environment.

CO5 – Evaluate measurements of protocol performance in wireless sensor networks.

CO6 – Understand security issues in wireless sensor networks.

TEXT/REFERENCE BOOKS:

- Ad-Hoc Wireless Networks: Architectures and Protocols – C. Siva Ram Murthy and B.S. Manoj, PHI.
- Holger Karl & Andreas Willig, Protocols And Architectures for Wireless Sensor Networks. John Wiley.
- Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks- Technology, Protocols, and Applications. John Wiley.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Edge and fog computing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand concepts of edge and fog computing.
- To study about edge and fog computing infrastructure.
- To explore applications of edge and fog computing.
- To learn about testing, simulation and challenges of edge and fog computing.

UNIT 1 FOUNDATIONS OF EDGE AND FOG COMPUTING 06 Hrs.

Internet of things and new computing paradigms, Addressing the challenges in federating edge resources, Integrating IoT+Fog+Cloud Infrastructures: System Modeling and Research Challenges, Management and Orchestration of Network Slices in 5G, Fog, Edge and Clouds, Optimization Problems in Fog and Edge Computing

UNIT 2 EDGE AND FOG COMPUTING INFRASTRUCTURE 08 Hrs.

Middleware for Fog and Edge Computing: Design Issues, A Light weight Container Middleware for Edge Cloud Architectures, Data Management in Fog Computing, Predictive Analysis to Support Fog Application Deployment, Using Machine Learning for Protecting the Security and Privacy of Internet of Things (IoT) Systems

UNIT 3 APPLICATIONS OF EDGE AND FOG COMPUTING 07 Hrs.

Fog Computing Realization for Big Data Analytics, Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

UNIT 4 TESTING, SIMULATION AND CASE STUDIES 05 Hrs.

Testing Perspectives of Fog-Based Applications, Legal Aspects of Operating IoT Applications in the fog, Modelling and Simulation of Fog and Edge Computing Environments Using simulation Toolkit, Smart cities, transportation and industrial automation case studies

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember concepts of edge and fog computing.
CO2- Understand about edge and fog computing infrastructure.
CO3- Apply the concepts of edge and computing to solve problems.
CO4- Analyse the different scenarios of edge and fog computing.
CO5- Evaluate performance of edge and fog computing through simulation.
CO6- Design different scenarios of edge and fog computing.

TEXT/REFERENCE BOOKS

- Rajkumar Buyya, Satish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", 1st Edition, Packt pub.
- Lea, Perry. Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. Packt Publishing Ltd, 2018.
- Singh, Ajit, and Sudhir Kumar Sinha. "Cloud computing Simply In Depth." 2018.
- Soldatos, John, ed. Building Blocks for IoT Analytics. River Publishers, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Edge and fog computing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To understand concepts of edge and fog computing.
- To study about edge and fog computing infrastructure.
- To explore applications of edge and fog computing.
- To learn about testing, simulation and challenges of edge and fog computing.

Laboratory Sessions would be based on following topics:

FOUNDATIONS OF EDGE AND FOG COMPUTING

- Internet of things and new computing paradigms, Addressing the challenges in federating edge resources
- Integrating IoT+Fog+Cloud Infrastructures: System Modeling and Research Challenges,
- Optimization Problems in Fog and Edge Computing

EDGE AND FOG COMPUTING INFRASTRUCTURE

- Middleware for Fog and Edge Computing: Design Issues
- A Lightweight Container Middleware for Edge Cloud Architectures
- Predictive Analysis to Support fog Application Deployment
- Using Machine Learning for Protecting the Security and Privacy of Internet of Things (IoT) Systems

APPLICATIONS OF EDGE AND FOG COMPUTING

- Fog Computing Realization for Big Data Analytics
- Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking,
- Fog Computing Model for Evolving Smart Transportation Applications

TESTING, SIMULATION AND CASE STUDIES

- Testing Perspectives of Fog-Based Applications, Legal Aspects of Operating IoT Applications in the fog
- Modeling and Simulation of Fog and Edge Computing Environments Using simulation Toolkit
- Smart cities, transportation and industrial automation case studies

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember concepts of edge and fog computing.
CO2- Understand about edge and fog computing infrastructure.
CO3- Apply the concepts of edge and computing to solve problems.
CO4- Analyse the different scenarios of edge and fog computing.
CO5- Evaluate performance of edge and fog computing through simulation.
CO6- Design different scenarios of edge and fog computing.

TEXT/REFERENCE BOOKS

- Rajkumar Buyya, Satish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", 1st Edition, Packt pub.
- Lea, Perry. Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. Packt Publishing Ltd, 2018.
- Singh, Ajit, and Sudhir Kumar Sinha. "Cloud computing Simply In Depth." 2018.
- Soldatos, John, ed. Building Blocks for IoT Analytics. River Publishers, 2016.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Intelligent Sensors and Actuators for IoT					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart knowledge related to the study of sensors and actuators for Internet of Things (IoT) applications.
- Understand technological challenges faced by IoT devices, with a focus on wireless, RF and wearable sensing modules.
- Explore and learn about practical IoT systems with the help of examples and illustrations..

UNIT 1 DEVICE TECHNOLOGY FOR IOT SENSORS AND ACTUATORS **07 Hrs.**

Materials and Structures for Sensor Applications, MEMS Technology and Fabrication Methods, MEMS Sensors, Transducers and Actuators, Combining MEMS with CMOS IC Fabrication, CMOS Sensor Platform, Smart Sensor Microsystems: Application-Dependent Design and Integration Approaches, Elements and Standards for Smart and Intelligent Sensing and Actuations.

06 Hrs.

UNIT 2 WIRELESS AND RF SENSORS

Frequency Spectrum for Wireless Sensors, Wireless Sensor Structure, Energy Storage Module, Power Management Module, RF Module, Antenna Considerations, Wave Propagation, Sensing Module, Energy Harvesting, Examples and Application Illustrations.

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UNIT 3 ADVANCE INTELLIGENT SENSORS AND ACTUATORS **06 Hrs.**

Wearable Sensors: Types, Applications, Requirements, Materials, Devices and Assembly, Microphone Arrays, Image and Biometric Sensors, Noise Reduction Techniques, Tracking and Prediction, Intelligent Sensor Agents, Sensor Fusion, Linear and Rotational Motion Actuators, Solid State Contactors and Servo Actuators, Actuators with Intelligent Controls.

UNIT 4 INTELLIGENT SENSORS AND ACTUATORS IN IOT SYSTEMS **07 Hrs.**

Cyber-physical Sensor and Actuator Integrations and Interfacing, Applications and Illustrations: Home Automation, Appliances, Automobile, Maintenance and Service, Environment, Healthcare, Agriculture, Manufacturing, Process Industries, Industrial Automation, Transportation, Smart Cities, Security Systems, Body Area Network, Assisted Living Systems, Aids to Disables etc., The connection between IoT, Industry 4.0, and productivity, Future Sensing and Actuation Systems.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify components of IoT sensing and actuation system.
CO2: Understand device technology and requirements of various sensors and actuators used in IoT systems.
CO3: Apply concepts to study existing IoT systems.
CO4: Analyze IoT systems for interfacing with sensors and actuators.
CO5: Contrast and compare characteristics and performance of different sensors and actuators for IoT applications.
CO6: Design a physical layer for IoT systems.

TEXT/REFERENCE BOOKS

- Understanding Smart Sensors by Randy Frank, Artech House sensors library.
- Smart Sensors at the IoT Frontier, Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L, Springer.
- Smart Sensors and Systems, Chong-Min KyungHiroto YasuuraYongpan LiuYoun-Long Lin, Springer.
- Intelligent Sensing, Instrumentation and Measurements, Subhas Chandra Mukhopadhyay, Springer.
- Wearable Sensors: Fundamentals, Implementation and Applications, Edward Sazonov, Elsevier.
- A Hands-On Course in Sensors Using the Arduino and Raspberry Pi, Volker Zeimann, CRC Press.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Intelligent Sensors and Actuators for IoT Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To impart knowledge related to the study of sensors and actuators for Internet of Things (IoT) applications.
- Understand technological challenges faced by IoT devices, with a focus on wireless, RF and wearable sensing modules.
- Explore and learn about practical IoT systems with the help of examples and illustrations..

Laboratory Sessions would be based on following topics:

DEVICE TECHNOLOGY FOR IOT SENSORS AND ACTUATORS

- MEMS Sensors, Transducers and Actuators, CMOS Sensor Platform, Smart Sensor Microsystems: Application-Dependent Design and Integration Approaches.
- Elements and Standards for Smart and Intelligent Sensing and Actuations.

WIRELESS AND RF SENSORS

- Frequency Spectrum for Wireless Sensors, Wireless Sensor Structure, Energy Storage Module, Power Management Module, RF Module, Antenna Considerations, Wave Propagation, Sensing Module, Energy Harvesting, Examples and Application Illustrations.

ADVANCE INTELLIGENT SENSORS AND ACTUATORS

- Wearable Sensors, Microphone Arrays, Image and Biometric Sensors, Noise Reduction Techniques, Tracking and Prediction.
- Intelligent Sensor Agents, Sensor Fusion.
- Linear and Rotational Motion Actuators, Solid State Contactors and Servo Actuators.
- Actuators with Intelligent Controls

INTELLIGENT SENSORS AND ACTUATORS IN IOT SYSTEMS

- Cyber-physical Sensor and Actuator Integrations and Interfacing.
- Applications and Illustrations: Home Automation, Appliances, Automobile, Maintenance and Service, Environment, Healthcare, Agriculture, Manufacturing, Process Industries, Industrial Automation, Transportation, Smart Cities, Security Systems, Body Area Network, Assisted Living Systems, Aids to Disables etc.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify components of IoT sensing and actuation system.
CO2: Understand device technology and requirements of various sensors and actuators used in IoT systems.
CO3: Apply concepts to study existing IoT systems.
CO4: Analyze IoT systems for interfacing with sensors and actuators.
CO5: Contrast and compare characteristics and performance of different sensors and actuators for IoT applications.
CO6: Design a physical layer for IoT systems.

TEXT/REFERENCE BOOKS

- Understanding Smart Sensors by Randy Frank, Artech House sensors library.
- Smart Sensors at the IoT Frontier, Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L, Springer.
- Smart Sensors and Systems, Chong-Min KyungHiroto YasuuraYongpan LiuYoun-Long Lin, Springer.
- Intelligent Sensing, Instrumentation and Measurements, Subhas Chandra Mukhopadhyay, Springer.
- Wearable Sensors: Fundamentals, Implementation and Applications, Edward Sazonov, Elsevier.
- A Hands-On Course in Sensors Using the Arduino and Raspberry Pi, Volker Zeimann, CRC Press.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development	25 Marks

<Course Code>					Cloud Architecture and Services					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- The fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges.
- To be familiar with cloud management techniques and cloud software deployment considerations.
- Understand Cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage
- Hands-on experience solving relevant problems through projects that will utilize existing public cloud tools.

UNIT-1: INTRODUCTION **6 Hrs.**

Overview of Computing Paradigm, Underlying Technologies, Evolution of Cloud Computing, Introduction to Cloud Computing, Business Models, Characteristics, Roles, Open Standards.

UNIT-2: CLOUD COMPUTING ARCHITECTURE **7 Hrs.**

Cloud computing stack, Service Models: IaaS, PaaS, SaaS, Deployment Models- Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud, Architectural design of compute and storage clouds, Public cloud platforms: GAE, AWS and Azure

UNIT-3: CLOUD PROGRAMMING AND SOFTWARE ENVIRONMENT **8 Hrs.**

Programming Support for Google App Engine, Programming on Amazon AWS and Microsoft Azure, Emerging Cloud software Environments, Managing Data: Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing.

UNIT-4: SERVICE MANAGEMENT IN CLOUD COMPUTING **5 Hrs.**

Service Level Agreements(SLAs), Comparing Scaling Hardware: Traditional vs. Cloud, Cloud Security

Case study: Open Source and Commercial Clouds.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Understand the basic concepts of Cloud Computing paradigm, underlying technologies, its application and challenges.
CO2- Apply fundamental concepts in cloud infrastructures to understand the trade-offs in power, efficiency and cost.
CO3- Analyse cloud computing architectural models.
CO4- Enumerate various threats in cloud security.
CO5- Evaluate programming, deployment and failure considerations when programming the cloud.
CO6- Develop a cloud based application for real world problem.

TEXT/REFERENCE BOOKS:

- Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.
- Distributed and cloud computing, Kai Hwang, Geoffrey C Fox and Jack J Dongarra, Morgan Kauffman
- Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Cloud Architecture and Services Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- The fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges.
- To be familiar with cloud management techniques and cloud software deployment considerations.
- Understand Cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage
- Hands-on experience solving relevant problems through projects that will utilize existing public cloud tools.

Laboratory Sessions would be based on following topics:

- **INTRODUCTION**
  - Underlying Technologies, Open Standards.
- **CLOUD COMPUTING ARCHITECTURE**
  - Cloud computing stack, Service Models: IaaS, PaaS, SaaS, Deployment Models, Public cloud platforms
- **CLOUD PROGRAMMING AND SOFTWARE ENVIRONMENT**
  - Google App Engine, Programming on Amazon AWS and Microsoft Azure, Emerging Cloud software Environments, Managing Data: Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing.
- **SERVICE MANAGEMENT IN CLOUD COMPUTING**
  - Comparing Scaling Hardware: Traditional vs. Cloud, Cloud Security

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:
CO1- Understand the basic concepts of Cloud Computing paradigm, underlying technologies, its application and challenges.
CO2- Apply fundamental concepts in cloud infrastructures to understand the trade-offs in power, efficiency and cost.
CO3- Analyse cloud computing architectural models.
CO4- Enumerate various threats in cloud security.
CO5- Evaluate programming, deployment and failure considerations when programming the cloud.
CO6- Develop a cloud based application for real world problem.

TEXT/REFERENCE BOOKS:

- Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.
- Distributed and cloud computing, Kai Hwang, Geoffrey C Fox and Jack J Dongarra, Morgan Kauffman
- Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Image Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce mathematical modelling and transforms for digital image processing.
- Understand methodology to analyze, design and implement images processing and analysis algorithms.
- Develop understanding for multi-dimensional signal processing.

UNIT 1 FUNDAMENTAL AND SPATIAL DOMAIN PROCESSING 07 Hrs.

Introduction, Image sampling and quantization, Basic relationships in pixels, Basic intensity transformations, Histogram processing, Spatial filtering: smoothing and sharpening, Basic mathematical tools in image processing, Color models.

UNIT 2 FREQUENCY DOMAIN PROCESSING 06 Hrs.

Sampling 2D functions, Aliasing, 2D Fourier Transform and properties, Filtering in frequency domain: smoothing, sharpening, selective filtering.

UNIT 3 IMAGE RESTORATION AND MORPHOLOGICAL OPERATIONS 06 Hrs.

Model of image degradation process, Restoration in presence of noise, Estimating degradation function, Inverse filtering, MMSE filtering, Morphological operations: Erosion and dilation, opening and closing, Basic morphological algorithms.

UNIT 4 IMAGE SEGMENTATION AND DESCRIPTION 07 Hrs.

Point, line and edge detection, Thresholding, Basic segmentation algorithms: region based, watershed, Image representation: chain codes, polygonal approximation, Boundary and regional descriptors: textures, moments.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Recall and identify properties of digital images and 2D transforms.
CO2 – Explain concepts and complexity of digital image processing techniques and systems.
CO3 – Practice and use image processing algorithms.
CO4 – Examine images and applications in time domain and frequency domain.
CO5 – Judge performance of image processing algorithms.
CO6 – Design image processing algorithms for real world problems.

TEXT/REFERENCE BOOKS

- Gonzalez, R. C., & Woods, R. E., "Digital image processing", Pearson, 4th Edition, 2018.
- Sonka, Milan, "Image processing, analysis and machine vision". Cengage Learning Pvt. Ltd, 4th Edition.
- Castleman, Kenneth "Digital Image Processing". Pearson Education, 1st Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Image Processing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- Introduce mathematical modelling and transforms for digital image processing.
- Understand methodology to analyze, design and implement images processing and analysis algorithms.
- Develop understanding for multi-dimensional signal processing.

Laboratory Sessions would be based on following topics:

FUNDAMENTAL AND SPATIAL DOMAIN PROCESSING

- Basic intensity transformations
- Histogram processing
- Spatial filtering

FREQUENCY DOMAIN PROCESSING

- Fourier Transform and properties
- Filtering in frequency domain

IMAGE RESTORATION AND MORPHOLOGICAL OPERATIONS

- Restoration in presence of noise
- Morphological operations

IMAGE SEGMENTATION AND DESCRIPTION

- Point, line and edge detection
- Thresholding
- Basic segmentation algorithms

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1 – Recall and identify properties of digital images and 2D transforms.

CO2 – Explain concepts and complexity of digital image processing techniques and systems.

CO3 – Practice and use image processing algorithms.

CO4 – Examine images and applications in time domain and frequency domain.

CO5 – Judge performance of image processing algorithms.

CO6 – Design image processing algorithms for real world problems.

TEXT/REFERENCE BOOKS:

- Gonzalez, R. C., & Woods, R. E., "Digital image processing", Pearson, 4th Edition, 2018.
- Sonka, Milan, "Image processing, analysis and machine vision". Cengage Learning Pvt. Ltd, 4th Edition.
- Castleman, Kenneth "Digital Image Processing". Pearson Education, 1st Edition.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Statistical Signal Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce mathematical ideas for analysis of random signals and statistical algorithms.
- Show applicability of statistical analysis in wide range of engineering applications.
- Explore tools for statistical signal analysis and characterization.

UNIT-1 FUNDAMENTALS OF RANDOM SIGNAL PROCESSING 08 Hrs.

Discrete time random processes, Stationarity and Ergodicity, Wide Sense cyclostationary stochastic process and time series, Covariance and Power Spectral density, Filtering of random processes, Poles, zeroes, and spectral factorization, Wold Decomposition, Probability distribution functions, Hypothesis tests, Distributional tests.

UNIT-2 ESTIMATION THEORY 07 Hrs.

Maximum Likelihood, Fisher Information, Cramer Rao bound, MAP estimation, MMSE estimation, Non parametric spectral estimation, Periodogram, windowing, Parametric spectral estimation, AR and ARMA modelling, Yule Walker equations, Applications to signal modeling, design of digital communication receivers, channel estimation and forecasting systems.

UNIT-3 ADAPTIVE FILTERING 07 Hrs.

Wiener filter, LMS algorithm, recursive least squares, Kalman filters and its variants, Constant modulus algorithm, Adaptive beam forming and generalized side lobe canceller, Applications to noise cancellation, echo cancellation, channel equalization, system identification, linear prediction etc.

UNIT-4 STATISTICAL SOURCE SEPARATION TECHNIQUES 04 Hrs.

The cock tail party problem, Independent component analysis, Blind Source Separation, Partial correlations and concentration matrix, Granger and other causality measures. Applications to speech enhancement, speaker separation etc.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Outline characteristics of random signals, statistical models and algorithms.
CO2: Understand classification of statistical signal processing algorithms to be applied in different situations.
CO3: Apply statistical signal processing algorithms to various applications like signal estimation and detection.
CO4: Analyze and compare performance of statistical signal processing algorithms.
CO5: Implement existing statistical signal processing algorithms using modern tools for various engineering applications.
CO6: Design a block diagram level simple statistical signal processing system.

TEXT/REFERENCE BOOKS

- Statistical Digital Signal Processing and Modelling, Monson H Hayes, Wiley India.
- Fundamentals of Statistical Signal Processing: Estimation Theory: Vol. 1, Steven M Kay, Pearson Indian Edition.
- Modern Spectral Estimation, Theory and Application, Steven Kay, Pearson Indian Edition.
- Linear Estimation, Thomas Kailath, Pearson Education.
- Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing, Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, McGraw-Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Statistical Signal Processing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Introduce mathematical ideas for analysis of random signals and statistical algorithms.
- Show applicability of statistical analysis in wide range of engineering applications.
- Explore tools for statistical signal analysis and characterization.

Laboratory Sessions would be based on following topics:

FUNDAMENTALS OF RANDOM SIGNAL PROCESSING

- Discrete time random processes, Stationarity and Ergodicity, Wide Sense cyclostationary stochastic process and time series.
- Covariance and Power Spectral density, Filtering of random processes, Poles, zeroes, and spectral factorization, Wold Decomposition, Probability distribution functions, Hypothesis tests, Distributional tests.

ESTIMATION THEORY

- Maximum Likelihood, Fisher Information, Cramer Rao bound, MAP estimation, MMSE estimation.
- Non parametric spectral estimation, Periodogram, windowing,
- Parametric spectral estimation, AR and ARMA modelling, Yule Walker equations,
- Applications to signal modeling, design of digital communication receivers, channel estimation and forecasting systems.

ADAPTIVE FILTERING

- Wiener filter, LMS algorithm, recursive least squares, Kalman filters and its variants, Constant modulus algorithm.
- Adaptive beam forming and generalized side lobe canceller.
- Applications to noise cancellation, echo cancellation, channel equalization, system identification, linear prediction.

STATISTICAL SOURCE SEPARATION TECHNIQUES

- The cock tail party problem, Independent component analysis, Blind Source Separation.
- Partial correlations and concentration matrix, Granger and other causality measures.
- Applications to speech enhancement, speaker separation etc.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Outline characteristics of random signals, statistical models and algorithms.
CO2: Understand classification of statistical signal processing algorithms to be applied in different situations.
CO3: Apply statistical signal processing algorithms to various applications like signal estimation and detection.
CO4: Analyze and compare performance of statistical signal processing algorithms.
CO5: Implement existing statistical signal processing algorithms using modern tools for various engineering applications.
CO6: Design a block diagram level simple statistical signal processing system.

TEXT/REFERENCE BOOKS

- Statistical Digital Signal Processing and Modelling, Monson H Hayes, Wiley India.
- Fundamentals of Statistical Signal Processing: Estimation Theory: Vol. 1, Steven M Kay, Pearson Indian Edition.
- Modern Spectral Estimation, Theory and Application, Steven Kay, Pearson Indian Edition.
- Linear Estimation, Thomas Kailath, Pearson Education.
- Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing, Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, McGraw-Hill.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Real Time Operating Systems					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand concepts of real time operating system
- To study scheduling schemes for real time operating system
- To design different components of RTOS kernels
- To implement different applications of RTOS

UNIT 1 INTRODUCTION **05 Hrs.**

Introduction to UNIX/LINUX, Overview of Commands, File I/O,(open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec). Examples of embedded system, their characteristics and their typical hardware components, embedded software architectures

UNIT 2 REAL TIME OPERATING SYSTEMS **09 Hrs.**

Defining RTOS, Need for RTOS, concept of real time tasks, Task classes, The Scheduler, Objects, Services, Characteristics of RTOS, Tasks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Structure and concepts of real time system, Performance measures for real time system: Properties, traditional performance measures, perform ability, cost functions and hard deadlines, and Estimating program run times

UNIT 3 EXCEPTIONS, INTERRUPTS AND TIMERS **06 Hrs.**

Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

UNIT 4 DIFFERENT TYPES OF RTOS AND CASE STUDIES **06 Hrs.**

Pattern based OS, RT Linux, Micro C/OS-II, VxWorks, Embedded Linux, and Tiny OS, RTOS tools, multi-core RTOS, multi-core scheduling shared resources and scheduling methods, Debugging with RTOS, Causes of failure, Fault types, Fault detection, Fault and error containment, RTOS for IoT and industrial automation.

Some of the above topics would be covered through the associated laboratory course.

Max.26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember concepts of RTOS and scheduling.
CO2- Understand the different types of scheduling algorithms and RTOS kernel.
CO3- Apply the concepts of RTOS to solve engineering problems.
CO4: Analyse different types of scheduling strategies for implementation of RTOS.
CO5- Evaluate different scenarios of RTOS for solution of problems.
CO6- Create different components of RTOS kernel.

TEXT/REFERENCE BOOKS

- David E. Simon , "An Embedded Software Primer", Pearson Education Asia Publication
- C.M. Krishna and Kang G. Shin, "Real Time Systems", TMH Publication
- Raj kamal, "Embedded system: Architecture Programming and Design", TMH Publication
- Michael J. Pont, "Patterns for Time-Triggered Embedded Systems"

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Real Time Operating Systems Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To understand concepts of real time operating system.
- To design scheduling schemes for real time operating system.
- To implement different components of RTOS kernels.
- To create different applications of RTOS.

Laboratory Sessions would be based on following topics:

INTRODUCTION

- Overview of Commands, File I/O,(open, create, close, lseek, read, write),
- Process Control (fork, vfork, exit, wait, waitpid, exec).

REAL TIME OPERATING SYSTEMS

- The Scheduler, Tasks States and Scheduling, Task Operations, Structure
- Communication and Concurrency. Defining Semaphores, Structure and concepts of real time system
- Performance measures for real time system: Properties, traditional performance measures, perform ability, cost functions and hard deadlines, and Estimating program run times

EXCEPTIONS, INTERRUPTS AND TIMERS

- Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts,
- Real Time Clocks
- Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

DIFFERENT TYPES OF RTOS AND CASE STUDIES .

- Pattern based OS, RT Linux, Micro C/OS-II, VxWorks, Embedded Linux, and Tiny OS
- RTOS tools, multi-core RTOS, multi-core scheduling shared resources and scheduling methods
- Debugging with RTOS,
- Causes of failure, Fault types, Fault detection, Fault and error containment
- RTOS for IoT and industrial automation.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember the implementation process of components of RTOS.
CO2: Understand the working of RTOS on embedded platform.
CO3: Apply concepts of RTOS to implement solution of engineering problems.
CO4: Analyze performance of RTOS on embedded platform.
CO5: Evaluate different components of RTOS on embedded platform.
CO6: Create full or partial RTOS kernels.

TEXT/REFERENCE BOOKS

- David E. Simon , “An Embedded Software Primer”, Pearson Education Asia Publication.
- C.M. Krishna and Kang G. Shin, “Real Time Systems”, TMH Publication.
- Raj kamal, “Embedded system: Architecture Programming and Design”, TMH Publication.
- Michael J. Pont, “Patterns for Time-Triggered Embedded Systems”.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Bioinspired Computing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the mathematics of nature.
- Understand the various computation processes involved in nature.
- Learn various bioinspired computation model and algorithms.
- Learn the various applications of bioinspired computation.

UNIT 1 INTRODUCTION TO BIOINSPIRED COMPUTING **7 Hrs.**

What is life, life and information, the logical mechanism of life, computational beauty in nature, self-organizing in nature, collective behavior, Organization and Emergent Complex Behavior, Cellular Automata, inspiration from nature for artificial and complex systems

UNIT 2 COMPUTATION IN NATURE **6 Hrs.**

What is computation, universal computation and life, modelling principles, Mathematical model for bio systems

UNIT 3 BIO INSPIRED MODELS AND ALGORITHMS **7 Hrs.**

L-system, Turtle graphics, the DNA and gene, Information and Sequence Space, Genetic algorithm, swarm intelligence, ant colony optimization, biological brain inspired Neuromorphic computing

UNIT 4 APPLICATION OF BIO INSPIRED COMPUTING **6 Hrs.**

Modelling traffic and human behavior, modelling crowd disaster, swarm art, robotic self-assembly, bio inspired collective robotics, swarm robots, Neuromorphic computing for low power and efficient devices

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the beauty of nature through computation.
CO2: Understand the computational processes involved with nature.
CO3: Implement the bioinspired algorithm to solve real world problems.
CO4: Analyse the natural behaviours through computational model.
CO5: Evaluate and optimize models using bio inspired schemes.
CO6: Design applications based on bioinspired models and algorithms.

TEXT/REFERENCE BOOKS

- Flake's, The Computational Beauty of Nature, MIT Press, 1998
- Floreano, Bio-Inspired Artificial Intelligence, MIT Press, 2008
- Nunes de Castro, Fundamentals of Natural Computing, Chapman & Hall, 2006
- P. Prusinkiewicz and A. Lindenmayer, The Algorithmic Beauty of Plants, Springer, 1991

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Bioinspired computing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Understand the mathematics of nature.
- Understand the various computation processes involved in nature.
- Learn various bioinspired computation model and algorithms.
- Learn the various applications of bioinspired computation.

Laboratory Sessions would be based on following topics:

BIOINSPIRED COMPUTING

Life and information, self-organizing in nature, collective behavior, Organization and Emergent Complex Behavior, Cellular Automata, inspiration from nature for artificial and complex systems

COMPUTATION IN NATURE

Universal computation and life, modelling principles, Mathematical model for bio systems

BIO INSPIRED MODELS AND ALGORITHMS

L-system, Turtle graphics, the DNA and gene, Information and Sequence Space, Genetic algorithm, swarm intelligence, ant colony optimization, biological brain inspired Neuromorphic computing

APPLICATION OF BIO INSPIRED COMPUTING

Modelling traffic and human behavior, modelling crowd disaster, swarm art, robotic self-assembly, bio inspired collective robotics, swarm robots, Neuromorphic computing for low power and efficient devices

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1: Recognize the beauty of nature through computation.
CO2: Understand the computational processes involved with nature.
CO3: Implement the bioinspired algorithm to solve real world problems.
CO4: Analyse the natural behaviours through computational model.
CO5: Evaluate and optimize models using bio inspired schemes.
CO6: Design applications based on bioinspired models and algorithms.

TEXT/REFERENCE BOOKS

- Flake's, The Computational Beauty of Nature, MIT Press, 1998
- Floreano, Bio-Inspired Artificial Intelligence, MIT Press, 2008
- Nunes de Castro, Fundamentals of Natural Computing, Chapman & Hall, 2006
- P. Prusinkiewicz and A. Lindenmayer, The Algorithmic Beauty of Plants, Springer, 1991

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					5G Networks					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the requirements of 5G technology.
- Study the architecture of 5G network and it's services.
- Understand the different core network technologies of 5G.
- Learn implementation plan and applications of 5G network.

UNIT 1 INTRODUCTION TO 5G NETWORKS **5 Hrs.**

Evolution of cellular systems 1G to 4G. Air interface technology evolution, network related evolution, Key technologies and services related evolution, Requirements, use cases and services of 5G, 5G network architecture.

UNIT 2 5G TECHNOLOGY ASPECTS **8 Hrs.**

5G new radio (gNB), 5G NG-RAN (C-RAN, D-RAN, Small Cells, etc), C-RAN overview, core network technologies for 5G: RAN and core network interfaces, NFV and SDN, Localized operations, control plane and user plane, Interworking with LTE, 5G network implementation: non stand alone and stand alone modes, 5G mm wave, cloud and virtualization, network slicing, multi access technologies,

UNIT 3 5G MILLIMETRE-WAVE COMMUNICATION **7 Hrs.**

spectrum regulations, deployment scenarios, beam-forming, physical layer techniques, interference and mobility management, Massive MIMO, propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM)

UNIT 4 5G APPLICATIONS AND OPEN SOURCE TOOLS **06 Hrs.**

Vehicle telematics, in vehicle infotainment, smart grid automation, mobile and collaborative robots, video surveillance, cooperative intelligent mobility, smart city healthcare applications of 5G IoT. Different open source tools for 5G. Environmental impacts of 5G and ethics

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember concepts of 5G architecture, entities, technology, networks
CO2- Understand about core network components, used cases and applications
CO3- Apply concepts of 5G mobile networks to solve complex engineering problems
CO4- Analyse different scenarios of 5G architecture, networks and technology
CO5- Evaluate potential solutions to complex engineering problems by using 5G technology
CO6- Create different scenarios of 5G technology and networks using different tools

TEXT/REFERENCE BOOKS

- Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks" , Cambridge University Press.
- Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
- Theodore S.Rappaport, Robert W.Heath, Robert C.Daniels, James N.Murdock, "Millimeter Wave Wireless Communications", Prentice Hall Communications.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					5G Networks Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- To understand the requirements of 5G technology.
- To simulate the architecture of 5G network and it's services.
- To design the different scenarios of 5G network.
- To evaluate applications of 5G network.

Laboratory Sessions would be based on following topics:

INTRODUCTION TO 5G NETWORKS

- Key technologies and services related evolution, Requirements
- Use cases and services of 5G, 5G network architecture.

5G TECHNOLOGY ASPECTS

- 5G new radio (gNB), 5G NG-RAN (C-RAN, D-RAN, Small Cells, etc), C-RAN overview,
- Core network technologies for 5G: RAN and core network interfaces,
- NFV and SDN, Localized operations, control plane and user plane,
- Interworking with LTE, 5G network implementation: non stand alone and stand alone modes, 5G mm wave, cloud and virtualization, network slicing, multi access technologies,

5G MILLIMETRE-WAVE COMMUNICATION

- Deployment scenarios, beam-forming, physical layer techniques, interference and mobility management
- Massive MIMO, propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM)

5G APPLICATIONS AND OPEN SOURCE TOOLS

- Vehicle telematics, in vehicle infotainment, smart grid automation, mobile and collaborative robots,
- Video surveillance, cooperative intelligent mobility, smart city healthcare applications of 5G IoT
- Different open source tools for 5G. Environmental impacts of 5G and ethics

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Remember concepts of 5G architecture, entities, technology, networks.
CO2- Understand about core network components, used cases and applications.
CO3- Apply concepts of 5G mobile networks to solve complex engineering problems.
CO4- Analyse different scenarios of 5G architecture, networks and technology.
CO5- Evaluate potential solutions to complex engineering problems by using 5G technology.
CO6- Create different scenarios of 5G technology and networks using different tools.

TEXT/REFERENCE BOOKS

- Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks" , Cambridge University Press.
- Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
- Theodore S.Rappaport, Robert W.Heath, Robert C.Daniels, James N.Murdock, "Millimeter Wave Wireless Communications", Prentice Hall Communications.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					High-Speed Computing Structures using FPGA					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES:

- To understand the concepts and logical structures of (datapath) Arithmetic-Logic sub-systems, which are part of high-speed VLSI computing systems.
- Design of Arithmetic-Logic structures using Verilog Hardware Description Language (HDL), and onto FPGA.

UNIT-1: OVERVIEW OF ARITHMETIC-LOGIC (ARL) STRUCTURES AND FPGA 4 Hrs.

Review of RTL (Register-Transfer Logic)/pipelined high-speed computing systems: ALU, data-path sub-systems, FSM, etc. Introduction to FPGA and implementation of Arithmetic-Logic (ARL) structures using HDL and onto FPGA. Timing analysis for RTL systems (Sequential Circuits): Set-up time (Max-delay) and Hold time (Min-delay) constraints; Clock-skew; FPGA applications.

UNIT-2: IMPLEMENTATION OF ADDER STRUCTURES 7 Hrs.

Structures of Adders: Ripple-carry adder, Carry-skip or bypass adder, multi-level skipping, Carry-select adder (multi-level), Conditional-sum adder, Carry look-ahead adder (based on propagate and generate signals), multi-level look-ahead blocks, Prefix-tree adders: Radix-2 and radix-4 Brent-Kung adder, Kogge-Stone adder, Sklansky adder; Hybrid adders: Carry select adder with look-ahead block, Sparse-tree adders; Carry-Save Adder (CSA) tree for multi-operand addition; Implementation using Verilog HDL .

UNIT-3: IMPLEMENTATION OF MULTIPLIER STRUCTURES 8 Hrs.

Structures of Unsigned Multiplier (serial left-shift or right-shift algorithm); Parallelogram/rectangular structures of Unsigned Multipliers; Radix-2, radix-4 and radix-8 Booth encoding based multiplier (for signed operands); Modified Baugh-Wooley Multiplier (for signed operands) and its parallelogram/rectangular structure; Divide and conquer multipliers (for unsigned operands); Squaring circuit (single operand multiplier, with reduced partial products); Implementation using Verilog HDL.

UNIT-4: OTHER DATAPATH ARITHMETIC-LOGIC (ARL) STRUCTURES 7 Hrs.

Fixed-Point (FXP) number system; Implementation of Math functions using: CORDIC Algorithm (circular/rectangular/hyperbolic versions with rotational/vectoring modes), and Newton-Raphson method, Piece-Wise-Linear-Approximation Look-up table; Arbiter FSM; Random number generator based on Linear Feedback Shift-Registers (LFSR), modular and standard LFSR; Implementation of Error Correcting Codes: LFSR based CRC, and Hamming7-4 and 12-8 codes; Funnel shifter and Barrel shifters; Implementation using Verilog HDL.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Identify datapath Arithmetic-Logic sub-systems and understand the basic concepts related to RTL/pipelined systems.
CO2- Analyze the internal logic and structures of various Adders.
CO3- Investigate the internal logic and structures of various Multipliers.
CO4- Design and simulate Adder structures, using Verilog HDL.
CO5- Design and simulate Multiplier structures, using Verilog HDL.
CO6- Implement Arithmetic-Logic sub-systems onto FPGA, using Verilog HDL.

TEXT/REFERENCE BOOKS:

- Neil Weste, David Harris, Ayan Banerjee, "CMOS VLSI design: A circuits and systems perspective", Pearson Education.
- Parhami Behrooz, "Computer arithmetic: Algorithms and hardware design", Oxford University Press.
- Stine James E., "Digital computer arithmetic datapath design using verilog HDL". Kluwer Academic Publishers
- Douglas Smith, "HDL Chip Design", Doone Publications

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs.

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					High-Speed Computing Structures using FPGA Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES:

- To understand the concepts and logical structures of (datapath) Arithmetic-Logic sub-systems, which are part of high-speed VLSI computing systems.
- Design of Arithmetic-Logic structures using Verilog Hardware Description Language (HDL), and onto FPGA

Laboratory Sessions would be based on following topics:

OVERVIEW OF ARITHMETIC-LOGIC (ARL) STRUCTURES AND FPGA

- Review of RTL (Register-Transfer Logic)/pipelined high-speed computing systems: ALU, data-path sub-systems, FSM, etc. Introduction to FPGA and implementation of Arithmetic-Logic (ARL) structures using HDL and onto FPGA. Timing analysis for RTL systems (Sequential Circuits): Set-up time (Max-delay) and Hold time (Min-delay) constraints; Clock-skew; FPGA applications.

IMPLEMENTATION OF ADDER STRUCTURES

- Structures of Adders: Ripple-carry adder, Carry-skip or bypass adder, multi-level skipping, Carry-select adder (multi-level), Conditional-sum adder, Carry look-ahead adder (based on propagate and generate signals), multi-level look-ahead blocks; Prefix-tree adders: Radix-2 and radix-4 Brent-Kung adder, Kogge-Stone adder, Sklansky adder; Hybrid adders: Carry select adder with look-ahead block, Sparse-tree adders; Implementation using Verilog HDL.
- Carry-Save Adder (CSA) tree for multi-operand addition; Implementation using Verilog HDL.

IMPLEMENTATION OF MULTIPLIER STRUCTURES

- Structures of Unsigned Multiplier (serial left-shift or right-shift algorithm); Parallelogram/rectangular structures of Unsigned Multipliers; Radix-2, radix-4 and radix-8 Booth encoding based multiplier (for signed operands); Modified Baugh-Wooley Multiplier (for signed operands) and its parallelogram/rectangular structure; Divide and conquer multipliers (for unsigned operands); Squaring circuit (single operand multiplier, with reduced partial products); Implementation using Verilog HDL.

OTHER DATAPATH ARITHMETIC-LOGIC (ARL) STRUCTURES

- Fixed-Point (FXP) number system; Implementation of Math functions using: CORDIC Algorithm (circular/rectangular/hyperbolic versions with rotational/vectoring modes), and Newton-Raphson method, Piece-Wise-Linear-Approximation Look-up table; Arbiter FSM; Random number generator based on Linear Feedback Shift-Registers (LFSR), modular and standard LFSR; Implementation of Error Correcting Codes: LFSR based CRC, and Hamming7-4 and 12-8 codes; Funnel shifter and Barrel shifters; Implementation using Verilog HDL.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1- Identify datapath Arithmetic-Logic sub-systems and understand the basic concepts related to RTL/pipelined systems.
CO2- Analyze the internal logic and structures of various Adders
CO3- Investigate the internal logic and structures of various Multipliers
CO4- Design and simulate Adder structures, using Verilog HDL
CO5- Design and simulate Multiplier structures, using Verilog HDL
CO6- Implement Arithmetic-Logic sub-systems onto FPGA, using Verilog HDL

TEXT/REFERENCE BOOKS:

- Neil Weste, David Harris, Ayan Banerjee, "CMOS VLSI design: A circuits and systems perspective", Pearson Education.
- Parhami Behrooz, "Computer arithmetic: Algorithms and hardware design", Oxford University Press.
- Stine James E., "Digital computer arithmetic datapath design using verilog HDL". Kluwer Academic Publishers
- Douglas Smith, "HDL Chip Design", Doone Publications

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Cognitive and Software Defined Radio					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the interplay of signal processing for power as well as spectrum efficient communication.
- Motivate for selecting appropriate commercial solutions for a practical transceiver design.
- Facilitate the understanding of resource management in communication systems.

UNIT 1 INTRODUCTION TO SDR **07 Hrs.**

Software Defined Radio (SDR), Anatomy of SDR, Design considerations, RF aspects, Dynamic Range, RF Receiver Front End Topologies, Enhanced Flexibility of the RF Chain with Software Radios, Noise and Distortion in the RF Chain, Separation of Digital and RF, Basics of antennas, MIMO, Adaptive Modulation and Coding, Multicarrier Modulation.

UNIT 2 SIGNAL PROCESSING FRAMEWORK FOR SDR **07 Hrs.**

Multi-Rate Signal Processing, Sample Rate Conversion , Poly-phase Filters, Digital Filter Banks, Timing Recovery in Digital Receivers, pulse Shaping, Digital signal Generation, Comparison of Direct Digital Synthesis with Analog Signal Synthesis performance, Analysis of Spurious Signals due to Periodic jitter, Hybrid DDS, PLL Systems, Applications of Direct Digital Synthesis, Generation of Random Sequences..

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UNIT 3 IMPLEMENTATION FRAMEWORK FOR SDR **06 Hrs.**

Digital Hardware Choices: using DSPs, FPGAs, and ASICs, Power Management Issues, Using a mix approach, Architecture of FPGA based SDR, Advance Buses, Hardware acceleration, Resource sharing, ADC and DAC architecture, Techniques to improve data converter performance, Distortion.

UNIT 4 COGNITIVE RADIO **06 Hrs.**

Cognitive radio cycle, SDR architecture for Cognitive radio, Spectrum node sensing, Cognitive radio performance analysis, Cooperative sensing, Blind receiver design, UWB and cognitive radio, Applications in harsh and irregular environments, Applications to Ham Radio and Citizen Band Radio Services, Case studies.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify components used in implementation of SDR.

CO2: Understand the design principles of software defined radio.

CO3: Apply use of digital hardware architectures and development methods to SDR design.

CO4: Analyse the radio resource management in heterogeneous networks.

CO5: Evaluate performance of software defined radio.

CO6: Design simple communication system using SDR concepts.

TEXT/REFERENCE BOOKS

- Jeffrey H. Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice Hall PTR.
- Di Pu, Alexander M. Wyglinski, “Digital Communication Systems Engineering with Software Defined Radio”, Artech House.
- Peter B. Kenington, “RF and Baseband Techniques for Software Defined Radio”, Artech House.
- Walter H.W. Tuttle bee, "Software Defined Radio: Enabling Technologies," John Wiley and Sons Ltd..

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Cognitive and Software Defined Radio Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Understand the interplay of signal processing for power as well as spectrum efficient communication.
- Motivate for selecting appropriate commercial solutions for a practical transceiver design.
- Facilitate the understanding of resource management in communication systems.

Laboratory Sessions would be based on following topics:

INTRODUCTION TO SDR

- Software Defined Radio (SDR), Anatomy of SDR, Design considerations.
- RF aspects, Dynamic Range, RF Receiver Front End Topologies, Enhanced Flexibility of the RF Chain with Software Radios.
- Noise and Distortion in the RF Chain, Separation of Digital and RF.
- Basics of antennas, MIMO, Adaptive Modulation and Coding, Multicarrier Modulation.

SIGNAL PROCESSING FRAMEWORK FOR SDR

- Multi-Rate Signal Processing, Sample Rate Conversion, Poly-phase Filters, Digital Filter Banks.
- Timing Recovery in Digital Receivers, pulse Shaping, Digital signal Generation, Comparison of Direct Digital Synthesis with Analog Signal Synthesis performance.
- Analysis of Spurious Signals due to Periodic jitter, Hybrid DDS, PLL Systems, Applications of Direct Digital Synthesis, Generation of Random Sequences.

IMPLEMENTATION FRAMEWORK FOR SDR

- Digital Hardware Choices: using DSPs, FPGAs, and ASICs.
- Power Management Issues, Using a mix approach, Architecture of FPGA based SDR.
- Advance Buses, Hardware acceleration, Resource sharing, ADC and DAC architecture, Techniques to improve data converter performance, Distortion.

COGNITIVE RADIO

- Cognitive radio cycle, SDR architecture for Cognitive radio, Spectrum node sensing.
- Cognitive radio performance analysis, Cooperative sensing, Blind receiver design.
- UWB and cognitive radio, Applications in harsh and irregular environments.
- Applications to Ham Radio and Citizen Band Radio Services, Case studies.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify components used in implementation of SDR.
CO2: Understand the design principles of software defined radio.
CO3: Apply use of digital hardware architectures and development methods to SDR design.
CO4: Analyze the radio resource management in heterogeneous networks.
CO5: Evaluate performance of software defined radio.
CO6: Design simple communication system using SDR concepts.

TEXT/REFERENCE BOOKS

- Jeffrey H. Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice Hall PTR.
- Di Pu, Alexander M. Wyglinski, “Digital Communication Systems Engineering with Software Defined Radio”, Artech House.
- Peter B. Kenington, “RF and Baseband Techniques for Software Defined Radio”, Artech House.
- Walter H.W. Tuttle bee, "Software Defined Radio: Enabling Technologies," John Wiley and Sons Ltd..

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Speech Signal Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce fundamentals of speech signal analysis.
- Introduce techniques for digital speech signal processing.
- Illustrate application of neural networks in speech signal processing.

UNIT 1 DIGITAL MODELS OF SPEECH SIGNAL AND BASIC SPEECH SIGNAL ANALYSIS 07 Hrs.

The speech signal, Speech production model, Classification of speech units, Windowing theorem, Short time speech analysis and synthesis tools, Homomorphic Speech Analysis, MFCC, Pitch Estimation and Tracking, Linear predictive coding (LPC) model, Digital Speech Coding and Evaluation of Coders.

07 Hrs.

UNIT 2 AUTOMATIC SPEECH RECOGNITION (ASR)

ASR problem formulation, The Decision Processes in ASR, Representative Recognition Performance, Feature extraction for ASR, Speech perception and perceptually based features, PLP and MFCC features, Speaker recognition, Speaker verification, Speaker identification, HMM, GMM and Neural network for ASR, Applications and present status.

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UNIT 3 SPEECH SYNTHESIS 04 Hrs.

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

UNIT 4 SPEECH ENHANCEMENT AND APPLICATIONS 08 Hrs.

A brief of human auditory system, Single channel speech enhancement, Short time spectral attenuation (STSA) methods for additive noise removal, Adaptive filters for additive noise removal, Acoustic echo and reverberation cancellation, Relative spectral attenuation (RASTA) processing of speech, Binaural signal processing, Multi-channel speech enhancement methods, Role of Microphone arrays and beamformers, Application to digital hearing aids and cochlear implant, Speaker separation problem and solutions.

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify different digital speech signal processing techniques and applications.
CO2: Understand signal processing techniques used in development of various speech processing applications.
CO3: Apply speech signal processing techniques to practical applications.
CO4: Analyze speech signal processing techniques.
CO5: Compare performance of speech processing systems.
CO6: Design simple speech processing systems at block diagram and flow chart level.

TEXT/REFERENCE BOOKS

- A.R. Jayan, Speech and Audio Signal Processing, PHI Learning Pvt. Ltd.
- Lawrence R. Rabiner, Ronald W. Schafer, Introduction to Digital Speech Processing, Pearson Education.
- Digital Speech Processing Using Matlab (Signals and Communication Technology), E. S. Gopi, Springer.
- Thomas F. Quatieri, Discrete-Time Speech Signal Processing – Principles and Practice, Pearson Education.
- Digital Signal Processing in Audio and Acoustical Engineering, Francis F. Li, Trevor J. Cox, CRC Press.
- Audio and Speech Processing with MATLAB, Paul R. Hill, CRC Press.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Speech Signal Processing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Introduce fundamentals of speech signal analysis.
- Introduce techniques for digital speech signal processing.
- Illustrate application of neural networks in speech signal processing.

DIGITAL MODELS OF SPEECH SIGNAL AND BASIC SPEECH SIGNAL ANALYSIS

- The speech signal, Speech production model, Classification of speech units.
- Windowing theorem, Short time speech analysis and synthesis tools, Homomorphic Speech Analysis.
- MFCC, Pitch Estimation and Tracking, Linear predictive coding (LPC) model.
- Digital Speech Coding and Evaluation of Coders.

AUTOMATIC SPEECH RECOGNITION (ASR)

- ASR problem formulation, The Decision Processes in ASR, Representative Recognition Performance,
- Feature extraction for ASR, Speech perception and perceptually based features, PLP and MFCC features,
- Speaker recognition, Speaker verification, Speaker identification,
- HMM, GMM and Neural network for ASR, Applications and present status. .

SPEECH SYNTHESIS

- Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

SPEECH ENHANCEMENT AND APPLICATIONS

- Single channel speech enhancement, Short time spectral attenuation (STSA) methods for additive noise removal, Adaptive filters for additive noise removal.
- Acoustic echo and reverberation cancellation, Relative spectral attenuation (RASTA) processing of speech.
- Binaural signal processing, Multi-channel speech enhancement methods, Role of Microphone arrays and beamformers.
- Application to digital hearing aids and cochlear implant, Speaker separation problem and solutions.

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify different digital speech signal processing techniques and applications.
CO2: Understand signal processing techniques used in development of various speech processing applications.
CO3: Apply speech signal processing techniques to practical applications.
CO4: Analyze speech signal processing techniques.
CO5: Compare performance of speech processing systems.
CO6: Design simple speech processing systems at block diagram and flow chart level.

TEXT/REFERENCE BOOKS

- A.R. Jayan, Speech and Audio Signal Processing, PHI Learning Pvt. Ltd.
- Lawrence R. Rabiner, Ronald W. Schafer, Introduction to Digital Speech Processing, Pearson Education.
- Digital Speech Processing Using Matlab (Signals and Communication Technology), E. S. Gopi, Springer.
- Thomas F. Quatieri, Discrete-Time Speech Signal Processing – Principles and Practice, Pearson Education.
- Digital Signal Processing in Audio and Acoustical Engineering, Francis F. Li, Trevor J. Cox, CRC Press.
- Audio and Speech Processing with MATLAB, Paul R. Hill, CRC Press.

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

<Course Code>					Fundamentals of Quantum Computing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Learn the fundamentals of quantum computing.
- Learn quantum information processing.
- Learn the various algorithms for quantum computing.
- Know the various types of quantum computer prototypes and programming languages.

UNIT 1 INTRODUCTION TO QUANTUM COMPUTING 7 Hrs.

Introduction, information and computation, characteristics of computational system, computational complexity, Computation and algorithms, Quantum theory, The multiverse interpretation of quantum theory, Qubit, Qubit- Blotch sparse representation.

UNIT 2 QUANTUM INFORMATION PROCESSING 6 Hrs.

Qubit measurement, system with multiple qubits, Quantum Gates, Quantum circuits, Non cooling theorem and quantum teleportation, Quantum entanglement, super dense coding, Quantum optic gates, Quantum Fidelity.

UNIT 3 ALGORITHMS FOR QUANTUM COMPUTING 6 Hrs.

Deutsch algorithm, Deutsch-Josza & Bernstein-Vazirani Algorithms, Simon Problem, Grover's Search Algorithm, Quantum Fourier Transform, Implementing QFT, Shor's Factorization Algorithm, Quantum Error Correction, Three Qubit Code, Shor's 9 Qubit Code

UNIT 4 QUANTUM COMPUTER PROTOTYPE AND PROGRAMMING LANGUAGES 7 Hrs.

Quantum computer prototypes, Quantum computer using ion traps and revisiting concept, Quantum computer using Superconducting circuits, Quantum computer using Optical lattice, Quantum computer using spin states of trapped electrons, Nuclear magnetic resonance quantum computer, Quantum supremacy,

Some of the above topics would be covered through the associated laboratory course.

Max. 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the potential of quantum computing.
CO2: Understand the quantum information processing.
CO3: Implement quantum algorithm.
CO4: Analyze the characteristics of various quantum algorithm.
CO5: Evaluate the quantum architecture.
CO6: Design and create quantum algorithm.

TEXT/REFERENCE BOOKS

- Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019
- Jack Hidary, Quantum Computing: An Applied Approach, Springer, 2019

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Fundamentals of Quantum Computing Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- Learn the fundamentals of quantum computing.
- Learn quantum information processing.
- Learn the various algorithms for quantum computing.
- Know the various types of quantum computer prototypes and programming languages.

Laboratory Sessions would be based on following topics:

FUNDAMENTALS OF QUANTUM COMPUTING
computational complexity, Computation and algorithms, Quantum theory, The multiverse interpretation of quantum theory, Qubit, Qubit- Blotch sparse representation.

QUANTUM INFORMATION PROCESSING
Qubit measurement, system with multiple qubits, Quantum Gates, Quantum circuits, Non cooling theorem and quantum teleportation, Quantum entanglement, super dense coding, Quantum optic gates, Quantum Fidelity.

ALGORITHMS FOR QUANTUM COMPUTING
Deutsch algorithm, Deutsch-Josza & Bernstein-Vazirani Algorithms, Simon Problem, Grover's Search Algorithm, Quantum Fourier Transform, Implementing QFT, Shor's Factorization Algorithm, Quantum Error Correction, Three Qubit Code, Shor's 9 Qubit Code

QUANTUM COMPUTER PROTOTYPE AND PROGRAMMING LANGUAGES
Quantum computer prototypes, Quantum programming

Some of the above topics would be covered through the associated theory course.

COURSE OUTCOMES
On completion of the course, student will be able to
CO1: Recognize the potential of quantum computing.
CO2: Understand the quantum information processing.
CO3: Implement quantum algorithm.
CO4: Analyze the characteristics of various quantum algorithm.
CO5: Evaluate the quantum architecture.
CO6: Design and create quantum algorithm.

TEXT/REFERENCE BOOKS

- Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019
- Jack Hidary, Quantum Computing: An Applied Approach, Springer, 2019

END SEMESTER LABORATORY EXAMINATION PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs.**

The laboratory exam would be conducted in the Lab, and students would be provided one or more questions on: designing/experimentation/programming-coding/implementation/investigation/solution-development.	25 Marks

Open Electives offered by the Department of ICT

Logisim: Design and Simulation of Digital Logic	3-0-0
Artificial Intelligence for Everyone	3-0-0
Image Processing for Engineers	3-0-0
Machine Learning for Basic Sciences	3-0-0
Introduction to Internet of Things for Industries	3-0-0
Energy Harvesting for Engineers	3-0-0
Fundamentals of IoT	3-0-0
Sensors and Signal Processing	3-0-0

<Course Code>					Logisim: Design and Simulation of Digital Logic					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES:

- To know the functionalities of the Logisim tool.
- To design and simulate digital combinational logic blocks, using Logisim
- T0 design and simulate digital sequential circuits, using Logisim

UNIT-1: INTRODUTION TO DIGITAL LOGIC **7 Hrs.**

Introduction: Digital Systems; Data representation and coding; Truth table; Basic logic operation and logic gates.
Number Systems and Codes: Positional number system; Binary; octal and hexadecimal number systems; Representation of signed numbers; Signed Arithmetic, Unsigned Arithmetic, SOP and POS forms of Boolean expression;

UNIT-2: DESIGN OF DIGITAL COMBINATIONAL CIRCUITS IN LOSIGIM **11 Hrs.**

Design and simulation of Combinational Logic Modules in Logisim: Decoders; encoders; multiplexers; demultiplexers; Parity circuits and comparators; Arithmetic modules- adders; sub tractors, multipliers, and ALU, etc.

UNIT-3: DESIGN OF DIGITAL SEQUENTIAL CIRCUITS IN LOSIGIM **12 Hrs.**

Design and simulation of Sequential Logic Modules in Logisim:
Sequencing Elements: D-latch; D flip-flop; JK flip-flop; T flip-flop
Sequential systems/modules: Design of Moore Finite state machines – state diagram, state-table; state assignment; Registers and Counters; Simple processor Design, Application examples. Implementation of Moore FSM using MUX, or using Decoders, or using ROM

UNIT-4: DESIGN OF MEMORY MODULES **9 Hrs.**

Design and simulation of Memory Modules in Logisim: RAM, ROM, Register File.

Max. 39 Hrs.

Delivery mode: 3 lectures in 60 capacity lab

COURSE OUTCOMES:

On completion of the course, the student will be able to:
CO1- Understand the basics of digital number systems, and standard digital logic gates.
CO2- Explore the functionalities and building blocks available in the Logisim tool.
CO3- Comprehend the functionality of digital combinational-logic circuits (decoder/encoder, MUX/De-MUX, comparators, adders, etc.), using Logisim tool.
CO4- Design and Simulate digital combinational-logic circuits in Logisim
CO5- Comprehend the basics of sequencing elements (latches and flip-flops), and the functioning of digital sequential-logic circuits (registers, counters, FSMs, etc.) using Logisim tool.
CO6- Design and simulate digital sequential-logic circuits in Logisim.

TEXT/REFERENCE BOOKS:

- M. Morris Mano and Michael Ciletti, "Digital Design", 4th Edition, Pearson Education
- Church, "Official 2.7.x documentation", Logisim; URL: http://www.cburch.com/logisim/docs.html

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Note: The Mid Semester and End Semester examinations would be conducted in the Lab, and students would be provided a list of design questions/experiments, to be implemented during the exam.	

<Course Code>					Artificial Intelligence for Everyone					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Learn the fundamentals of Artificial Intelligence.
- Study Neural networks and their architectures.
- Explore the various applications of AI.
- Understand the code of conduct and ethics in AI.

UNIT 1 INTRODUCTION TO ARTIFICIAL INTELLIGENCE 10 Hrs.

Philosophy, fundamental nature of intelligence, Terminologies of AI, what is data, what is machine learning, what machine learning can and cannot do, how to choose a proper AI model for a particular objective

UNIT 2 NEURAL NETWORK 10 Hrs.

Introduction to biological neuron, Characteristics of biological Neural Networks, Historical Development of Artificial Neural Networks, Artificial Neural Networks: Models of Neuron, Terminology, Topology, Basic Learning Laws, Gradient descent algorithm, Backpropagation algorithm, Pattern Recognition Problem, Types of Neural Networks, Deep Neural network architectures

UNIT 3 APPLICATIONS OF AI 10 Hrs.

AI in medicine, AI for healthcare, AI in autonomous manufacturing assembly line, AI in autonomous driving, AI for smart cities, AI in defense, AI in security and surveillance, AI in Education, AI in finance, AI in extra-terrestrial intelligence search, AI in Environment and ecology.

UNIT 4 ETHICS IN AI, SOCIAL RESPONSIBILITY AND SECURITY 09 Hrs.

Inequality and disruption due to raise of AI, Bias, Ethical Aspects of Model Robustness and Reliability, Ethics in Domain-Specific AI Algorithms, explainable AI, how do machines affect our behaviour and interaction, possible risk due to Artificial General Intelligence and Superintelligence, code of conduct, the democratization of AI, emotional intelligence and AI.

Max. 39 Hrs.

Delivery mode: 3 lectures in 60 capacity lab

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize the potential of artificial intelligence systems.
CO2: Understand the Statistical Techniques and Machine Learning Algorithm
CO3: Implement the neural network architectures.
CO4: Analyze the ethical and social impact of AI.
CO5: Evaluate the performance of various neural network architectures.
CO6: Organize ethical guidelines for the safe use of AI.

TEXT/REFERENCE BOOKS

- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016
- Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
- Virginia Dignum, Responsible Artificial Intelligence, Springer, 2019

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Image Processing For Engineers					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce mathematical modelling and transforms for digital image processing.
- Understand methodology to analyse, design and implement images processing ~~and analysis~~ algorithms.
- Develop understanding for multi-dimensional signal processing.

UNIT 1 INTRODUCTION **11 Hrs.**

Introduction, Image sampling and quantization, Basic relationships in pixels, Basic intensity transformations, Histogram processing, Spatial filtering: smoothing and sharpening, Basic mathematical tools in image processing, Color models.

UNIT 2 PRE-PROCESSING **09 Hrs.**

Sampling 2D functions, Aliasing, 2D Fourier Transform and properties, Filtering in frequency domain: smoothing, sharpening, selective filtering.

UNIT 3 IMAGE RESTORATION AND MORPHOLOGICAL OPERATIONS **09 Hrs.**

Model of image degradation process, Restoration in presence of noise, Estimating degradation function, Inverse filtering, MMSE filtering, Morphological operations: Erosion and dilation, opening and closing, Basic morphological algorithms.

UNIT 4 APPLICATIONS **10 Hrs.**

Edge detection, Corner detection, Feature detection, Colour extraction, Texture detection, person detection, face detection.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Recall and identify properties of digital images and 2D transforms.

CO2 – Explain concepts and complexity of digital image processing techniques and systems.

CO3 – Practice and use image processing algorithms.

CO4 – Examine images and applications in time domain and frequency domain.

CO5 – Judge performance of image processing algorithms.

CO6 – Design image processing algorithms for real world problems.

TEXT/REFERENCE BOOKS

- Gonzalez, R. C., & Woods, R. E., "Digital image processing", Pearson, 4th Edition, 2018.
- Sonka, Milan, "Image processing, analysis and machine vision". Cengage Learning Pvt. Ltd, 4th Edition.
- Castleman, Kenneth "Digital Image Processing". Pearson Education, 1st Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

A. Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)) — 20 to 40 Marks

B. Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)) — 80 to 60 Marks

<Course Code>					Machine Learning for basic sciences					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Introduce principles of Machine Learning from mathematically motivated perspective.
- Work with supervised and unsupervised learning.
- Learn tools to apply machine learning algorithms in basic sciences

UNIT 1 INTRODUCTION TO MACHINE LEARNING 8 Hrs.

Overview of machine learning, Linear algebra, vector, Matrix, tensor, using python, Probability theory, conditional probability, joint probability, conditional independence, Bayes' Theorem, Linear Regression, Subset selection, PCA, Linear Discriminant Analysis (LDA)

UNIT 2 CLASSIFICATION 10 Hrs.

Multiclass Classification, KNN, Neural Network, loss functions, Back Propagation, Parameter estimation, Support Vector Machine, Naïve Bayes Classification, Decision Tree, pruning, Random forest, boosting

UNIT 3 CLUSTERING 12 Hrs.

Clustering- Partitioning, Hierarchical, Density based, Gaussian Mixture Model, Expectation Maximization, K means

UNIT 4 APPLICATIONS OF MACHINE LEARNING IN BASIC SCIENCE 09 Hrs.

Application of machine learning in Material science and chemistry, in astrophysics, in High energy physics, in biology, in applied mathematics.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: List machine learning algorithm for the problem domain.
CO2: Compare different machine learning algorithms for the problems.
CO3: Implement machine learning technique in basic science applications
CO4: Analyze important parameters and structure of the machine learning algorithms.
CO5: Judge efficacy of machine learning algorithm.
CO6: Design and create machine learning algorithm for basic sciences.

TEXT/REFERENCE BOOKS

- Simon Haykin, Neural Networks and Learning Machines, Third Edition, Paper Back, Pearson India
- Ethem Alpaydin, Introduction to Machine Learning, Third edition, PHI, 2015
- Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning. Springer. 2001

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Introduction to Internet of Things for Industries					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart knowledge of basics of Internet of things (IoT).
- To develop skills to build industry relevant projects.
- To impart Sensitization towards security and technical issues related to IoT.

UNIT 1 INTRODUCTION **10 Hrs.**

Introduction, IoT components, architecture, key IoT technologies, M2M to IoT, devices and gateways, LAN, WAN, IoT business process, Analytics, real world design constraints, IoT use cases: building automation, smart grid, industrial automation, smart cities.

UNIT 2 ELEMENTS of IoT **10 Hrs.**

Hardware Components- Computing platforms, Communication, I/O interfaces, Software Components- Programming API's for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

UNIT 3 IoT for INDUSTRIES **10 Hrs.**

Introduction, industrial devices & processes, data flow, Industrial IoT (IIoT) implementation, OEM platforms, Cloud for IIoT, design examples, diagnostics, maintenance and predictive analysis, AWS, Google cloud, Azure platforms. MQTT.

UNIT 4 SECURITY FOR THE IoT **09 Hrs.**

Defining analytics , IoT analytics challenges, data size, resource constraints, data quality, Strategies to Organize Data for Analytics, related data science. Cybersecurity for IoT, IoT Dataflow and Security , Endpoint Security and Trustworthiness, Secured Connectivity , Securing IIoT Edge, Cloud, and Apps, 7Secure Processes and Governance, IIoT Security Using Emerging Technologies, Real-World Case Studies in IIoT.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand Internet of Things and its hardware and software components.

CO2 – Interpret the architecture and its relation with available resources.

CO3 – Interpret Interface I/O devices, sensors & communication modules.

CO4 – Distinguish between usage of IoT protocols.

CO5 – Compare different frameworks for implementation.

CO6 – Understand the security aspects for IoT devices.

TEXT/REFERENCE BOOKS

- Giacomo Veneri, Antonio Capasso, Hands-On Industrial Internet of Things, packt publishers, 2018.
- Adrian McEwen, "Designing the Internet of Things", Wiley publishers.
- Vijay Madisetti, Arshdeep Bahga, İnternet of Things, "A Hands on Approach", University Press.
- Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

20ICXXXX					Energy Harvesting for Engineers					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand different energy sources and generation process.
- To understand the current status of conventional and modern energy sources.
- To understand future scope of next generation energy sources.

UNIT 1 FOSSIL FUEL AND ALTERNATE SOURCE OF ENERGY **10 Hrs.**

Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. Geothermal Energy: Geothermal Resources, Geothermal Technologies.

UNIT 2 SOLAR AND HYDRO ENERGY **10 Hrs.**

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

UNIT 3 PIEZOELECTRIC AND WIND ENERGY HARVESTING **09 Hrs.**

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power . Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

UNIT 4 ELECTROMAGNETIC ENERGY HARVESTING **10 Hrs.**

Electromagnetic Energy Harvesting: rectifier circuits, filters, regulator ICs, design of DC supply, RF energy harvesting using antenna, Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability. Introduction to futuristic energy harvesting.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Remember different fossil fuels availability.
CO2: Understand the impact and use of ocean energy.
CO3: Demonstrate the use and availability of solar and hydro energy.
CO4: Illustrate the use of piezoelectricity.
CO5: Evaluate the uses and applications of wind energy.
CO6: Elaborate futuristic energy harvesting methods.

TEXT/REFERENCE BOOKS

- S. Rao and Dr. B. B. Parulekar, "Energy Technology-Nonconventional, Renewable & Conventional" , Khanna Publishers.
- G. D. Rai, "Solar Energy Utilization", Khanna Publishers.
- G. D. Rai, "Non-Conventional Energy Sources", Khanna Publishers.
- Tasneem Abbasi and S. A. Abbasi, "Renewable Energy Sources-Their Impact on Global Warming and Pollution", PHI Learning Pvt. Ltd.
- H.P. Garg, "Advanced in Solar Energy Technology", D. Reidel Publishing Co., Drdricht.
- S.P. Sukhatme, "Solar Energy", Tata McGrew Hill Company Ltd., New Delhi
- Harsh K. Gupta and Roy Sukanta, "Geothermal Energy: An Alternative Resource for the 21st Century", Elsevier Science.
- E. H. Thorndike, "Energy and Environment", Addison-Wesley 1976

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.(10 to 20 marks each)	80 to 60 Marks

<Course Code>					Fundamentals of Internet of Things					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart necessary and practical knowledge of components of Internet of Things.
- To develop skills required to build real-life IoT based applications.
- To develop skills for effective data analysis for IoT.

UNIT 1 INTRODUCTION **10 Hrs.**

Architecture, Design principles, capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

UNIT 2 ELEMENTS OF IoT **10 Hrs.**

Hardware Components- Computing platforms, Communication, I/O interfaces, Software Components- Programming API's for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

UNIT 3 IoT APPLICATION **12 Hrs.**

Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices. IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.

UNIT 4 ANALYTICS FOR THE IoT **07 Hrs.**

Defining analytics , IoT analytics challenges, data size, resource constraints, data quality, Strategies to Organize Data for Analytics, related data science.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand and explain the concept of wireless sensor networks and their applications.

CO2 – Interpret the architecture and its relation with available resources.

CO3 – Interpret Interface I/O devices, sensors & communication modules.

CO4 – Distinguish between usage of IoT protocols.

CO5 – Compare different frameworks for implementation.

CO6 – Analyse the information extracted from data from IoT devices.

TEXT/REFERENCE BOOKS

- Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.
- Adrian McEwen, "Designing the Internet of Things", Wiley publishers.
- Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, "A Hands on Approach", University Press.
- Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

<Course Code>					Sensors and Signal Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand various sensors and their characteristics.
- To define appropriate signal conditioning requirements.
- To study analog and digital signal processing systems for interfacing with sensors.

UNIT-1 INTRODUCTION TO BASIC SENSORS AND SIGNAL CONDITIONING 12 Hrs.

Introduction to sensors, transducers, actuators, signal conditioning and signal processing, Basic model diagram and components of electronic sensor and IoT system, Introduction to sensor technologies, Sensor classifications, Smart sensors, Displacement and Position Sensors: Potentiometer, LVDT, Liquid level sensor, Strain Gauges etc., Signal Conditioning: Amplification, Filtering, Linearization, Impedance Matching, Bridge Circuits, Loading Effect, Common Mode Rejection etc., Motion sensors: Accelerometer (MEMS capacitive, Piezo-electric etc.), Signal conditioning for measuring velocity and displacement, MEMS Gyroscope, Measurement of Magnetic Field: Hall Effect Sensor, Magnetometer and Compass, Interfacing with GPS.

UNIT-2 PHYSICAL QUANTITY MEASUREMENT AND CONTROL 11 Hrs.

Pressure Sensors: Diaphragm, Bellows, Burdon Tubes and Solid State, Liquid flow sensors: Magnetic Flow Sensors, Ultrasonic sensors for distance, level and flow measurement, Proximity Sensors and Signal Conditioning Circuits, Temperature Sensors: RTD, Thermistor, Thermocouple, Bimetal Strip, Solid State IC Sensors, Signal Conditioning and Applications, Optical Sensors: LDR, Photodiode, Phototransisor, Optocoupler, Applications: Object counting, Shaft Encoders etc., Actuators: DC, Servo and Stepper Motors, Direction and Speed Controls, Motor Drivers, Solenoid, Feedback and control mechanism

UNIT-3 DIGITAL INTERFACES **08 Hrs.**

Zero Crossing Detectors, Schmitt Trigger, Sample and Hold Circuits, Analog to Digital and Digital to Analog Convertors, Data Acquisition Systems, Data Logging Systems, Concepts of Microcontroller I/O ports and Interfacing ADC and DACs, System with on chip and on device sensors, Display Devices: LED, LCD, TFT etc. Application: illustration using simple robot (e.g. Firebird-V)

UNIT-4 ROLE OF DIGITAL CONTROL, SIGNAL PROCESSING AND APPLICATIONS 08 Hrs.

Elements of Digital Control and Signal Processing, Simple Digital Control Strategies, Noise Reduction, Tracking and Prediction, Applications: Home & Industrial Automation, Environment, Healthcare, Agriculture, Transportation etc.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify components of modern sensing and actuation system.

CO2: Understand principles, working and operation of various sensors, actuators and signal conditioning circuits.

CO3: Apply concepts to study data acquisition systems and advanced systems.

CO4: Analyze electronic circuit for interfacing with sensors.

CO5: Implement sensors and signal conditioning system to interface with digital platforms.

CO6: Design simple sensor and signal processing system.

TEXT/REFERENCE BOOKS

- Process Control Instrumentation Technology, Curtis D. Johnson, PHI
- A Hands-On Course in Sensors Using the Arduino and Raspberry Pi, Volker Zeimann, CRC Press.
- Signal Processing for Intelligent Sensor Systems with MATLAB, David C. Swanson, CRC Press.
- Intelligent Sensing, Instrumentation and Measurements, Subhas Chandra Mukhopadhyay, Springer
- Sensors, Actuators and Their Interfaces, Nathan Ida, Scitech Publishing.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

Semester - VIII

PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR

SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B TECH IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester VIII			**B. Tech. in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1		Comprehensive Project	0	0	20	10	20				There will be three reviews (30 %, 30 %, 40 %)		100
		Total	0	0	20	10	20						100

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LE – Lab Exam, LW – Lab Work

<Course Code>					Comprehensive Project						
Teaching Scheme					Examination Scheme						
L	T	P	C	Hrs/Week	Theory			Practical			Total Marks
					MS	ES	IA	Continuous Evaluation	Mid-term Evaluation	End-term Evaluation	
0	0	20	10	20	--	--	--	30	30	40	100

COURSE OBJECTIVES:

- To provide an opportunity to solve real-world problems with industry using ICT tools.
- To facilitate industry-academia interactions.
- To provide an opportunity for life and domain skill enhancement.
- To make ready the students for the academia/research/industry and for the society at large.

The scope of the Comprehensive Project(CP): The students are expected to work on a comprehensive project in any of the ICT related areas. The CP can be based on novel ideas and their implementation, an extensive survey of technology or methods, development of proof of concepts. Thus, students are expected to use acquired skills or develop new skills while working under the supervision of industry or academic mentor within the stipulated time frame.

Pedagogy: The student can opt for either in-house or an industry project.

COURSE OUTCOMES:

At the end of this course students will be able to:
CO1: Recognize the real-world problem.
CO2: Understand the problem and its technological significance.
CO3: Implement and analyze existing feasible solutions using available tools.
CO4: Design and create a solution using science, technology, engineering, and mathematical principles.
CO5: Study the impact of the proposed solution/CP towards, society, environment, infrastructure, energy, and economy
CO6: Apply principles of management, finance, teamwork, ethics, and communicate effectively in a professional environment, for lifelong learning.

EVALUATION:

The evaluation will be based on continuous (30%), mid-term presentation (30%), end-term presentation (40%).