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||Jai Sri Gurudev||

Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

AICTE Approved, Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF(151-300) in 2023,Gold Rated by QS I-Gauge

P.B. No.20, B.B Road, Chikkaballapur - 562 101, Karnataka

Estd : 1986

VI Semester
Scheme & Syllabus of B.E. Programme
Electronics & Communication Engineering
(2024 Scheme)

Core Values

Spiritual, Judicious, Commitment, Integrity, Trustworthy



AICTE | NATIONAL INSTITUTIONAL RANKING FRAMEWORK 151-300 | NBA | NAAC A+ | QS I-GAUGE GOLD | INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating

SJC INSTITUTE OF TECHNOLOGY, CHIKKABALLAPURA

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SCHEME OF TEACHING AND EXAMINATION – B.E. – Branch Name: ECE

(Applicable for students admitted from the Academic Year 2024-25 and onwards)

6th Semester

Electronics and Communication Engineering

Sl. No.	Course Code	Course Title	Course Type	TD/ PSB	Teaching Hours / Week			Examination				
					L	T	P	SEE Duration (Hrs)	CIE Marks	SEE Marks	Total Marks	Credits
1	BEC601	VLSI Design and Testing	PCC	ECE	3	2	0	**3**	**50**	**50**	**100**	**4**
2	BEC602	Embedded System Design	IPCC	ECE	3	0	2	**3**	**50**	**50**	**100**	**4**
3	BEC623x	Professional Elective Course – II	PEC	ECE	3	0	0	**3**	**50**	**50**	**100**	**3**
4	BEC624x	Professional Elective Course – III	PEC	ECE	3	0	0	**3**	**50**	**50**	**100**	**3**
5	BEC645x	Open Elective Course – I	OEC	ECE	3	0	0	**3**	**50**	**50**	**100**	**3**
6	PROJ606	Major Project Phase - I	PROJ	ECE	0	0	4	-	**100**	-	**100**	**2**
7	BECL607	VLSI Design and Testing Lab	PCCL	ECE	0	0	2	**3**	**50**	**50**	**100**	**1**
8	BCE608	Competency Enhancement Course-4	NCMC	CDCAC	0	2	0	-	**100**	-	**100**	**0**
9	BIK609	Indian Knowledge System	NCMC	Any Dept.	1	0	0	-	**100**	-	**100**	**0**
10	BNS610	National Service Scheme (NSS)	NCMC	NSS Coordinator	0	0	2	-	**100**	-	**100**	**0**
	BPE610	Physical Education (PE) (Sports and Athletics)		Physical Education Director								
	BYO610	Yoga		Yoga Teacher								
	BMU610	Music		Music Teacher								
									700	**300**	**1000**	**20**

ASC: Applied Science Course, PCC: Professional Core Course, IPCC: Integrated Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, NCMC: Non Credit Mandatory Course, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Professional Elective Course – II

Course Code	Course Name	Course Code	Course Name
BEC623A	Multimedia Communication	BEC623C	DSP Algorithms and Architecture
BEC623B	Artificial Neural Networks	BEC623D	Error Control Coding

Professional Elective Course – III

Course Code	Course Name	Course Code	Course Name
BEC624A	Digital Image Processing	BEC624C	Operation Research
BEC624B	Optical Communication and Networks	BEC624D	Introduction to Deep Learning

Open Elective Course – I

Course Code	Course Name	Course Code	Course Name
BEC645A	Digital System Design using Verilog	BEC645C	Electronic Communication System
BEC645B	Consumer Electronics	BEC645D	Basic VLSI Design

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical's of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2024-25 may please be referred.

National Service Scheme /Physical Education/Yoga/Music: All students have to register for any one of the courses namely National Service Scheme, Physical Education, Yoga and Music with the concerned coordinator / teacher of the course during the first week of 3rd semester. Activities shall be carried out between 3rd semester to the 6th semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Music activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work

Semester: VI						
VLSI DESIGN AND TESTING						
Course Code	**:**	BEC601		**Credits**	**:**	4
Hours/Week(L:T:P)	**:**	3:2:0		**CIE**	**:**	50 Marks
Total Hours	**:**	50 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Logic Design, Basic Electronics
Knowledge on Fundamental Concepts	MOSFET Operation, Implementation of Boolean Expression
Knowledge on Connected Tools (If any)	LTSPICE/Microwind/Cadence etc..,

Course Learning Objectives: This course will enable the students to	
CLO1	Deals with analysis and design of digital CMOS integrated circuits.
CLO2	Emphasizes on basic theory of digital circuits, design principles and techniques for digital design blocks implemented in CMOS technology.
CLO3	Analyze the switching characteristics of digital circuits along with delay and power estimation.
CLO4	Understanding the CMOS sequential circuits and memory design concepts.
CLO5	Explore the knowledge of VLSI Design flow and Testing

Module – 1	**8 Hrs**
Introduction to MOS and CMOS Circuits: Introduction, MOS Transistor, CMOS Logic, CMOS fabrication & Layout, Design Portioning, Logic Design, Circuit Design, Physical Design. **Text Book 1: Chapter 1: 1.1,1.3,1.4,1.5,1.6,1.8,1.9,1.10 to 1.6**	
Module – 2	**8 Hrs**
MOS Transistor Theory & Fabrication: Introduction, Long Channel I-V Characteristics, C-V Characteristics, Non-Ideal Effects, DC Transfer Characteristics, CMOS Technologies, CMOS Process Enhancements **Text Book 1: 2.1, 2.2,2.3,2.4,2.5, 3:3.2, 3.4**	
Module – 3	**8 Hrs**
Delay: Introduction, Transient Response, RC Delay Model, Linear Delay Model **Power:** Introduction, Dynamic Power, Static Power **Inter Connect:** Introduction, Interconnect modeling: Resistance, Capacitance, Interconnect Impact: Delay, Energy, cross talk, Intern connect Engineering: Width, Spacing & Layer, Repeaters **Text Book 1:4.1,4.2, 4.3, 4.4, 5.1,5.2,5.3 ,6.1, 6.2.1, 6.2.2, 6.3.1,6.3.2,6.3.3, 6.4.1, 6.4.2**	
Module – 4	**8 Hrs**
Combinational Circuit Design: Introduction, Circuit Families **Sequential Circuit Design**: Introduction, Circuit Design of Latches and Flip flops **Data Path Systems:** Single bit addition, carry propagate addition, one/zero detector, Comparators, Linear Feedback Shift Register, barrel shifter, Unsigned array multiplication **Text Book 1: 9.1,9.2,10.1, 10.3, 11.1,11.2.1,11.2.2, 11.3, 11.4, 11.5.4, 11.8.2, 11.9.1**	

Module – 5	8 Hrs
Array Sub System: Introduction, SRAM: SRAM Cells, Row Circuitry, Column Circuitry, DRAM, Read only Memory **Testing, Debugging and Verification:** Introduction, Logic Verification Principles, Manufacturing Test Principles, Design for Testability, Boundary scan **Text Book 1: 12.1, 12.2.1,12.2.2, 12.2.3, 12.3, 12.4, 15.1, 15.3, 15.5, 15.6, 15.7**	
Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret MOS transistor theory and CMOS fabrication process with design rules.
CO2	Apply semiconductor physics principles to MOS transistors, develop CMOS-based digital circuits and evaluate MOS geometric effects
CO3	Evaluate circuit performance, optimize transistor sizing and power, & apply scaling techniques in VLSI design.
CO4	Comprehend MOS logic circuits, flip-flop designs, VLSI design methodologies, and digital circuit testing techniques.
CO5	Design and implement CMOS logic circuits using modern EDA tools such as LTSpice, Microwind, Cadence, Mentor Graphics etc.,

Text Books	
1	CMOS VLSI Design: A circuits and systems perspective ,Neil H.E. Weste, David Harris, ,4th Edition, 2015, Pearson Education, ISBN:9789332542884

Reference Books	
1	CMOS Circuit Design, Layout and Simulation, R Jacob Baker: 4th Edition,2019, IEEE Press- John Wileay & Sons, 2019,ISBN: 978-1-119-48139-3
2	Basic VLSI Design, Pucknell Douglas A, Eshraghian, Kamran, 3rd Edition, 2003,PHI Learning, ISBN-9788120309869
3	VLSI Test Principles and Architectures: Design for Testability, L.T. Wang, C.W. Wu, and X. Wen,1st Edition, 2006, Elsevier,ISBN: 9781493300860 Ebook: https://lniv.fe.uni-lj.si/courses/pev/TestPrinciples.pdf

Skill Development Activities Suggested
QUIZ, Free Open-Source Simulation (LTSPICE, Logisim, QUCS), Industry Expert talk, Case studies on Modern Technology, Project Based Learning

Web links and Video Lectures (e – Resources)	
1	https://archive.nptel.ac.in/courses/117/101/117101058/
2	https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ee09/
3	https://youtube.com/playlist?list=PL018645397D9487AF&feature=shared
4	https://ocw.mit.edu/courses/6-374-analysis-and-design-of-digital-integrated-circuits-fall-2003/
5	https://ocw.mit.edu/courses/6-111-introductory-digital-systems-laboratory-spring-2006/resources/l15_vlsi_print/
6	https://pages.hmc.edu/harris/cmosvlsi/4e/index.html
7	https://cmosedu.com/

CO-PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2										3	2	-
CO2	3	2	1		1						2	3	-
CO3		3	2								2	3	-
CO4	2	1			1						2	2	-
CO5	3	2	3	2	3			2		2	3	2	3

Semester: VI						
Embedded System Design						
Course Code	:	BEC602		**Credits**	:	04
Hours/Week(L:T:P)	:	3:0:2		**CIE**	:	50 Marks
Total Hours	:	40+12 Hrs		**SEE**	:	50 Marks
Course Type	:	IPCC		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	**Microcontrollers**
Knowledge on Fundamental Concepts	Basic Electronics and Digital Logic, Microprocessors and Microcontrollers, Programming Languages (C/C++ and Assembly).
Knowledge on Connected Tools (If any)	**Keil ,Ardunio IDE**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamental concepts, key characteristics, and application areas of embedded systems across various domains.
CLO2	Describe the fundamental concepts of ARM Cortex-M3 architecture, including instruction sets, memory systems, and pipeline structure
CLO3	Understand the embedded system's real-time operating system and its application in IoT
CLO4	Develop Programs using assembly language and C to demonstrate the functionality of Cortex-M3 instructions
CLO5	Program various embedded components using the embedded C program

Module – 1	**08Hrs**

Introduction to Embedded System: What is an Embedded Systems? Embedded systems Vs General computing systems, History of Embedded Systems, Classification of Embedded systems, Major Application Areas of Embedded Systems. Purpose of Embedded Systems, The Typical Embedded System, Microprocessor Vs Microcontroller, Differences between RISC and CISC, Harvard V/s Von Neumann Processor/Controller Architecture, Big-endian V/s Little-endian processors, Memory (ROM and RAM types), Sensors & Actuators, The I/O Subsystem – I/O Devices, Light Emitting Diode (LED), 7- Segment LED Display, Optocoupler, Relay, Piezo buzzer, Push button switch, Communication Interfaces, On-board Communication Interface, External Communication Interface, Embedded Firmware, Other System Components

Text Book 1: All the Topics from Ch-1 and Ch-2.

Module – 2	**08 Hrs**

Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co-Design and Program Modeling (excluding UML), Embedded firmware design and development (excluding C language)

Text Book 1: Ch-3, Ch-4 (4.1, 4.2.1 and 4.2.2 only), Ch-7 (Sections 7.1, 7.2 only),

Ch-9 (Sections 9.1, 9.2, 9.3.1, 9.3.2 only)

Module – 3	08 Hrs
RTOS and IDE for Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Preemptive Task scheduling techniques, Task Communication, Task synchronization issues – Racing and Deadlock. How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment – Block diagram (excluding Keil). **Text Book 1: Ch-10 (Sections 10.1, 10.2, 10.3, 10.5.2 , 10.7, 10.8.1.1, 10.8.1.2 only), Ch-12, Ch-13 (a block diagram before 13.1, only).**	
Module – 4	**08 Hrs**
ARM Embedded Systems: Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware – AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT) code, Operating System, Applications. ARM Processor Fundamentals, ARM core dataflow model, registers, current program status register, Pipeline, Exceptions, Interrupts and Vector Table, Core extensions. **Text Book 2: Chapter 1, 2**	
Module – 5	**08 Hrs**
Introduction to the ARM Instruction set: Introduction, Data processing instructions, Load – Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, ARMv5E extensions, Conditional Execution. **Text Book 2: Chapter 3**	

PRACTICAL COMPONENT OF IPCC

Conduct the following experiments on an ARM CORTEX M3 evaluation board to learn Assembly Language Program and using evaluation version of Embedded 'C' & Keil uVision-4 tool/compiler.

SL.NO	EXPERIMENTS
1	Write a program to find the sum of the first 10 integer numbers.
2	Write an Assembly Language Program (ALP) to i) Multiply two 16-bit numbers. ii) Add two 32-bit numbers.
3	Write a program to find the factorial of a number.
4	Write a program to add an array of 16 bit numbers and store the 32 bit result in internal RAM.
5	Write a program to find the square of a number (1 to 10) using a look-up table.
6	Write a program to find the largest or smallest number in an array of 32 numbers.
7	Write a program to arrange a series of 32 bit numbers in ascending/descending order.
8	Write a program to count the number of ones and zeros in two consecutive memory locations
9	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
10	Interface a DAC and generate Triangular and Square waveforms.
11	Display the Hex digits 0 to F on a 7-segment LED interface, with a suitable delay in between.
12	Interface a simple Switch and display its status through Relay, Buzzer and LED

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend Embedded Systems Design concepts
CO2	Interpret the fundamental concepts of ARM Cortex-M3 architecture, including instruction sets, memory systems, and pipeline structure
CO3	Apply and Analyze the behaviour of Real-Time Operating System (RTOS).
CO4	Develop Programs using assembly language and C to demonstrate the functionality of Cortex-M3 instructions.
CO5	Engage in self-study to design, implement and demonstrate an Embedded system application.
Text Books	
1	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education
2	Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008.
Reference Book	
1	Raj Kamal, "Embedded Systems: Architecture and Programming", Tata McGraw Hill, 2008.

Web links and Video Lectures (e – Resources)	
1	https://archive.nptel.ac.in/courses/106/105/106105193/
2	https://developer.arm.com/documentation/dui0068/b/ARM-Instruction-Reference
3	https://www.udemy.com/course/introduction-to-arm-cortex-m3-and-m4-processors/
4	www.Nuvoton .com/websites on Advanced ARM Cortex Processors
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
Programming Assignments / Mini Projects can be given to improve programming skill	

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2								2	2	2	2
CO2	3	2								1	2	2	2
CO3	3	3	2							1		2	2
CO4	3	3	3	2	2					2		2	3
CO5	3	3	3	2	3	1	1	2	2	3	3	2	3

Semester: VI						
MULTIMEDIA COMMUNICATION						
Course Code	**:**	BEC623A		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Digital Signal Processing, Digital Communication and Computer Networks
Knowledge on Fundamental Concepts	Sampling and Quantization, Compression Techniques, Transmission Protocols
Knowledge on Connected Tools (If any)	Basic Programming Skills like MATLAB, Scilab and Python

Course Learning Objectives: This course will enable the students to	
CLO1	Gain fundamental knowledge in understanding the basics of different multimedia Networks and applications
CLO2	Understand digitization principle techniques required to analyze different media Types.
CLO3	Analyze compression techniques required to compress text, image, audio and video.
CLO4	Explore different multimedia concepts applied to the internet
CLO5	Gain fundamental knowledge about multimedia communication across different Networks.

Module – 1	**08 Hrs**
Multimedia Communications: Introduction, Multimedia Information Representation, Multimedia Networks, Multimedia Applications, Application and Networking Terminology. **Text Book 1: Chapter 1 - 1.1 to 1.5**	
Module – 2	**08 Hrs**
Text and Image Compression: Digitization principles, Text, Images, Compression principles, Text compression: Static Huffman Coding, Dynamic Huffman coding, Arithmetic coding, LZ & LZW Coding, Image compression: Graphics Interchange Format, Tagged Image File Format, Digitized Document, Digitized Pictures and JPEG. **Text Book 1: Chapter 2 - 2.2 to 2.4, Chapter 3 – 3.2 to 3.4**	
Module – 3	**08 Hrs**
Audio and Video compression: Introduction, Audio compression: DPCM, ADPCM, APC, LPC, Code-excited LPC, Perceptual coding, MPEG audio coders, Dolby audio coders, Video compression: Video compression principles, Video compression standards – H.261, H.263 and MPEG. **Text Book 1: Chapter 4 - 4.1 to 4.3(4.3.1 to 4.3.4)**	
Module – 4	**08 Hrs**
Enterprise Networks & The Internet: Introduction, LANs, Ethernet, Token Ring, Bridges, FDDI, IP datagrams, Fragmentation, IP addresses, ARP and RARP, ICMP. **Text Book 1: Chapter 8 – 8.1 to 8.6, Chapter 9 – 9.2 to 9.5,9.7**	
Module – 5	**08 Hrs**
Multimedia Communications Across Networks: Packet Audio/Video in the Network Environment, Video Transport Across Generic Networks, Multimedia Transport Across ATM Networks, Multimedia Across IP Networks, Multimedia Across DSLs. **Text Book 2: Chapter 6 – 6.1 to 6.5**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret the concepts of multimedia communication, networking and its applications.
CO2	Apply digitization techniques to represent different types of media.
CO3	Analyze various compression techniques for text, images, audio and video.
CO4	Outline basic enterprise network concepts, LAN types, IP addressing, and key protocols.
CO5	Examine multimedia concepts and demonstrate media compression using MATLAB/ any open source tools

Text Books	
1	Multimedia Communications - Fred Halsall, Pearson Education, 2001, ISBN - 978813170994
2	Multimedia Communication Systems - K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Pearson education, 2002.

Reference Books	
1	Multimedia: Computing, Communications and Applications - Raif Steinmetz, Klara Nahrstedt, Pearson Education, 2002, ISBN-978817758
2	Fundamentals of Multimedia– Ze-NianLi, MarkSDrew, and JiangchuanLiu, Springer Nature; 2nd edition, 2014.

Skill Development Activities Suggested
Implementation of compression algorithms using MATLAB/any open source tools (Python, Scilab, etc.)

Web links and Video Lectures (e – Resources)	
1	https://www.slideshare.net NPTEL Video Lectures
2	https://archive.nptel.ac.in/courses/117/105/117105083/
3	Multimedia Computing lecture: Communications & Networking – You Tube

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PSO1**	**PSO2**
CO1	2	2										3	
CO2	2	3										2	
CO3	3	3	2	2								2	2
CO4	2	2										2	
CO5	3	3	2	2	3	1	1	1	3	2	2	2	2

Semester: VI						
Artificial Neural Networks						
Course Code	**:**	BEC623B		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Signal Processing, Mathematics, Biology
Knowledge on Fundamental Concepts	Machine learning, Programming
Knowledge on Connected Tools (If any)	Python/C++

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the concepts of ANN and comparison with human brain
CLO2	Acquire knowledge on Generalization and function approximation of ANN architectures
CLO3	Understand reinforced learning sing neural network
CLO4	Acquire knowledge on unsupervised learning on neural network
CLO5	Develop the ability to apply neural network models such as SVMs, RBFs, and SOMs to real-world problems in image classification, signal processing, and data compression

Module – 1	**08 Hrs**
Introduction: Biological Neuron- Artificial Neural Model- Types of activation functions. **Architecture:** Basics of Linear Algebra, Probability & Optimization, Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks. **Learning:** Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNs, Perceptron Learning Algorithm, Perceptron Convergence Theorem. .	
Module – 2	**08 Hrs**
Supervised Learning: Perceptron learning and Non Separable sets, Signal classification using perceptrons, a.-Least Mean Square Learning, Adaptive Filtering in Communication Systems, MSE Error surface, Design and Optimization of Filters, Steepest Descent Search, JL-LMS approximate to gradient descent, Application of LMS to Noise Cancelling, Multi-layered Network Architecture.	
Module – 3	**08 Hrs**
Support Vector Machines and Radial Basis Function: Learning from Examples (features extracted from signals, images, or sensor data), Support Vector Machines, SVM application to Image Classification, Radial Basis Function, Learning in RBFNs, RBF application to face recognition, Signal classification, fault detection.	
Module – 4	**08 Hrs**
Attractor Neural Networks: Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.	

Module – 5	**08 Hrs**
Self-organization Feature Map: Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self organization Feature Maps, SOM for Modulated Signal Classification, SOM for Image Compression, Growing Neural Gas.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.
CO2	Understand the concepts and techniques of neural networks through the study of important neural network models.
CO3	Apply supervised learning techniques like Perceptron and LMS algorithms to signal classification, adaptive filtering, and noise cancellation in communication systems.
CO4	Understand and simulate attractor neural networks like Hopfield and BAM for pattern association, memory recall, and optimization tasks relevant to ECE applications.
CO5	Design and apply Self-Organizing Maps and Vector Quantization for real-world ECE scenarios.

Text Books	
1	Neural Networks A Classroom Approach- Satish Kumar, McGraw Hill Education (India) Pvt. Ltd, Second Edition.

Reference Books	
1	Introduction to Artificial Neural Systems-J.M. Zurada, Jaico Publications 1994.
2	Artificial Neural Networks-B. Yegnanarayana, PHI, New Delhi 1998.
3	Digital Signal Processing: Principles, Algorithms, and Applications – *John G. Proakis & Dimitris G. Manolakis* 2006, 4th Edition
4	Statistical and Adaptive Signal Processing – *Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon* 2005, 1st Edition

Skill Development Activities Suggested
• Quizzes • Assignments • Seminar

Web links and Video Lectures (e – Resources)	
1	https://developers.google.com/machine-learning/crash-course/neural-networks
2	https://www.edx.org/learn/neural-network
3	https://www.coursera.org/courses?query=neural%20networks

CO-P0 Mapping

CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	3				3						2	
CO2	1	2										3	
CO3	1	2		2								2	
CO4		1		3	2							3	
CO5	1		3		2	3		3					3

Semester: VI						
DSP Algorithms and Architecture						
Course Code	**:**	BEC623C		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Signals and system, DSP and DIP
Knowledge on Fundamental Concepts	Basics of Signals, Systems and Images
Knowledge on Connected Tools (If any)	MATLAB, SCi LAB, Simulink and CCS

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the concepts of digital signal processing techniques.
CLO2	Impart knowledge on computational building blocks of DSP processors and its speed issues.
CLO3	Explain the various addressing modes, peripherals, interrupts and pipelining structure of the TMS320C54xx processor.
CLO4	Learn how to interface the external devices to the TMS320C54xx processor in various modes.
CLO5	Understand DSP algorithms and applications with their implementation using TMS320C54xx processor.

Module – 1	**08 Hrs**
Introduction to Digital Signal Processing: Introduction, A Digital Signal – Processing system, Major features of programmable Digital signal processors, The Sampling Process, Discrete Time Sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear Time-Invariant Systems, Digital Filters, Decimation and Interpolation. **Text Book 1:** Chapter 1 Section 1.3, Chapter 2: 2.1 to 2.8	
Module – 2	**08 Hrs**
Architectures for Programmable Digital Signal Processing Devices: Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing. **Text Book 1:** Chapter 4: Section 4.1 to 4.9	
Module – 3	**08 Hrs**
Programmable Digital Signal Processors: Introduction, Commercial Digital Signal-processing Devices, Data Addressing Modes of TMS32OC54XX, Memory Space of TMS32OC54xx Processors, Program Control. Detail Study of TMS320C54X & 54xx Instructions and Programming, On – Chip Peripherals, Interrupts of TMS32OC54XX Processors, Pipeline Operation of TMS32OC54xx Processor. **Text Book 1:** Chapter 5: Section 5.1 to 5.10	
Module – 4	**08 Hrs**
Implementation of Basic DSP Algorithms: Introduction, The Q – notation, FIR Filters, IIR Filters, Interpolation and Decimation Filters (one example in each case). **Implementation of FFT Algorithms:** Introduction, An FFT Algorithm for DFT Computation, Overflow and Scaling, Bit – Reversed Index. Generation & Implementation on the TMS32OC54xx. **Text Book 1:** Chapter 7: Section 7.1 to 7.6 and Chapter 8: 8.1 to 8.6	

Module – 5	08 Hrs
Interfacing Memory and Parallel I/O Peripherals to Programmable DSP Devices: Introduction, Memory Space Organization, External Bus Interfacing Signals. Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O Direct Memory Access (DMA). **Interfacing and Applications of DSP Processors:** Introduction, Synchronous Serial Interface, A CODEC Interface Circuit, DSP Based Bio-telemetry Receiver, A Speech Processing System, An Image Processing System. Chapter 9: Section 9.1 to 9.8, Chapter 10: 10.1 to 10.5 and **Text Book 1:** Chapter 11: 11.1 to 11.5	
Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend the knowledge & concepts of digital signal processing techniques.
CO2	Apply knowledge of various types of addressing modes, interrupts, peripherals and pipelining structure of TMS320C54xx processor.
CO3	Develop assembly language programs to implement FIR, IIR filters and FFT algorithms.
CO4	Analyze interface the external devices to the TMS320C54xx processor in various modes
CO5	Build the Applications on Programmable DSP devices.

Text Books	
1	Digital Signal Processing", Avatar Singh and S Srinivasan, Thomson Learning, 2004.

Reference Books	
1	"Digital Signal Processing: A practical approach", Ifeachor E C, Jervis B. W Pearson-Education, PHI, 2002.
2	"Digital Signal Processors", B Venkataramani and M Bhaskar, TMH, 2nd Ed., 2010.
3	"Architectures for Digital Signal Processing", Peter Pirsch, John Wiley.

Skill Development Activities Suggested
1. Use of Video/Animation to explain functioning of various concepts. 2. Encourage collaborative (Group Learning) Learning in the class. 3. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.

Web links and Video Lectures (e – Resources)	
1	Student support materials, https://imageprocessingplace.com/root_files_V3/students/students.htm
2	NPTEL Course, Introduction to Digital signal Processing & Architecture, https://nptel.ac.in/courses/

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CO1	3	2										2	1
CO2	3	2			2							2	2
CO3	3	2	2	2	2							2	2
CO4	3	2	2	2	2	2		1	1			2	1
CO5	3	2	2		2	2	1	2	2	2	2	3	2

Semester: VI						
ERROR CONTROL CODING						
Course Code	**:**	**BEC623D**		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40L		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Digital Communication
Knowledge on Fundamental Concepts	Different Types of Digital Coding Techniques
Knowledge on Connected Tools (If any)	

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel
CLO2	Apply modern algebra and probability theory for the coding.
CLO3	Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes.
CLO4	Detect and correct errors for different data communication and storage systems.
CLO5	Analyse and implement different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm

Module – 1	**08 Hrs**
Introduction to Algebra: Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2^m) and its basic properties, Computation using Galois Field GF (2^m) Arithmetic, Vector Spaces, Matrices. **Text Book 1: Chapter 2**	
Module – 2	**08 Hrs**
Linear Block Codes: Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block Code, Error-Detecting and Error-Correcting Capabilities of a Block Code, Standard Array and Syndrome Decoding, Probability of an Undetected Error for Linear Codes over a BSC. **Text Book 1: Chapter 3**	
Module – 3	**08 Hrs**
Cyclic Codes: Description of Cyclic Codes, Generator and Parity-Check Matrices of Cyclic Codes, Encoding of Cyclic Codes, Syndrome Computation and Error Detection, Decoding of Cyclic Codes, Cyclic Hamming Codes, Shortened Cyclic Codes **Text Book 1: Chapter 4**	
Module – 4	**08 Hrs**
BCH Codes: Description of the Codes, Decoding of the BCH Codes, Implementation of Galois Field Arithmetic, Implementation of Error Correction, Nonbinary BCH Codes and Reed-Solomon Codes, Weight Distribution and Error Detection of Binary BCH Codes **Text Book 1: Chapter 6**	
Module – 5	**08 Hrs**
Convolutional Codes: Encoding of Convolutional Codes, Structural Properties of Convolutional Codes, State Diagram, State table, State Transition Table, Tree Diagram, trellis diagram, Distance Properties of Convolutional Codes, The Viterbi Algorithm. **Text Book 1: Chapter 10, 11**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the concept of the Groups, Fields, and properties for Arithmetic vector space and Matrices.
CO2	Apply modern algebra and probability theory for the coding.
CO3	Compare Block codes such as Linear Block Codes, Cyclic codes and Convolutional codes. Also detect and correct errors for different data communication and storage systems.
CO4	Analyse different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm.
CO5	Implement a Mini-project to enhance the coding skill / Online Certification course on related area.

Text Books	
1	'Error control coding', Shu Lin and Daniel J. Costello. Jr, Pearson, Prentice Hall, 2nd edition, 2004.
2	Digital Communication systems', Simon Haykin, Wiley India Private. Ltd, ISBN 978-81-265-4231-4, First edition, 2014

Reference Books	
1	'Theory and practice of error control codes', Blahut. R. E, Addison Wesley, 1984
2	'Introduction to Error control coding', Salvatore Gravano, Oxford University Press, 2007
3	'Digital Communications - Fundamentals and Applications', Bernard Sklar, Pearson Education (Asia) Pvt. Ltd., 2nd Edition, 2001

Skill Development Activities Suggested
Online certification courses can be suggested in the related area.

Web links and Video Lectures (e – Resources)	
1	https://archive.nptel.ac.in/courses/117/104/117104121/
2	https://www.youtube.com/watch?v=0lCYkXUOA5Y
3	https://www.youtube.com/watch?v=2_uC9stwBR4
4	https://www.youtube.com/watch?v=M5ZiflJXluQ

CO – PO MAPPING

CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	1	2								2	3
CO2	3	2	1	1							1	3	2
CO3	3	2	2	1							1	2	2
CO4	3	2	2	1	1							3	2
CO5	3	3	3	2	3	1	1	2	1	3	2	3	3

Semester: VI						
Digital Image Processing						
Course Code	**:**	BEC624A		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40L		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Signals and system, DSP
Knowledge on Fundamental Concepts	Basics of Signals, Systems and Images
Knowledge on Connected Tools (If any)	MATLAB, Sci LAB, Simulink, Python

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals of digital image processing.
CLO2	Impart knowledge on image transform used in digital image processing.
CLO3	Understand the image enhancement techniques in spatial domain used in digital image processing.
CLO4	Learn the Color Image Processing and frequency domain enhancement techniques in digital image processing.
CLO5	Understand the image restoration techniques and methods used in digital image processing.

Module – 1	**08 Hrs**
Digital Image Fundamentals: What is Digital Image Processing?, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels. [**Text Book 1:** Chapter 1, Chapter 2: Sections 2.1 to 2.5]	
Module – 2	**08 Hrs**
Image Transforms: Introduction, Two-Dimensional Orthogonal and Unitary Transforms, Properties of Unitary Transforms, Two-Dimensional DFT, cosine Transform, Haar Transform. **Text Book 2:** Chapter 5: Sections 5.1 to 5.3, 5.5, 5.6, 5.9]	
Module – 3	**08 Hrs**
Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. [**Text Book 1:** Chapter 3: Sections 3.2 to 3.6]	
Module – 4	**08 Hrs**
Frequency Domain: Basics of Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters. **Color Image Processing:** Color Fundamentals, Color Models, Pseudo-color Image Processing. [**Text Book 1:** Chapter 4: Sections 4.7 to 4.9 and Chapter 6: Sections 6.1 to 6.3]	
Module – 5	**08 Hrs**
Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing **Restoration**: A model of the Image Degradation/Restoration Process, Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering. [**Text Book 1:** Chapter 5: Sections 5.1, to 5.4.3, 5.7, 5.8, Chapter 9: Sections 9.1 to 9.3]	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain image formation and Analyze the role of human visual system plays in perception of gray and color image data.
CO2	Apply and evaluate various transforms on digital images.
CO3	Analyze various Image Enhancement techniques in Time and frequency domains for Grayscale and color images.
CO4	Interpret image restoration and Morphological process.
CO5	Utilize above knowledge for image Processing in real world using modern tool.

Text Books	
1	Digital Image Processing- Rafael C Gonzalez and Richard E Woods, PHI, 3rd Edition 2010.
2	Fundamentals of Digital Image Processing- A K Jain, PHI Learning Private Limited 2014.

Reference Books	
1	Digital Image Processing- S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2014

Skill Development Activities Suggested
1. Use of Video/Animation to explain functioning of various concepts. 2. Encourage collaborative (Group Learning) Learning in the class. 3. Verilog /VHDL coding for Image manipulation. 4. Simulink models for Image processing.

Web links and Video Lectures (e – Resources)	
1	Image databases, https://imageprocessingplace.com/root_files_V3/image_databases.htm
2	Student support materials, https://imageprocessingplace.com/root_files_V3/students/students.htm
3	NPTEL Course, Introduction to Digital Image Processing, https://nptel.ac.in/courses/117105079
4	Computer Vision and Image Processing, https://nptel.ac.in/courses/108103174
5	Image Processing and Computer Vision – Matlab and Simulink

CO – PO MAPPING

	PO1	**PO2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2									2	3	2
CO2	3	3			2						2	3	2
CO3	3	3			2						2	2	2
CO4	3	3	2		2	1	1	1		1	2	2	2
CO5	3	3	3	2	2	1	1	1	2	2	2	2	1

Semester: VI						
Optical Communication and Networking						
Course Code	**:**	BEC624B		**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Fundamentals of Physics, Electromagnetic Theory, Analog & Digital Communication
Knowledge on Fundamental Concepts	Ray Theory, concepts of pn junction
Knowledge on Connected Tools (If any)	---

Course Learning Objectives: This course will enable the students to	
CLO1	Learn the basic principle of optical fiber communication with different modes of light propagation.
CLO2	Understand the transmission characteristics and losses in optical fiber.
CLO3	Study of optical components and its applications.
CLO4	Describe the working principle of optical amplifiers and receivers.
CLO5	Assimilate the concepts of WDN and optic networks.

Module-1	**08 Hrs**
Introduction to Optical Fibers: Basic elements of Optical Fiber Communication, Evolution of fiber optic Networks, Basic Laws and Definitions of Optics, Optical Fiber Configurations and Modes, Single Mode Fibers, Optical Fiber Materials, Photonic Crystal Fiber Concepts **Text 1: 1.6,1.7,2.2,2.3,2.5.1,2.5.2,2.7,2.8**	
Module-2	**08 Hrs**
Optical Signal Attenuation and Dispersion: Fiber Attenuation: Absorption, Scattering Losses, Bending Loss, Core and Cladding Losses, Dispersion: Origins, Factors contributing to dispersion, Material induced dispersion **Text 1: 3.1,3.2.1, 3.2.3, 3.2.5,** **Optical Fiber Connectors:** Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers. **Text 2: 5.2,5.3,5.4,5.6**	
Module-3	**08 Hrs**
Optical Sources: Semiconductor Energy Bands, Intrinsic and Extrinsic Materials, Principles of LED's: LED Structures, Semiconductor Materials for Light Sources, LED Quantum Efficiency and Output Power, Response time, Laser diodes: Modes, Rate Equation, External Differential Quantum Efficiency, Laser Resonant Frequencies **Photodetection devices:** Operation of Photodiodes, The pin Photodetector, Basics of Avalanche Photodiodes, Comparisons of Photodetectors **Text 1: 4.1.1,4.1.2,4.2,4.3.1,4.3.2,4.3.3,4.3.4.,6.1,6.3**	

Module-4	08 Hrs
Optical Receivers: Basic Receiver Operation, Performance Characteristics of Digital Receivers, Principles of Eye Diagrams, Burst-Mode Receivers, Characteristics of Analog Receivers **Optical Amplifiers:** General Applications of Optical Amplifiers, Semiconductor Optical Amplifier: Amplifier Signal Gain, SOA Bandwidth, Erbium-Doped Fiber Amplifiers: Basics of Fiber Amplifier Pumping, Construction of an EDFA, Optical Signal-To-Noise Ratio (OSNR). **Text 1: 7.1,7.2,7.3,7.4,7.5,11.1,11.2,11.3,11.5.**	

Module-5	08 Hrs
Integrated optics and photonics: Integrated optics and photonics technologies, Planar waveguides, Beam splitters, directional couplers and switches, Modulators **Text 2:11.2,11.3,11.4.1,11.4.2.** **Wavelength Division Multiplexing:** Concepts of WDM, Mach-Zehnder Interferometer Multiplexers, Nonreciprocal Isolators and Circulators, Grating Basics, Fiber grating filters, Dielectric Thin-Film Filters. **Text 1: 10.1,10.2.5,10.3,10.4.1,10.4.2,10.5.**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret the fundamental laws and propagation modes for optical fibers.
CO2	Apply the principles of signal attenuation to determine various loss in optical fibers and connectors.
CO3	Analyze the performance of optical sources, and detectors used in fiber optic communication systems.
CO4	Summarize the role of optical amplifiers and photonics to improve signal performance in optical communication systems.
CO5	Infer the concepts of Wavelength Division Multiplexing to enhance the capacity of optical fiber.

Text Books	
1	Gred Keiser, "Fiber Optic Communication", Springer 2021,1st Edition, ISBN-9789813346642
2	John M Senior, Optical Fiber Communications, Principles and Practice, 3rd Edition, Pearson Education, 2010, ISBN:9788131732663

Reference Books	
1	Rajiv Ramaswami, "Optical Networks", Second Edition, Elsevier, 2004
2	J. Gower, "Optical Communication Systems", Prentice Hall of India, 2001
3	Govind P. Agrawal, "Fiber-optic Communication Systems", Third Edition, John Wiley & Sons, 2004.

Web links and Video Lectures (e-Resources)	
1	https://archive.nptel.ac.in/courses/108/106/108106167/
2	https://doi.org/10.1007/978-981-33-4665-9

CO – PO MAPPING

CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2										3	
CO2	3	3	2	2								3	
CO3	3	3	2	2								3	
CO4	3	3	2								2		2
CO5	3	2	2										3

Semester: VI						
Operation Research						
Course Code	**:**	BEC624C		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Basic mathematics
Knowledge on Fundamental Concepts	Calculus, linear algebra, and probability & statistics
Knowledge on Connected Tools (If any)	Python

Course Learning Objectives: This course will enable the students to	
CLO1	Gain comprehensive knowledge of OR principles, including linear programming, transportation models, assignment problems, and network analysis.
CLO2	Develop the ability to mathematically model complex decision-making scenarios using optimization and simulation techniques.
CLO3	Infer methods like simplex algorithm, dynamic programming, queuing theory, and inventory models.
CLO4	Become proficient in OR software to efficiently solve and visualize OR problems.
CLO5	Critically assess how OR-based decisions influence economic, environmental, and social systems, aligning with goals like sustainability and ethical responsibility

Module – 1
OR fundamentals: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables). **Text Book1**- Chapter 1:1-1.6
Module – 2
LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method **Text Book1**- Chapter 2:2.1-2.4
Module – 3
Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem. **Text Book1**-Chapter 3:3.1-3.5
Module – 4
Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems. **Text Book2**-Chapter 2:2.1-2.4

Module – 5
Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games. **Text Book2**- Chapter 6:6.1-6.3

Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret the role of optimization models in decision-making across business and engineering domains.
CO2	Solve real-world problems using quantitative techniques such as simplex method, transportation and assignment models.
CO3	Construct complex systems and operations problems using simulation, queuing theory, and decision trees.
CO4	Critically assess solution strategies and trade-offs to ensure optimal and sustainable outcomes.
CO5	Design new models and strategies for operational efficiency using tools and case-based learning.

Text Books	
1	Operations Research, Theory and Applications, K Sharma, Sixth Edition,2017,Trinity Press, Laxmi Publications Pvt. Ltd, ISBN:9385935143
2	Operations Research, An Introduction, Hamdy A. Taha ,Seventh Edition, 2006, PHI Private Limited, ISBN: 0130488089

Reference Books	
1	Operations Research, A M Natarajan, P Balasubramani, 2005,Pearson Education,ISBN: 9332526478
2	Operations Research, P K Gupta and D S Hira, 2007, S. Chand and Company LTD. Publications, New Delhi ,ISBN: 9788121902816

Skill Development Activities Suggested
• Quizzes • Numerical problems

Web links and Video Lectures (e – Resources)	
1	https://or.du.ac.in/or
2	https://www.coursera.org/courses?query=operations%20research

CO-PO mapping

CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**
CO1	3	3	2							1	1	3	2
CO2	3	3	2	1	3			1	2	2	2	3	2
CO3	3	3	2	2	2	2	2	-	2	2	1	2	2
CO4	3	3	3	2	2	3	3	2	2	2	2	2	2
CO5	2	2	3	2	3	2	3	2	2	2	3	2	2

Semester: VI						
Introduction to Deep Learning						
Course Code	**:**	BEC624D		**Credits**	**:**	3
Hours/Week (L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Introduction to AI, Introduction to ML
Knowledge on Fundamental Concepts	Knowledge of Linear Algebra, DSP, PDE
Knowledge on Connected Tools (If any)	Jupyter Notebook or any equivalent Python development environment

Course Learning Objectives: This course will enable the students to	
CLO1	Gain insights into the evolution of AI and the growing need for deep learning in various domains.
CLO2	Develop knowledge of fundamental deep learning concepts, including neural network structures and training processes
CLO3	Build deep learning models with popular frameworks and libraries
CLO4	Apply deep learning models like CNNs, RNNs and GANs to real-world problems
CLO5	Equip students with the skills to design and implement real-world applications using suitable deep learning architectures

Module – 1	**08 Hrs**
Machine Learning Basics Learning algorithms: regression - classification - clustering, under fitting and Overfitting, Hyper parameters and validation sets, Estimators, bias and variance, Maximum likelihood estimation, Supervised and Unsupervised learning algorithms, Building a Machine learning algorithm. **Text Book1:** Chapter 5.1 to 5.11	
Module – 2	**08 Hrs**
Foundations of Deep Networks Neural networks: Perceptron - Multilayer Feedforward Networks - Backpropagation learning, Activation functions: Linear - sigmoid - rectified linear and softmax, Loss functions, regularization, Deep networks: Architecture and design, Pretrained Networks - Deep Belief Networks(DBNs) - Generative Adversarial Networks(GANs). Text Book1: Chapter 6.1 to 6.6 ,7.1,7.5,7.6,15.2,20.2,20.10	
Module – 3	**08 Hrs**
Convolutional Neural Networks (CNNs) Convolutional Operation, Motivation, Pooling layers, Fully connected layers, A complete CNN architecture: AlexNet - VGG - Inception - ResNet, Training a Convnet: weights initialization - batch normalization - hyperparameter optimization, Variants of CNN architecture. **Text Book1:** Chapter 9.1,9.2,9.3,9.4,9.5	
Module – 4	**08 Hrs**
Sequence Modeling Using Recurrent Nets Recurrent Neural Networks (RNN), Bidirectional RNNs, Deep RNNs, Recursive NN, Challenge of long-term dependencies, Long Short- Term Memory (LSTM) and other Gated RNNs. **Text Book1:** Chapter 10.2,10.3,10.5,10.6,10.7,10.10	
Module – 5	**08 Hrs**
Applications of Deep Learning Case studies (one in each) in Computer Vision, Speech Processing, Natural Language Processing. **Text Book1:** Chapter 12.2,12.3,12.4	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the fundamentals principles, theory and approaches for learning with deep neural networks.
CO2	Interpret the architecture and key concepts of deep neural networks and common models like DBNs and GANs.
CO3	Apply the principles of Convolutional Neural Networks to design and train models using architectures like AlexNet, VGG, and ResNet.
CO4	Analyze the behavior and performance of recurrent architectures like RNNs and LSTMs in processing sequential data.
CO5	Design and develop real-world applications using deep learning network architectures.

Text Books	
1	Ian Goodfellow, Yoshua Benjio & Aaron Courville, Deep Learning, MIT Press, 2016
2	Josh Patterson & Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017.
3	Francois Chollet, "Deep Learning with Python", Manning Publications, 1st Edition, Manning Publications, 2017.

Reference Books	
1	Jake VanderPlas, "Python Data Science Handbook", O'Reilly Publications, 2016-17.
2	Richard O. Duda, Peter E. Hart and David G. Stork, Pattern Classification, John Wiley & Sons Inc.

Web links and Video Lectures (e – Resources)	
1	Deep Learning https://onlinecourses.nptel.ac.in/noc25_ee16
2	Deep Learning https://onlinecourses.nptel.ac.in/noc25_cs21
3	Machine Learning & Deep Learning – Fundamentals & Applications https://onlinecourses.nptel.ac.in/noc25_ee181
4	https://www.simplilearn.com/artificial-intelligence-masters-program-training-course
5	https://www.pdfdrive.com/machine-learning-with-python-cookbook-practical-solutions-from-preprocessing-to-deep-learning-d176361144.html
6	http://www.deeplearningbook.org

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2											2	
CO2	2	1										2	
CO3	3	3	2								2	3	
CO4	3	3	3	2							2	3	
CO5	3	3	3	3	3	2	2	3	3	2	3	3	3

Semester: VI						
Digital System Design using Verilog						
Course Code	**:**	**BEC645A**		**Credits**	**:**	3
Hours/Week (L: T:P)	**:**	3:0:0		**CIE**	**:**	50Marks
Total Hours	**:**	40L		**SEE**	**:**	50Marks
Course Type	**:**	Elective		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Basic Electronics, Digital Electronics and Verilog HDL
Knowledge on Fundamental Concepts	Fundamental concept of Logic Gates, Boolean Algebra, Digital Circuits Design and Verilog HDL
Knowledge on Connected Tools (If any)	Xilinx ISE

Course Learning Objectives: This course will enable the students to	
CLO1	To impart the concepts of different Verilog HDL constructs.
CLO2	To impart the concepts of familiarizing the different levels of abstraction in Verilog.
CLO3	To impart the understanding of the concept of Verilog Tasks and Functions.
CLO4	To impart the concepts of Verilog HDL Timing and Delay Simulation.
CLO5	Interpret the various constructs in logic synthesis of digital circuits

Module – 1	**08Hrs**
Overview of Digital Design with Verilog HDL: Evolution of Computer-Aided Digital Design (CAD), Emergence of HDLs, Typical Design flow, Importance of HDLs, Popularity of Verilog HDL, Trends in HDLs. **Hierarchical Modeling Concepts**: Design Methodologies, Top-down and Bottom-up design methodology, Modules, Instances, Components of a Simulation, Design Block, Stimulus Block (Test Bench) with example. **Text Book 1:** 1.1 to 1.6, 2.1 to 2.6	
Module – 2	**08Hrs**
Basic Concepts: Lexical Conventions, Data Types, System Tasks, Compiler Directives. (Text 1: 3.1 to 3.3) Modules and Ports: Modules, Ports, Connecting Ports, Hierarchical Names. **Text Book 1:** 4.1 to 4.3	
Module – 3	**08 Hrs**
Gate-Level Modeling: Gate Types-Modeling using basic Verilog gate primitives, Description of AND/OR and BUF/NOT type gates. Gate Delays-Rise, Fall and Turn-Off Delays, Min, Max and Typical Delays. **Dataflow Modeling**: Continuous assignments, Delay Specification, Expressions, Operators, Operands, Operator Types, Examples **Text Book 1:** 5.1, 5.2, 6.1 to 6.5	
Module – 4	**08 Hrs**
Behavioral Description: Structured Procedures, Initial and Always statements, Procedural Assignments Blocking and Non-Blocking statements, Conditional statements, Multiway Branching, Loops, Sequential and Parallel blocks, Examples-4-to-1 Multiplexer, 4-bit Counter. **Text Book 1:** 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.9.1, 7.9.2	

Module – 5	08 Hrs
Structural Description: Highlights of Structural Descriptions, Organization of Structural Description, Binding **Tasks and Functions**: Differences between Tasks and Functions, Declaration and Invocation, Examples **Text Book 2:** 4.1, 4.2, 4.3, Listings 4.1 to 4.13 only Verilog **Text Book 1:** 8.1, 8.2.1, 8.2.2, 8.3, 8.3.1, 8.3.2	
Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the knowledge of design methodologies to various digital circuits
CO2	Analyze the various levels of abstractions on digital sub systems using HDL
CO3	Interpret the given case study material related to design and demonstrate an of Digital sub system.
CO4	Model Combinational and sequential circuits using Verilog.
CO5	Develop a digital circuit using modern Simulation tool.

Text books	
1	Verilog HDL: A Guide to Digital Design and Synthesis", Samir Palnitkar, Pearson education, Second edition, 2017.
2	HDL programming (VHDL and Verilog)", Nazeih M Botros, John Wiley India Pvt. Ltd., 2nd edition 2015.
Reference Books	
1	Donald E. Thomas, Philip R. Moorby, "The Verilog Hardware Description Language", Springer Science Business Media, LLC, Fifth edition,2014.
2	Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL" Pearson (Prentice Hall), Second edition, 2011.
3	Padmanabhan, Tripura Sundari, "Design through Verilog HDL", Wiley, 2016.

Skill Development Activities Suggested
• Project Based Learning. • Hands-on Learning using Free and Open-Source simulation Tools

Web links and Video Lectures (E – Resources)	
1	https://onlinecourses.nptel.ac.in/noc24_cs61
2	https://www.udemy.com/course/verilog-hdl-fundamentals-for-digital-design-and-verification/

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2									1	2	-
CO2	3	2	2								1	3	-
CO3	3	3	2								1	3	-
CO4	2		3		3						1	3	2
CO5	2	2	3	1	3	1	1	2	2	2	1	3	2

Semester: VI						
CONSUMER ELECTRONICS						
Course Code	**:**	**BEC645B**		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	OEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Electronic Instrumentation
Knowledge on Fundamental Concepts	Transducers, DAC
Knowledge on Connected Tools (If any)	

Course Learning Objectives: This course will enable the students to	
CLO1	To understand the working principles and classifications of various microphones and loudspeakers.
CLO2	To understand the working principles and classifications of various audio systems and their roles in audio systems.
CLO3	To explore the structure, recording, and playback processes of Audio Compact Disc systems, along with error correction techniques and digital-to-analog conversion.
CLO4	To analyse the fundamentals of colour television systems, including the transmission of colour signals, and to study recent advances in television technology.
CLO5	To gain knowledge of modern consumer electronic devices such as mobile phones, home appliances, and computers, focusing on their applications and technological advancements.

Module – 1	**08 Hrs**
Microphones: Introduction, Requirements, Quality of Microphones, Classification, Moving Coil Microphone, Ribbon Microphone, Condenser (or Capacitor) Microphone, Crystal Microphone, Carbon Microphone, Electret Microphone. **Loudspeakers:** Introduction, Features of Loudspeaker, Moving Coil (Cone Type) Loudspeaker, Electrodynamic Loudspeaker, Horn Loudspeaker, Loudspeaker for High Fidelity Systems. **(Text Book 1 : Chapter 5 and Chapter 6)**	
Module – 2	**08 Hrs**
Audio Compact Disc Systems: Introduction, Comparison of CD and Tape, Optical Recording, Details of a Compact Disc, Details of Recording Process, Details of playback Process, Geometry of Audio Disc, Encoding Process and Error Correction, D/A Convertor, Handling of Compact Disc. **(Text Book 1 : Chapter 10)**	

Module – 3	**08 Hrs**
Colour Television: Introduction, Light Energy, Primary Colours, Tristimulus Values, Trichromatic Coefficients, Colour Triangle, Mixing of Colours, Grassman's Law, Colour Specifications, Bandwidth for Colour Signal Transmission. Chromaticity Diagram, Spectral and Non-Spectral Colours, Colour Circle, Visibility Curve, Digital Television (DTV) and High Definition Television (HDTV), Recent Advances in TV technology, LCD TV, LED TV, Plasma TV **(Text Book 1 : Chapter 14)**	
Module – 4	**08 Hrs**
Cable Television: Introduction, Video Monitor, Closed Circuit Television (CCTV), Cable Television, Cable TV Using Internet. **Miscellaneous Devices:** Digital Watch, Calculator, An Electronic Guessing Game, Cordless Telephone. **(Text Book 1 : Chapter 15 and Chapter 17)**	
Module – 5	**08 Hrs**
Advances in Consumer Electronics: Mobile Telephone, Cellular Telephone, UPS, Inverter, Decorative Lighting, Remote Control for TV and VCR, Facsimile (FAX), Pager, Microwave Oven, LCD Timer with Alarm, Electronic Ignition System for Automobiles, Washing Machine, Organisation of Digital computer, Microprocessor, Note Book, Laptop, Tablet PC, Ultrabook, IPAD, Recent Advances in Consumer Electronics. **(Text Book 1 : Chapter 17)**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the functioning and classification of various types of microphones and loudspeakers.
CO2	Demonstrate knowledge of the optical recording and playback processes in audio compact disc systems.
CO3	Analyse the principles of colour television and modern display technologies.
CO4	Evaluate the working of cable television systems and miscellaneous consumer devices.
CO5	Explore advancements in consumer electronics, such as mobile phones, computing devices, and home appliances.

Text Books	
1	B.R. Gupta, V. Singhal "Consumer Electronics", S.K. Kataria & Sons, 6th edition, 2013, ISBN 978-93- 5014-407-7.

Reference Books	
1	R.P.Bali, Consumer Electronics, Pearson Education (2008).

Skill Development Activities Suggested

1. Troubleshoot the common consumer electronics products like T.V., Washing machine, microwave oven, FAX, Copier machine.
2. Conduct market survey for latest home appliances and compare specifications of reputed brands and prepare a report
3. Make visit to service centers of gadgets covered in curriculum and if possible work there for some days on voluntarily basis during holidays.
4. Search internet websites for DYS (Do Your Self) repair of electronic gadgets and try your hands to repair some gadgets based on that.

Web links and Video Lectures (e – Resources)	
1	Android Mobile Application Development: https://onlinecourses.swayam2.ac.in/nou24_ge66/preview
2	Microelectronics: Devices to Circuits: https://onlinecourses.nptel.ac.in/noc24_ee139/preview

CO – PO MAPPING

CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2					2	2				3	3	2
CO2	2	1	1			1	2				1	3	2
CO3	3	2	1	1		1				1	1	3	2
CO4	3	2					1			2	3	3	2
CO5		2	1				1		1		3	3	2

Semester: VI					
ELECTRONIC COMMUNICATION SYSTEM					
Course Code	**:**	BEC645C	**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40L	**SEE**	**:**	50 Marks
Course Type	**:**	OEC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Basics of semiconductor devices and applications, like diode, transistors
Knowledge on Fundamental Concepts	Signal representation, operation of semiconductor devices
Knowledge on Connected Tools	Matlab/Multisim

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the amplitude and frequency modulation techniques and perform time and frequency domain transformations.
CLO2	Learn the concepts of amplitude and frequency modulation and demodulation of analog signals and compare the performance.
CLO3	Characterize the influence of channel noise on analog modulated signals.
CLO4	Understand the characteristics of pulse amplitude modulation, pulse position modulation and pulse code modulation systems.
CLO5	Gain the Knowledge of various digital modulation techniques.

Module – 1	**08 Hrs**
AMPLITUDE MODULATION: Introduction, Amplitude Modulation: Time & Frequency – Domain description, Switching modulator, Envelop detector. DOUBLE SIDE BAND-**SUPPRESSED CARRIER MODULATION:** Time and Frequency – Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing. SINGLE **SIDE–BAND AND VESTIGIAL-SIDEBAND METHODS OF MODULATION:** SSB Modulation, VSB Modulation, Frequency Translation, Frequency- Division Multiplexing, **Text Book 1:** Chapter 3.	
Module – 2	**08 Hrs**
ANGLE MODULATION: Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, Phase–Locked Loop: Nonlinear & Linear model of PLL. The Super heterodyne Receiver **Text Book 1:** Chapter 4	
Module – 3	**08 Hrs**
NOISE: Shot Noise, Thermal noise, White Noise, Noise Equivalent Bandwidth. **NOISE IN ANALOG MODULATION**: Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasis in FM **Text Book 1:** Chapter 6	

Module – 4	08 Hrs
DIGITAL REPRESENTATION OF ANALOG SIGNALS: Introduction, Why Digitize Analog Sources?, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, The Quantization Process, Quantization Noise, Pulse–Code Modulation: Sampling, Quantization, Encoding, Regeneration, **Text Book 1:** Chapter 7	

Module – 5	08 Hrs
DIGITAL COMMUNICATION TECHNIQUES: Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)–Phase Shift Keying (PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System **Text Book 1:** Chapter 8	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the schemes of amplitude modulation and demodulation of analog and compare its performance.
CO2	Analyze various FM Modulation Techniques for Transceiver
CO3	Characterize the influence of channel noise on analog modulated signals.
CO4	Representation of an analog signal in digital form using various techniques.
CO5	Demonstrate generation and detection of Analog and Digital modulation techniques using modern tools.

Text Books	
1	Simon Haykins & Moher, Communication Systems, 5th Edition, John Wiley, India Pvt. Ltd, 2010, ISBN 978 – 81 – 265 – 2151 – 7.

Reference Books	
1	Modern Digital and Analog Communication Systems, B. P. Lathi, Oxford University Press., 4th edition
2	An Introduction to Analog and Digital Communication, Simon Haykins, John Wiley India Pvt. Ltd., 2008, ISBN 978–81–265–3653–5.
3	Principles of Communication Systems, H.Taub & D.L.Schilling, TMH, 2011.
4	Communication Systems, Harold P.E, Stern Samy and A.Mahmond, Pearson Edition, 2004.

Web links and Video Lectures (e – Resources)	
1	https://web.stanford.edu/class/ee179/Notes.html
2	https://www.skylineuniversity.ac.ae/pdf/computer/An%20Introduction%20to%20Digital%20Multimedia.pdf

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1							2	1	2	1
CO2	3	2	1							1	1	2	1
CO3	3	3	2							1	1	2	1
CO4	3	2	2	2	2					2	1	2	1
CO5	3	2	2	2	3	1	1	2	2	3	1	1	3

Semester: VI						
Basic VLSI Design						
Course Code	**:**	**BEC645D**		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50Marks
Total Hours	**:**	40L		**SEE**	**:**	50Marks
Course Type	**:**	Elective		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Logic Design, Basic Electronics
Knowledge on Fundamental Concepts	MOSFET Operation, Implementation of Boolean Expression
Knowledge on Connected Tools (If any)	

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals of VLSI design – including digital IC design flow and CMOS technology.
CLO2	Infer the fabrication processes and layout design rules.
CLO3	Illustrate the CMOS inverter behavior and combinational/sequential logic circuit design.
CLO4	Demonstrate VLSI design tools and methodologies (HDL-based simulation, synthesis, and layout).
CLO5	Explore the knowledge of VLSI Design flow and Testing

Module – 1	**08 Hrs**
Introduction: A Brief History, MOS Transistors, CMOS Logic (1.1 to 1.4 of TEXT1) **MOS Transistor Theory:** Introduction, Long-channel I-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics **Text Book 1:** 2.1, 2.2, 2.4 and 2.5.	
Module – 2	**08 Hrs**
Fabrication: CMOS Fabrication and Layout, Introduction, CMOS Technologies, Layout Design Rules, **Text Book 1:** 1.5 and 3.1 to 3.3.	
Module – 3	**08 Hrs**
CMOS Circuit and Logic Design: Introduction, CMOS Logic structures, CMOS Complementary logic, Pseudo n-MOS logic, Dynamic CMOS logic, Clocked CMOS Logic, Cascade Voltage Switch logic, Pass transistor Logic, Electrical and Physical design of Logic gates, The inverter, NAND and NOR gates, Body effect, Physical Layout of Logic gates, Input output Pads. **Text Book 2:** 5.1,5.2,5.2.1, , 5.2.2, 5.2.3, 5.2.4, 5.2.6, 5.2.8, 5.3,5.3.1,5.3.2, 5.3.4 ,5.3.8,5.5	

Module – 4	**08 Hrs**
Subsystem Design: Some Architectural Issues, Switch Logic, Gate (restoring) Logic, Parity Generators, Multiplexers, The Programmable Logic Array (PLA) **FPGA Based Systems**: Introduction, Basic concepts, Digital design and FPGAs, FPGA based System design, FPGA architecture, Physical design for FPGAs **Text Book 4:** 1.1 to 1.4, 3.2, 4.8 and 6.1 to 6.3, 6.4.1, 6.4.3, 6.4.6.	
Module – 5	**08 Hrs**
Faults in digital circuits: Failures and faults, Modeling of faults, Temporary faults **Test generation for combinational logic circuits**: Fault diagnosis of digital circuits, test generation techniques for combinational circuits, Detection of multiple faults in combinational logic circuits. (1.1 to 1.3, 2.1 to 2.3 of TEXT3) **Test generation for sequential circuits**: Testing of sequential circuits as iterative combinational circuits, state table verification, test generation based on circuit's structure, functional fault models, and test generation based on functional fault models. (4.1 to 4.5, 5.1 to 5.7 of TEXT3)	
Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the fundamentals of semiconductor physics in MOS transistors.
CO2	Draw the basic gates using the stick and layout diagrams with the knowledge of physical design aspects.
CO3	Infer the subsystem design and FPGA based system.
CO4	Design and realize combinational and sequential digital circuits in CMOS logic.
CO5	Engage students to enhance their VLSI knowledge by participating in relevant online learning programs.

Text Books	
1	"CMOS VLSI Design- A Circuits and Systems Perspective", Neil H E Weste, and David Money Harris 4th Edition, Pearson Education.
2.	Principals of CMOS VLSI Design A System approach Neil H E Weste and Kamran Eshraghain . Addition Wisley Publishing company..
3.	"Digital Circuit Testing and Testability", Lala Parag K, New York, Academic Press, 1997.
4.	"FPGA Based System Design", Wayne Wolf, Pearson Education, 2004, Technology and Engineering.

Reference Books	
1	Douglas A Pucknell & Kamran Eshragian, ''Basic VLSIDesign'', PHI 3rd Edition, (original Edition- 1994).
2	BehzadRazavi, ''Design of Analog CMOS Integrated Circuits'', TMH, 2007.

Skill Development Activities Suggested
QUIZ, Free Open-SourceSimulation (LTSPICE, Logisim,QUCS), Industry Expert talk, Case studies on Modern Technology, Project Based Learning

Web links and Video Lectures (e – Resources)	
1	https://archive.nptel.ac.in/courses/117/101/117101058/
2	https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ee09/
3	https://youtube.com/playlist?list=PL018645397D9487AF&feature=shared
4	https://ocw.mit.edu/courses/6-374-analysis-and-design-of-digital-integrated-circuits-fall-2003/
5	https://ocw.mit.edu/courses/6-111-introductory-digital-systems-laboratory-spring-2006/resources/l15_vlsi_print/
6	https://pages.hmc.edu/harris/cmosvlsi/4e/index.html
7	https://cmosedu.com/

CO – PO MAPPING

CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2											2	1
CO2	3	2	1									3	1
CO3		3	2									3	1
CO4	2	1										2	2
CO5	3	2	3	2	3			2		2	1	2	3

Semester: VI						
VLSI DESIGN AND TESTING LAB						
Course Code	**:**	BECL607		**Credits**	**:**	1
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	12 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Digital electronics, HDL, Basic electronics
Knowledge on Fundamental Concepts	Verilog/VHDL Language, MOSFET
Knowledge on Connected Tools (If any)	**CADENCE, Xilinx, LTSPICE/Magic**

Course Learning Objectives: This course will enable the students to	
CLO1	Design, model, simulate and verify digital circuits.
CLO2	Perform ASIC design flow and understand the process of synthesis, synthesis constraints and evaluating the synthesis reports to obtain optimum gate level netlist
CLO3	Perform RTL-GDSII flow and understand the ASIC Design flow.

List of Experiments	
1	Design a 4-Bit Adder • Write a Verilog description • Verify the Functionality using Test-bench • Synthesize the design by setting proper constraints and generate the gate level netlist. From the report generated identify Critical path, Maximum delay, Total number of cells, Power requirement and Total area required
2	4-Bit Shift and add Multiplier • Write Verilog Code • Verify the Functionality using Test-bench • Synthesize the design by setting proper constraints and obtain the gate level netlist. From the report generated identify Critical path, Maximum delay, Total number of cells, Power requirement and Total area required
3	32-Bit ALU Supporting 4-Logical and 4-Arithmetic operations, using case and if statement for ALU Behavioral Modeling • Write Verilog description • Verify functionality using Test-bench • Synthesize the design targeting suitable library and by setting area and timing constraints • Tabulate the Area, Power and Delay for the Synthesized netlist • Identify Critical path
4	Flip-Flops (D,SR and JK) • Write the Verilog description • Verify the Functionality using Test-bench • Synthesize the design by setting proper constraints and obtain the gate level netlist. From the report gate level netlist identify Critical path, Maximum delay, Total number of cells, Power requirement and Total area required. • Verify the functionality using Gate level netlist and compare the results at RTL and gate level netlist

5	Four bit Synchronous MOD-N counter with Asynchronous reset • Write Verilog Code • Verify functionality using Test-bench • Synthesize the design targeting suitable library and by setting area and timing constraints • Tabulate the Area, Power and Delay for the Synthesized netlist Identify Critical path • Verify the functionality using Gate level netlist and compare the results at RTL and gate level netlist.
6	a) Construct the schematic of CMOS inverter with load capacitance of 0.1pF and set the widths of inverter with Wn = Wp, Wn = 2Wp, Wn = Wp/2 and length at selected technology. Carry out the following: i. Set the input signal to a pulse with rise time, fall time of 1ns and pulse width of 10ns and the time period of 20ns and plot the input voltage and output voltage of designed inverter? ii. From the simulation result compute tpHL, tpLH and td for all three geometrical settings of width? iii. Tabulate the results of delay and find the best geometry for minimum delay for CMOS inverter. b) Draw layout of inverter with Wp/Wn = 40/20, use optimum layout methods. Verify for DRC and LVS, extract parasitic and perform post layout simulations, compare the results with pre layout simulations and compare the results.
7	Capture the schematic of 2-input CMOS NOR gate having similar delay as that of CMOS inverter computed in experiment above. Verify the functionality of NOR gate and also find out the delay td for all four possible combinations of input vectors. Table the results. Increase the drive strength to 2X and 4X and tabulate the results.
8	Design and characterize 6T binary SRAM cell and measure the following: • Read Time, Write Time, SNM, Power • Draw Layout of 6T SRAM, use optimum layout methods. Verify for DRC & LVS, extract parasitic and perform post layout simulations, compare the results with pre-layout simulations. Record the observations.
9	a) Construct the schematic of Common Source Amplifier with PMOS Current Mirror Load and find its transient response and AC response? Measure the Unit Gain Bandwidth (UGB), amplification factor by varying transistor geometries, study the impact of variation in width to UGB. b) Draw Layout of common source amplifier, use optimum layout methods. Verify for DRC & LVS, extract parasitic and perform post layout simulations, compare the results with prelayout simulations. Record the observations.
10	a) Construct the schematic of two-stage operational amplifier and measure the following:i. Unity gain Bandwidth ii. dB Bandwidth iii. Gain Margin and phase margin with and without coupling capacitance iv. Use the op-amp in the inverting and non-inverting configuration and verify its functionality. v. Study the UGB, 3dB bandwidth, gain and power requirement in op-amp by varying the stage wise transistor geometries and record the observations. b) Draw layout of two-stage operational amplifier with minimum transistor width set to 300 (in 180/90/45 nm technology), choose appropriate transistor geometries as per the results obtained in part a. Use optimum layout methods. Verify for DRC and LVS, xtractparasitic and perform post layout simulations, compare the results with pre-layout simulations and perform the comparative analysis.

Demonstration Experiments (For CIE)	
11	UART • Write Verilog description • Verify the Functionality using Test-bench • Synthesize the design targeting suitable library and by setting area and timing constraints • Tabulate the Area, Power and Delay for the Synthesized netlist, Identify Critical path
12	Construct the schematic of the Boolean Expression Y= AB+CD+E using CMOS Logic. Verify the functionality of the expression find out the delay td for some combination of input vectors. Tabulate the results.
Course Outcomes: After completing the course, the students will be able to	
CO1	Design and simulate combinational and sequential digital circuits using Verilog HDL.
CO2	Understand the synthesis process of digital circuits using EDA tool.
CO3	Perform ASIC design flow and understand the process of synthesis, synthesis constraints and evaluating the synthesis reports to obtain optimum gate level netlist.
CO4	Design and simulate basic CMOS circuits like inverter, NOR gate and any Boolean expression,
CO5	Perform RTL_GDSII flow and understand the stages in ASIC design.

Text Books	
1	Principals of CMOS VLSI Design A System approach Neil H E Weste and Kamran Eshraghain . Addition Wisley Publishing company
2	CMOS Digital Integrated Circuits: Analysis and Design", Sung Mo Kang & Yosuf Leblebici, Third Edition, Tata McGraw-Hill

Reference Books	
1	"CMOS VLSI Design- A Circuits and Systems Perspective", Neil H E Weste, and David Money Harris 4th Edition, Pearson Education.
2	"Basic VLSI Design", Douglas A Pucknell, Kamran Eshraghian, 3rd Edition, Prentice Hall of India publication, 2005.

Skill Development Activities Suggested
Project-based learning

CO – PO MAPPING

CO-PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PSO 1	PSO 2
CO1	2	1	2	1	3							2	2
CO2	3	2	1	1	3							3	2
CO3	2	3	2	1	3							3	2
CO4	2	1	2	1	3							2	2
CO5	2	1	2	1	3							2	2

Semester: VI						
Competency Enhancement Course-4						
Course Code	**:**	BCE608		**Credits**	**:**	0
Hours/Week(L:T:P)	**:**	2:0:0		**CIE**	**:**	100 Marks
Total Hours	**:**	40		**SEE**	**:**	-
Course Type	**:**	NCMC		**SEE Duration**	**:**	-

Prerequisites:	
Courses	Competency Enhancement Course 3, Fundamentals of Data Structures & Algorithms
Knowledge on Fundamental Concepts	Complexity analysis, competitive programming paradigms, and algorithmic problem solving
Knowledge on Connected Tools	NA

Course Learning Objectives: This course will enable the students to	
CLO1	Understand and apply fundamental data structures.
CLO2	Analyze and design algorithms using various paradigms.
CLO3	Evaluate the time and space complexity of algorithms using asymptotic notations.
CLO4	Develop problem-solving strategies for competitive programming.
CLO5	Apply algorithmic thinking in real-world applications through hands-on coding labs, group exercises, and simulations.

Module – 1	**8 Hrs**
Data Structures Overview of Data Structures, Searching and Sorting Algorithms, Stack, Queue, Linked, List, Trees, Graphs **Textbook-1, Ch1-15**	
Module – 2	**8 Hrs**
Algorithms Analysis of Algorithms, Pattern Matching, Bit Algorithms, Mathematical Algorithms, Randomized Algorithms, Dynamic Programming, Backtracking Algorithms, Greedy Algorithms, Sliding Window Approach **Textbook -2, Ch8-13**	
Module-3	**8 Hrs**
Time Complexity Big O Notation, Omega Notation, Theta Notation, Best, Worst, and Average Case Analysis, Asymptotic Analysis, Amortized Analysis, Time Complexity of Common Algorithms, Sorting (e.g., QuickSort, MergeSort), Searching (e.g., Binary Search), Graph Algorithms (e.g., BFS, DFS), Space Complexity Basics **Textbook -3, Ch1-6**	
Module-4	**8 Hrs**
Foundation of Competitive Coding Importance of Competitive Coding for interviews and placements, Problem decomposition & edge case identification, Basics of time and space complexity, Story-based introduction to problem-solving, Brainstorm real-world scenarios & translate to problems, Identify edge cases via mini-quizzes, Live walkthroughs (e.g., parking fee	

calculator), Coding warm-up challenge **Textbook -3, Ch7-10**	
Module-5	**8 Hrs**
Data Structures Simplified Arrays, Linked Lists, Stacks, Queues, Hashing, Trees, Graphs, Mapping DS to real-life systems (e.g., ticket booking, social feeds), Trade-offs in DS selection, Implement DS in hands-on coding labs, Real-life simulation: Airline or hospital queue system, Use case discussions, Group exercises with efficiency comparisons **Algorithmic Paradigms & Optimization** Greedy, Divide & Conquer, DP, Backtracking, Practical applications with real-world stories, Efficiency and trade-offs, Debugging complex logic, Group challenge: Route optimization using Dijkstra, Hands-on: Knapsack, Fibonacci DP, Game simulations, Compare multiple approaches for the same problem, Debugging hackathons **R-1, C1-10, 20,21&22**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply fundamental data structures such as arrays, stacks, queues, linked lists, trees and graphs to solve real-life computational problems.
CO2	Analyze and implement algorithmic strategies and backtracking for optimized problem-solving.
CO3	Evaluate the time and space complexity of algorithms using asymptotic notations to ensure computational efficiency.
CO4	Design and implement algorithms for searching, sorting and graph traversal with appropriate time complexity.
CO5	Demonstrate proficiency in competitive coding practices by identifying edge cases, decomposing problems and debugging logical errors.
CO6	Relate data structures and algorithmic techniques to real-world applications and industry use-cases such as routing, scheduling and transaction systems.

Text Books	
1	**The C Programming Language,** Brian W. Kernighan and Dennis M. Ritchie 2nd Edition, Pearson Education India – 2015, (ISBN- 978-9332549449)
2	**Let Us C,** Yashavant Kanetkar, 15th Edition, BPB Publications- 2016, (ISBN-978-8183331630)
3	**Object-Oriented Programming with C++**, E. Balagurusamy, 8th Edition, Tata McGraw-Hill – 2020, (ISBN- 978-9389949186)
4	Data Structures and Algorithms, Narasimha Karumanchi, 2023 Edition (latest available), paperback, CareerMonk Publications, (ISBN: 9788193245279)

Web links and Video Lectures (e – Resources)	
1	https://www.sanfoundry.com/best-reference-books-programming-language-c/?utm_source.com
2	https://studylib.net/doc/27609260/addison-wesley-c-primer-plus-6th-edition-2014?utm_source.com
3	https://books.dwf.dev/docs/c-programming-language/first-edition/types-operators-expressions?utm_source.com
4	https://www.geeksforgeeks.org/types-of-database-management-systems/?utm_source.com
5	https://faculty.kutztown.edu/shim/356CHAPTER%205.pdf?utm_source.com

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2								
CO2	3	3	2								
CO3	3	2		2							
CO4	3	2	3								
CO5		3			1						1
CO6	2		2			1					

Semester: VI						
Indian Knowledge Systems						
Course Code	**:**	**BIK609**		**Credits**	**:**	0
Hours/Week(L:T:P)	**:**	1:0:0		**CIE**	**:**	**100 Marks**
Total Hours	**:**	15		**SEE**	**:**	-
Course Type	**:**	NCMC		**SEE Duration**	**:**	-

Prerequisites:	
Courses	Environmental Studies, Indian Philosophy or Ethics
Knowledge on Fundamental Concepts	Basic understanding of ancient Indian civilization, literature
Knowledge on Connected Tools (If any)	NA

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the foundational concepts of Indian Knowledge Systems (IKS)
CLO2	Explore the contributions of traditional Indian knowledge to various fields in the humanities and sciences
CLO3	Recognize the relevance and applications of traditional knowledge in professional domains
CLO4	Develop an appreciation for the interdisciplinary nature of IKS
CLO5	Analyze the integration of IKS with contemporary academic and professional practices

Module – 1	**5 Hrs**
Introduction to Indian Knowledge Systems (IKS) Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge. **Textbook-1, Ch.1,2&3, Textbook-2: Ch. 2&3**	
Module – 2	**5 Hrs**
Traditional Knowledge in Humanities and Sciences Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology. **Textbook-1, Ch.4,5,6&7, Textbook-2: Ch. 3&4**	
Module-3	**5 Hrs**
Traditional Knowledge in Professional domain Town planning and architecture Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals. **Textbook-1, Ch.8,9,10,11&12, Textbook-2: Ch. 5,6&7**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Elucidate the scope, significance and philosophical foundations of Indian Knowledge Systems (IKS).
CO2	Compare traditional knowledge systems with indigenous and western knowledge frameworks.
CO3	Identify the applications of traditional Indian knowledge in humanities and scientific domains.
CO4	Demonstrate an understanding of traditional Indian contributions to professional domains.
CO5	Relate traditional knowledge systems to contemporary global frameworks such as Sustainable Development Goals (SDGs).

Text Books	
1	Introduction to Indian Knowledge System- concepts and applications, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0
2	Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230

Reference Book	
1	Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334

Web links and Video Lectures (e – Resources)	
1	https://www.youtube.com/watch?v=LZP1StpYEPM
2	http://nptel.ac.in/courses/121106003/
3	http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4	https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5	https://unctad.org/system/files/official-document/ditcted10_en.pdf
6	http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7	https://unfoundation.org/whatwedo/issues/sustainabledevelopmentgoals/?gclid=EAIaIQobChMInpJtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE

CO – PO MAPPING

CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	2					3					1
CO2	2	2				2	1				2
CO3	3					1					1
CO4	3	2									1
CO5	2					3	2				2

Semester: VI						
National Service Scheme						
Course Code	**:**	BNS610		**Credits**	**:**	0
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	100 Marks
Total Hours	**:**	24 Hrs		**SEE**	**:**	-
Course Type	**:**	NCMC		**SEE Duration**	**:**	-

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the community in general in which they work
CLO2	Identify the needs and problems of the community and involve them in problem – solving
CLO3	Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions t
CLO4	Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
CLO5	Appraise the importance of ethical issues and team working abilities pertaining to the social services.

Activity– 1	**08Hrs**
Plantation and adoption of plants. Know your plants.	
Activity – 2	**08 Hrs**
Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).	
Activity – 3	**08 Hrs**
Govt. school Rejuvenation and helping them to achieve good infrastructure.	

Pedagogy – Guidelines, it may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution

Sl.	**Topic**	**Group Size**	**Location**	**Activity Execution**	**Reporting**	**Evaluation of the Topic**
1	Plantation and adoption of plants. Know your plants.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.	Place selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
2	Organize National integration and social harmony events /workshops	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.	Place selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer

	/seminars. (Minimum 02 programs).					
3	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.	Place selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer

Plan of Action (Execution of Activities for 6th Semester)

Sl. No.	Practice Session Description
1.	Lecture session by NSS Officer
2.	Selection of topic, Commencement of activity and its progress
3.	Execution of Activity
4.	Case study based Assessment, Individual performance
5.	Sector wise study and its consolidation
6.	Video based seminar for 10 minutes by each student At the end of semester with Report.

- In the 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of the semester student performance has to be evaluated by the NSS Officer for the assigned activity progress and its completion.
- At the end of the 6th semester, consolidated report of all activities compiled report should be submitted as per the instructions.

Course Outcomes: After completing the course, the students will be able to	
CO1	Exploit the importance of his / her responsibilities towards society.
CO2	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.
CO4	Implement government or self-driven projects effectively in the field of societal problems.
CO5	Appraise the importance of ethical issues and team working abilities pertaining to the social services.

Assessment Details for CIE (100 Marks)

Weightage	CIE- 100 Marks
Selection of Topic, Commencement of activity and its progress	**40 Marks**
Case study based Assessment	**20 Marks**
Sector wise study and its consolidation	**20 Marks**

Video based seminar for 10 minutes by each student at the end of semester with Report	**20 Marks**
Total Marks for the course in the semester	**100 Marks**

Suggested Learning Resources: **Books:**	
1	NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2	Government of Karnataka, NSS cell, activities reports and its manual.
3	Government of India, NSS cell, Activities reports and its manual.

CO-PO Matrix

CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1						3					3		
CO2						3					3		
CO3						3					3		
CO4						3					3		
CO5						2	3	3			3		

Semester: VI						
Physical Education						
Course Code	**:**	BPE610		**Credits**	**:**	0
Hours/Week(L:T:P)	**:**	0:0:1		**CIE**	**:**	**100 Marks**
Total Hours	**:**	24		**SEE**	**:**	**-**
Course Type	**:**	NCMC		**SEE Duration**	**:**	**-**

Course Learning Objectives: This course will enable the students to	
CLO1	Develop awareness about common postural deformities and equip students with techniques for stress management to enhance physical and mental well-being.
CLO2	Enable students to acquire the basic rules, techniques, and motor skills of selected games such as Throw Ball, Table Tennis, or Athletics, and to encourage regular participation in physical activities.
CLO3	Improve cardiovascular fitness, flexibility, and coordination through structured aerobic exercises.

Module – 1	**4 Hrs**
Orientation A. Postural deformities. B. Stress management	
Module – 2	**16 Hrs**
Specific games (Any one to be selected by the student) A. Throw ball B. Table Tennis C. Athletics (Field Events- Jumps) – Any event as per availability of Ground.	
Module-3	**4 Hours**
Aerobics	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify common postural deformities and suggest corrective measures
CO2	Apply basic stress management techniques to enhance physical and mental well-being
CO3	Demonstrate fundamental skills, rules and techniques of a selected game (Throw Ball / Table Tennis / Athletics – Field Events)
CO4	Exhibit improved coordination, flexibility, endurance and cardiovascular fitness through aerobic exercises
CO5	Integrate principles of physical fitness, posture correction and stress management into daily routines for holistic health

Scheme and Assessment for auditing the course and Grades:

Sl. No.	**Activity**	**Marks**
1.	Participation of student in all the modules	20
2.	Quizzes – 2, each of 15 marks	30
3.	Final presentation / exhibition / Participation in competitions/ practical on specific tasks assigned to the students	50
	Total	**100**

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2					2	3		2		
CO2	2					3	3	2	2		
CO3	2	1				2			3		
CO4	3					2			2		
CO5	3	2				3	3	2	3		

Semester: IV						
Yoga						
Course Code	:	BYO610		**Credits**	:	0
Hours/Week(L:T:P)	:	0:0:2		**CIE**	:	100 Marks
Total Hours	:	12 Hrs		**SEE**	:	-
Course Type	:	NCMC		**SEE Duration**	:	-

Course Learning Objectives: This course will enable the students to	
CLO1	Describe patanjali's ashtanga yoga and its role in holistic well-being.
CLO2	Perform the suryanamaskar sequence with correct breathing and posture.
CLO3	Identify different types of asanas with their techniques and benefits.
CLO4	Utilize the knowledge of kapalabhati with proper technique and safety measures.
CLO5	Apply pranayama techniques to enhance physical and mental health.

Module - 1	**02 Hrs**
Patanjali's Ashtanga Yoga: Introduction, its need and importance, Eight limbs of Yoga – overview, **Yama:** Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha **Niyama:** Shoucha, Santosha, Tapa, Svaadhyaya, Eshvarapranidhana **Text Book 1: Ch. 1 (Part 1)**	
Module - 2	**02 Hrs**
Surya Namaskar: Concept and significance of Surya Namaskar, 12-step Surya Namaskar sequence, Practice - 4 rounds of Surya Namaskar, Breathing coordination and posture alignment. **Text Book 1: Ch. 2 (Part 2)**	
Module - 3	**03 Hrs**
Asanas: Meaning of Asana, Need and importance of practicing Asanas, Classification of Asanas, Sitting Asanas - Sukhasana, Paschimottanasana, Standing Asanas - Ardhakati Chakrasana, Parshva Chakrasana, Prone Line Asana - Dhanurasana, Supine Line Asanas - Halasana, Karna Peedasana, For each Asana - Meaning by name, Technique of performing, Precautionary measures, Benefits **Text Book 1: Ch. 2 (Part 2)**	
Module - 4	**02 Hrs**
Kriyas: Introduction to Shatkarmas (Cleansing practices), Meaning and importance of Kapalabhati, Technique of Kapalabhati (40 strokes/min, 3 rounds), Precautionary measures and benefits. **Text Book 1: Ch. 3 (Part 3)**	
Module - 5	**03 Hrs**
Pranayama: Meaning, need, and importance of Pranayama, Types of Pranayama and their benefits, For each type - Meaning by name, Technique, Precautionary measures, Benefits, Types included – Suryanuloma-Viloma, Chandranuloma–Viloma, Suryabhedana, Chandra Bhedana, Nadishodhana **Text Book 1: Ch. 3 (Part 3)**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Summarize patanjali's ashtanga Yoga and its significance in promoting daily well-being.
CO2	Demonstrate surya namaskar with correct sequence, breathing and posture alignment.
CO3	Classify various types of asanas with their benefits and precautions.
CO4	Utilize the knowledge to practice kapalabhati with correct technique, breathing rhythm and safety guidelines.
CO5	Apply pranayama to improve overall physical fitness and mental wellness.

Text Book	
1	"The Illustrates Light on Yoga" by BKS Iyengar, HarperCollins Publishers, ISBN-81:7223-606-9

Reference Books	
1	Teaching Methods for Yogic practices by Dr. M L Gharote & Dr. S K Ganguly, 4th Edition, Kaivalyadhama Publishers, ISBN-10 : 9788189485245
2	Yoga Instructor Course hand book published by SVYASA University, Bengaluru
3	Yogapravesha in Kannada by Ajitkumar
4	Yoga for Children –step by step – by Yamini Muthanna

Web links and Video Lectures (e – Resources)	
1	https://www.youtube.com/playlist?list=PLzF4lOyPf_Z9yQ_Gphjh1wZ5fEhMg6hmP
2	https://www.youtube.com/playlist?list=PLOzRYVm0a65cCcY4qKX5MIyJxBt7hJgQY
3	https://youtu.be/KB-TYlgd1wE
4	https://youtu.be/aa-TG0Wg1Ls

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						2			2		
CO2						2	2	3	2		2
CO3						2	2	3	2		2
CO4						2	2	3	2		2
CO5						2	2	3	2		2

Semester: VI					
Music					
Course Code	:	BMU610	**Credits**	:	0
Hours/Week(L:T:P)	:	0:0:2	**CIE**	:	100 Marks
Total Hours	:	26 Hrs	**SEE**	:	-
Course Type	:	NCMC	**SEE Duration**	:	-

Course Objectives: This course will enable the students to	
1	Understand the foundational concepts of Indian classical music, including the evolution and structure of Shruthi, Nada, Swara, Laya, Raga, Tala and Mela systems.
2	Recognize and describe various types of Carnatic compositions such as Geethe, Jathi, Swara, Swarajathi, Varna, Krithi and Thillana, along with the basics of the notation system.
3	Appreciate the contributions of key composers like Purandaradasa, Thyagaraja and Mysore Vasudevacharya to Indian music and understand their musical legacy.
4	Identify and explain the classification and basic construction of traditional Indian musical instruments, including string, wind, percussion and idiophones, with appropriate examples.
5	Demonstrate basic vocal proficiency through the practice of Sarale Varase exercises, notations for Suladi Sapta Tala in Mayamalavagowla raga and performance of selected compositions such as Geethe, Jathi Swara and Krithi.

Module -I	**03 Hrs**
Preamble Contents of the curriculum intended to promote music as language to develop an analytical, creative and intuitive understanding. For this the student must experience music through study and direct participation in improvisation and composition. Origin of the Indian Music: Evolution of the Indian music system, understanding of Shruthi, Nada, Swara, Laya, Raga, Tala, Mela **Textbook1, V-1 Ch. 1-4**	
Module – II	**03 Hrs**
Compositions Introduction to the types of composition in Carnatic Music – Geethe, Jathi, Swara, Swarajathi, Varna, Krithi and Thillana, Notation System. **Textbook2 – Ch. 4-7**	
Module –III	**03 Hrs**
Composers Biography and contributions of Purandaradasa, Thyagaraja, Mysoro asudevacharya, Kanakadasa **Textbook3 – Ch. 2-5**	
Module –IV	**03 Hrs**
Music Instruments Classification and construction of string instruments, wind instruments, percussion Instruments, Idiophones (Ghana Vaadya), Examples of each class of instruments. **Textbook1,V-4 – Ch. 2-6**	
Module –V	**14 Hrs**
Abhyasa Gana Singing the swara exercises (Sarale Varase Only), Botatio writing for sarale varase and sulafi sapta tala (Only in mayamalavagowla raga), singing 4 geethe in malahari and one jathi swara, oe krithi in a mela raga **Textbook1, V-1&2**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Outline the evolution of Indian music and key concepts like Shruthi, Swara, Raga and Tala.
CO2	Identify and interpret basic Carnatic compositions using standard notation.
CO3	Summarize the contributions of composers.
CO4	Classify Indian musical instruments and describe their construction and use.
CO5	Demonstrate basic Carnatic vocal skills through selected exercises and compositions.

Text Books	
1	South Indian Music – Vol. I to VI, Prof. P. Sambamoorthy, The Indian Music Publishing House, Chennai.
2	A Textbook of Carnatic Music, Dr. S. Bhagyalekshmy, CBH Publications
3	Karnataka Sangeetha Charitre, Dr. V. S. Sampathkumaracharya, Kannada University, Hampi.

Reference Books	
1	Music of India, B. Chaitanya Deva, Munshiram Manoharlal Publishers
2	Essentials of Musicology in South Indian Music, Prof. S. R. Janakiraman, Asian Educational Services

CO – PO MAPPING

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3		1		1		1	1	1		1
CO2	3		3	1	2	1	2	1	1		1
CO3	1				1	1	1		1		
CO4	2		2		3	1	1	1	1		1
CO5	3			1	2	1	1	1	1		1

Institute Vision

Preparing Competent Engineering and Management Professionals to Serve the Society

Institute Mission

- Providing Students with a Sound Knowledge in Fundamentals of their branch of Study.
- Promoting Excellence in Teaching, Training, Research and Consultancy.
- Exposing Students to Emerging Frontiers in various domains enabling Continuous Learning.
- Developing Entrepreneurial acumen to venture into Innovative areas.
- Imparting Value based Professional Education with a sense of Social Responsibility.

Department Vision

Transforming Individuals into Competent Electronics and Communication Engineers for Technological and Societal Advancements.

Department Mission

- Strengthening Fundamental Knowledge for Academic and Professional Excellence.
- Empowering innovation through Research in Emerging Technologies.
- Fostering Industry-Institute Collaboration for Technical & Entrepreneurial Progress.
- Equipping Students with Technical Skills and Ethical Values to cater Societal Needs.
- Nurturing Supportive Environment for Lifelong Learning.

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

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