DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Dr. Babasaheb Ambedkar Technological University, Lonere

(Established as a University of Technology in the State of Maharashtra)

(Under Maharashtra Act No. XXIX of 2014)

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Course Structure and Detailed Syllabus

for

M. Tech. Programme in Electronics & Communication (VLSI Design)

In line with New Education Policy 2020 guidelines

(Effective from Academic Year 2023-24 for main campus)

Dr. Babasaheb Ambedkar Technological University
M.Tech Electronics & Communication (VLSI Design)
In line with New Education Policy 2020 guidelines
(Effective from AY 2023-24 for main campus)

	Course Code	Course Title	L	T	P	Cr	Categorisation
SEM- I	12968PC101	Signal Theory	3	1	-	4	PCC
	12968PC103	RTL Simulation & Synthesis with PLDs	3	1	-	4	PCC
	12968PE101	Program Elective-I	3	1	-	4	PEC
	12968PE103	Program Elective-II	3	1	-	4	PEC
	12968PC105L	PG Lab-I	-	-	4	2	PCC
	12968SE101	Seminar I	-	-	4	2	ELC
	12968AU101	YOGA for Stress Management	-	-	2	-	Audit Course
		Total	**12**	**4**	**10**	**20**	
SEM- II	12968PC102	Estimation and Detection Theory	3	1	-	4	PCC
	12968PC104	Analog & Digital VLSI Design	3	1	-	4	PCC
	12968PE102	Program Elective-III	3	1	-	4	PEC
	12968OE102	Open Elective I	3	-	-	3	OE
	12968PC106L	PG Lab-II	-	-	4	2	PCC
	12968MP102	Mini-Project	-	-	4	2	ELC
	12968AE102	IKS Bucket[#]	3	-	-	3	AEC/VEC/IKS
	12968AU102	Disaster Management	-	-	2	-	Audit Course
		Total	**15**	**3**	**10**	**22**	
SEM- III	12968OE201	Open Elective II	3	-	-	3	OE
	12968MD201	Multidisciplinary Minor	3	-	-	3	MDM
	12968SE201	Seminar II	-	-	4	2	ELC
	12968PR201	Project I	-	-	-	10	ELC
		Total	**6**		**4**	**18**	
SEM-IV	12968PR202	Project II	-	-	-	20	ELC
		Total				**20**	

Note:
1. Students can complete 40% of the courses from SWAYAM /NPTEL/Coursera/ from Institutes with MoU signed by university.
2. Existing passing rules will be applicable.

Credit Distribution

SEM I	SEM II	SEM III	SEM IV	Total
20	22	**18**	**20**	**80**

Abbreviations: PCC (Programme Core Course), PEC (Programme Elective Course), ELC (Experiential Learning Courses), OE (Open Elective), AEC (Ability Enhancement Courses), VEC (Value Education Courses), IKS (Indian Knowledge System), MDM (Multidisciplinary Minor).

	Program Elective -I
A)	Advanced Signal Processing
B)	Programming Language for Embedded Systems
C)	Mixed Signal Design
D)	RF Engineering
E)	VLSI Signal Processing
F)	Embedded System Design

	Program Elective -II
A)	Parallel Processing
B)	System Design with Embedded Linux
C)	CAD of Digital Systems
D)	Smart Antennas
E)	ASIC Design
F)	VLSI Design Verification & Testing

	Program Elective -III
A)	Memory Technologies
B)	System On-Chip Design
C)	Low Power VLSI Design
D)	Multirate Signal Processing
E)	Real Time Embedded Systems

	Open Elective I
A)	New Labour Codes of India
B)	Urban Utilities Planning: Water Supply, Sanitation and Drainage
C)	Environment and Development
D)	Entrepreneurship
E)	Research Methodology

	Open Elective II
A)	Student Psychology
B)	Business To Business Marketing (B2B)
C)	Organizational Behaviour
D)	Principles Of Economics
E)	Intellectual Property & Rights
F)	Introduction to Public Administration

	Multidisciplinary Minor
A)	Design Of Mechatronic Systems
B)	Ethical Hacking
C)	Sustainable Power Generation Systems
D)	Components And Applications of Internet of Things
E)	Linear Algebra
F)	Artificial Intelligence and Machine Learning

	Indian Knowledge System (IKS)
A)	Indian Knowledge System (IKS): Concepts and Applications in Engineering
B)	Indian Knowledge System(IKS): Humanities and Social Sciences

SEMESTER I

12968PC101	Signal Theory	Credits 04

Course Objectives:

1. To provide in depth understanding of random nature of a signal using probability and random experiments.
2. To prepare mathematical background for communication signal analysis.
3. To provide in depth understanding of random processes.

Course Outcomes:

1. Learner will be able to apply knowledge of basic probability theory.
2. Learner will be able to understand concept of Random Variable.
3. Learner will be able to estimate different aspects of Random Variable like Mean,
4. Variance, Moments, distribution function, density function etc.
5. Learner will be able to distinguish multiple Random Variable and its properties.
6. Learner will be able to hypothesize nature of different Random Processes.
7. Learner will be able to adapt basic concepts of estimation on multiple and repeated data measurement.

UNIT I
Probability
The meaning of probability, the axioms of probability, repeated trials.

UNIT II
The Concept of a Random Variable
Introduction, Distribution and density functions, Specific random variables, Conditional distributions, Asymptotic approximations for Binomial random variables.

UNIT III
Functions of One Random Variable
The Random Variable g(X), The Distribution of g(X), Mean and variance, Moments, Characteristic functions.

UNIT IV
Two Random Variables
Bi-variable distribution, one function of two random variables, two function of two random variables, Joint moments, Joint characteristic functions, Conditional distributions, Conditional expected values.

UNIT V
Sequences of Random variables
General concepts conditional densities, Characteristic functions, and normality, mean square estimation stochastic convergence and limit theorem, Random Numbers: Meaning and Generation.

UNIT VI
Stochastic Processes
Introduction, Estimation, Parameter Estimation, Hypothesis Testing General concept, Random walks and other applications, Spectral representation, and estimation, Mean square estimation, Markov chains.

Textbooks / References:

1. Papoulis, S. Pillai, Probability, Random Variables and Stochastic Processes, 4th edition, Tata McGraw Hill, 2017.
2. T. Veerajan, Probability, Statistics and Random Processes, Tata McGraw-Hill Education (India) Pvt Limited, Third Edition, 2008.
3. R.P. Singh, S.D. Sapre, Communication Systems: Analog and Digital, Tata McGraw-Hill Education (India) Pvt Limited, Third Edition, 2017.
4. B.P. Lathi, Modern Digital and Analog Communication Systems, Oxford University Press, Third edition, 2010.

12968PC103 RTL Simulation & Synthesis with PLDs Credits 04

Course Objectives:
1. Learn about Register-Transfer Level (RTL) design, including the use of registers and data paths in digital systems.
2. Familiarize yourself with different types of Programmable Logic Devices (PLDs), such as Field-Programmable Gate Arrays (FPGAs) and Complex Programmable Logic Devices (CPLDs).
3. Gain proficiency in Hardware Description Languages (HDLs) like VHDL or Verilog for RTL design and synthesis.
4. Understand testing and verification methodologies for digital circuits, including the use of testbenches and simulation test vectors.

Course Outcomes:
1. Describe Finite State Machines and comprehend concepts of clock related issues.
2. Model digital circuits using Verilog and understand the concepts of analog and mixed signal Systems design using Verilog AMS.
3. Outline the concepts of different design flows in VLSI.
4. Illustrate different low power latches and Flip-flops.

UNIT I
Design strategies
Top-down approach to design, Design of FSMs (Synchronous and asynchronous), Static timing analysis, Meta-stability, Clock issues, Need and design strategies for multi-clock domain designs.

UNIT II
Modelling of digital circuits
Design entry by Verilog, Combinational and Sequential Logic Design: Multiplexer/ Demultiplexer, ALU, parity circuits, Flip-flops, Shift Registers, Counters, Finite State Machines, Sequence generator, Sequence detector, Verilog AMS.

UNIT III
Design methodologies
Programmable Logic Devices, FPGA, SoC, Introduction to ASIC Design Flow, Floor Planning, Placement, Clock tree synthesis, Routing, Physical verification.

UNIT IV
Low power Latches and Flip-flops
Introduction, Need for low power latches and flip-flops, Evolution of Latches and Flip-flops, Quality measures for latches and flip-flops, Design perspective.

UNIT V
IP and Prototyping
IP in various forms: RTL Source code, Encrypted Source code, Soft IP, Netlist, Physical IP, use of external hard IP during prototyping.

Textbooks / References:

1. Richard S. Sandige, Modern Digital Design, MGH, International Editions,1990
2. T. R. Padmanabhan and B. F.V.G. Bala Tripura Sundari, Design through Verilog HDL, WSE, IEEE Press, 2004.
3. Zeidman, Bob. Designing with FPGAS and CPLDS. CRC Press, 2002.
4. KiatSeng Yeo, Samir S. Rofail, Wang-Ling Goh, CMOS/Bi CMOS ULSI Low Voltage Low Power, Pearson Education Asia 1st Indian reprint, 2002.
5. Doug Amos, Austin Lesea, Rene Richter, FPGA based prototyping methodology manual, Xilinx.

12968PE101A	**Advanced Signal Processing**	**Credits 04**

Course Objectives:

1. Provide students with a deep understanding of advanced signal processing theories and mathematical concepts, including topics such as Fourier analysis, wavelet analysis, stochastic signal processing, and advanced linear algebra.
2. Develop expertise in digital signal processing techniques, algorithms, and tools. This includes knowledge of filter design, spectral analysis, adaptive signal processing, and multirate signal processing.

Course Outcomes:

1. Proficiency in advanced mathematical techniques and tools used in signal processing, including complex analysis, Fourier analysis, wavelet analysis, and linear algebra.
2. The ability to represent and analyze signals in both time and frequency domains, including techniques such as Fourier transforms, Laplace transforms, and Z-transforms.
3. Proficiency in digital signal processing techniques, including the design and implementation of digital filters, discrete-time signal processing, and spectral analysis.

4. The ability to apply signal processing techniques to real-world problems in various domains, including telecommunications, audio and speech processing, image and video processing, and biomedical signal processing.

UNIT I
Review of filter concept
Review of design techniques and structures for FIR and IIR filters, representation of numbers, quantization of filter coefficients, round-off effects in digital filters.

Unit II
Analysis of LSI systems
Frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems

UNIT III
Multirate Digital Signal Processing
Introduction, Decimation by a factor D, Interpolation by a factor I, sampling rate conversion by rational factor I/D, implementation of sampling rate conversion, multistage implementation of sampling rate conversion, sampling rate conversion of band pass signals, sampling rate conversion by an arbitrary factor, application of Multirate signal processing, digital filter bank, two-channel quadrature-mirror filter bank, M-channel QMF bank.

UNIT IV
Wavelet Transform
Introduction to wavelet transform- Short Time Fourier Transform (STFT), Wavelet transform, Haar wavelet and Multirate resolution analysis, Daubechies wavelet, some other standard wavelets, applications of wavelet transform.

UNIT V
Power Spectrum Estimation
Estimation of spectra from finite-duration observation of signals, non-parametric methods for power spectrum estimation, parametric methods for power spectrum estimation, filter bank methods, Eigen analysis algorithms for spectrum estimation.

Textbooks / References:
1. Discrete Time Signal Processing by A.V. Oppenheim and Schafer, Prentice Hall.
   Digital Signal Processing: Principle, Algorithms and Applications by John G. Proakis and D.G. Manolakis, Prentice Hall.
2. Theory and Application of Digital Signal Processing by L. R. Rabiner and B. Gold, Prentice Hall.
3. Introduction to Digital Signal Processing by J.R. Johnson, Prentice Hall.
4. Digital Signal Processing by D. J. DeFatta, J. G. Lucas and W. S. Hodgkiss, J Wiley and Sons, Singapore.

12968PE101B Programming language for embedded systems Credits 04

Course Objectives:

1. To understand role of programming language in embedded systems

Course Outcomes:

1. Learner will be able to define embedded system
2. Learner will be able to classify between processors, programming languages, operating systems etc.
3. Learner will be able to describe architecture of 8051 microcontroller
4. Learner will be able to write a program basic technique for reading from port pins
5. Learner will learn concept of Object-oriented programming
6. Learner will be able to create hardware delays using timers
7. Learner will be able to solve a real word problem using knowledge of embedded C

UNIT I
Programming Embedded Systems in C
Introduction, what is an embedded system, Which processor should you use, Which programming language should you use, Which operating system should you use, how do you develop embedded software, Conclusions

UNIT II
Introducing the 8051 Microcontroller Family
Introduction, what is in a name, the external interface of the Standard 8051, Reset requirements, Clock frequency and performance, Memory issues, I/O pins, Timers, Interrupts, Serial interface, Power consumption, Conclusions

UNIT III
Reading Switches
Introduction, Basic techniques for reading from port pins, Example:
Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, dealing with switch bounce, Example: Reading switch inputs (basic code), Example: Counting goats, Conclusions

UNIT IV
Adding Structure to the Code
Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the „Hello Embedded World‟ example, Example: Restructuring the goat-counting example, Further examples, Conclusions

UNIT V
Meeting Real-Time Constraints
Introduction, creating „hardware delays‟ using Timer 0 and Timer 1, Example: Generating a precise 50 ms delay, Example: Creating a portable hardware delay, why not use Timer, the need for „timeout‟ mechanisms, creating loop timeouts, Example: Testing loop timeouts, Example: A more reliable switch interface, creating hardware timeouts, Example: Testing a hardware timeout, Conclusions

UNIT VI
Case Study:
Intruder Alarm System Introduction, the software architecture, Key software components used in this example, running the program, the software, Conclusions

References/Text Books:

1. Michael J. Pont , Embedded C, A Pearson Education
2. Nigel Gardner, PIC micro MCU C-An introduction to programming, The Microchip PIC in CCS C

12968PE101C	Mixed Signal Design	Credits 04

Course Objective

1. To make the students to understand the design and performance measures concept of mixed signal circuit.

Course Outcomes

1. Learner will be able to understand the fundamentals of data converters and also optimized their performances.
2. Learner will be able to understand the design methodology for mixed signal IC design using gm/Id concept.
3. Learner will be able to analyze the design of current mirrors and operational amplifiers
4. Learner will be able to design the CMOS digital circuits and implement its layout.
5. Learner will be able to design the frequency and Q tunable time domain filters.

UNIT I
Concepts of Mixed-Signal Design and Performance Measures.

UNIT II
Fundamentals of Data Converters. Nyquist Rate Converters and Over sampling Converters.

UNIT III
Design methodology for mixed signal IC design using gm/Id concept.

UNIT IV
Design of Current mirrors. References. Comparators and Operational Amplifiers.

UNIT V
CMOS Digital Circuits Design: Design of MOSFET Switches and Switched-Capacitor Circuits, Layout Considerations.

UNIT VI
Design of frequency and Q tunable continuous time filters.

References/Textbooks

1. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS, Circuit Design, Layout, and Simulation, Wiley-IEEE Press, 1998
2. David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley, and Sons,1997.

12968PE101D RF Engineering Credits 04

Course Objectives:

1. To inculcate understanding of the basics required for circuit representation of RF networks.
2. To deal with the issues in the design of microwave amplifier.
3. To instil knowledge on the properties of various microwave components.
4. To deal with the microwave generation and microwave measurement techniques

Course Outcomes:

1. Explain the active & passive microwave devices & components used in Microwave communication systems.
2. Analyze the multi- port RF networks and RF transistor amplifiers.
3. Generate Microwave signals and design microwave amplifiers.
4. Measure and analyze Microwave signal and parameters.

UNIT I

Two Port Network Theory

Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters, Different types of interconnections of Two port networks, High Frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network, Transmission matrix, RF behaviour of Resistors, Capacitors, and Inductors.

UNIT II

RF Amplifiers and Matching Networks

Characteristics of Amplifiers, Amplifier power relations, Stability considerations, Stabilization Methods, Noise Figure, Constant VSWR, Broadband, High power and Multistage Amplifiers, Impedance matching using discrete components, Two component matching Networks, Frequency response and quality factor, T and Pi Matching Networks, Microstrip Line Matching Networks.

UNIT III

Passive And Active Microwave Devices

Terminations, Attenuators, Phase shifters, Directional couplers, Hybrid Junctions, Power dividers, Circulator, Isolator, Impedance matching devices: Tuning screw, Stub, and quarter wave transformers. Crystal and Schottky diode detector and mixers, PIN diode switch, Gunn diode oscillator, IMPATT diode oscillator and amplifier, Varactor diode, Introduction to MIC.

UNIT IV

Microwave Generation

Review of conventional vacuum Triodes, Tetrodes and Pentodes, High frequency effects in vacuum Tubes, Theory, and application of two cavity Klystron Amplifier, Reflex Klystron oscillator, traveling wave tube amplifier, Magnetron oscillator using Cylindrical, Linear, Coaxial Voltage tunable Magnetrons, Backward wave Crossed field amplifier and oscillator.

UNIT V

Microwave Measurements

Measuring Instruments: Principle of operation and application of VSWR meter, Power meter, Spectrum analyzer, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Q- factor, Dielectric constant, Scattering coefficients, Attenuation, S-parameters.

References/Text Books:

1. David M. Pozar, "Microwave Engineering," Wiley India (P) Ltd, New Delhi, 2008.
2. Thomas H Lee, "Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits," Cambridge University Press, 2004.
3. Mathew M Radmanesh, "RF and Microwave Electronics", Prentice Hall, 2000.
4. Annapurna Das and Sisir K Das, "Microwave Engineering", Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2005.
5. Reinhold Ludwig and Gene Bogdanov, "RF Circuit Design: Theory and Applications," Pearson
6. Education Inc., 2011
7. Robert E Colin, "Foundations for Microwave Engineering," John Wiley & Sons Inc, 2005

12968PE101E VLSI signal processing Credits 04

Course Objectives:

1. To enable students to design VLSI systems with high speed and low power.
2. To encourage students to develop a working knowledge of the central ideas of implementation of DSP algorithm with optimized hardware.

Course Outcomes:

1. Learner will be able to acquire the knowledge of round off noise computation and numerical strength reduction.
2. Learner will be able to design Bit level and redundant arithmetic Architectures.

UNIT I

An overview of DSP concepts, Representations of DSP algorithms. Systolic Architecture Design: FIR Systolic Array, Matrix-Matrix Multiplication, 2D Systolic Array Design. Digital Lattice Filter Structures: Schur Algorithm, Derivation of One-Multiplier Lattice Filter, Normalized Lattice Filter, Pipelining of Lattice Filter.

UNIT II

Scaling and Round off Noise - State variable description of digital filters, Scaling and Round off Noise computation, round off Noise in Pipelined IIR Filters, Round off Noise Computation using state variable description, Slow-down, Retiming and Pipelining.

UNIT III

Bit level arithmetic Architectures- parallel multipliers, interleaved floor-plan, and bit-plane based digital filters, Bit serial multipliers, Bit serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

UNIT IV

Redundant arithmetic -Redundant number representations, carry free radix-2 addition and subtraction, Hybrid radix-4 addition, Radix-2 hybrid redundant multiplication architectures, data format conversion, Redundant to Non-redundant converter.

UNIT V

Numerical Strength Reduction - Sub expression Elimination, Multiple Constant Multiplication,

UNIT VI
Sub expression sharing in Digital Filters, Additive and Multiplicative Number Splitting.

References/Text Book(s)

1. K.K.Parhi, "VLSI Digital Signal Processing Systems", John-Wiley, 2007.
2. JU. Meyer -Baese, Digital Signal Processing with FPGAs, Springer, 2004.
3. Recent literature in VLSI Digital Signal Processing Systems.

12968PE101F Embedded System Design Credits 04

Course Objectives:

1. A To introduce students to the modern embedded systems and to show how to understand and program such systems using a concrete platform built around a modern embedded processor.

Course Outcomes

1. Learner will understand fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware
2. Learner will be able to analyze a wide competence from different areas of technology, especially from computer engineering, study of processor for deep understanding analyze case study of Pentium processor
3. Learner will be able to demonstrate architecture of processors, Instruction set, Addressing modes. Programming for various applications. Interfacing of LED/LCD, keyboard, stepper motor, ADC/DAC, and sensors, RTC, serial communication with micro-controller.
4. Learner will be able to analyze deep state-of-the-art theoretical knowledge in the areas of real-time systems, artificial intelligence, learning systems, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software development of embedded systems.
5. Learner will be able to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system.
6. Learner will be able to understand and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.

UNIT I
Introduction to embedded computing: Complex systems and microprocessors – Design example: Model train controller –Embedded system design process – Formalism for system design–Instruction sets Preliminaries – ARM Processor – CPU: Programming input and output – Supervisor mode, exception, and traps – Coprocessor – Memory system mechanism – CPU performance – CPU power consumption.

UNIT II
Computing platform and design analysis CPU: buses – Memory devices – I/O devices – Component interfacing – Design with microprocessors – Development and Debugging – Program design Model of programs

UNIT III

Assembly and linking: Assembly and Linking – Basic compilation techniques – Analysis and optimization of execution time, power, energy, program size – Program validation and testing.

UNIT IV

Process and operating systems: Multiple tasks and multi processes – Processes – Context Switching – Operating Systems –Scheduling policies - Multiprocessor – Inter Process Communication mechanisms – Evaluating operating system performance – Power optimization strategies for processes.

UNIT V

Hardware accelerates & networks: Accelerators – Accelerated system design – Distributed Embedded Architecture –Networks for Embedded Systems – Network based design –Internet enabled systems.

UNIT VI

Case study: Hardware and software co-design - Data Compressor - Software Modem – Personal Digital Assistants – Set Top Box. – System-on-Silicon – FOSS Tools for embedded system development.

References/Text Book(s)

1. Wayne Wolf, Computers as Components - Principles of Embedded Computer System Design, Morgan Kaufmann Publisher, 2006.
2. K.V.K.K.Prasad, Embedded Real-Time Systems: Concepts, Design & Programming, dreamtech press, 2005.
3. Tim Wilmshurst, An Introduction to the Design of Small-Scale Embedded Systems, Palgrave Publisher, 2004.
4. Sriram V Iyer, Pankaj Gupta, Embedded Real Time Systems Programming, Tata McGraw Hill, 2004.
5. Tammy Noergaard, Embedded Systems Architecture, Elsevier,2006
6. David E-Simon, An Embedded Software Primer, Pearson Education, 2007.

12968PE103A	**Parallel Processing**	**Credits 04**

Course Objectives:

1. A practically oriented introduction to programming paradigms for parallel computers.
2. Definitions of program efficiency on parallel computers, addresses the modelling, analysis, and measurement of program performance. Description, implementation and use of parallel programming, parallel features, parallel communication operations, library routines and applications.

Course Outcomes:

1. Be proficient at programming multiple parallel machines in more than one special programming language or programming system
2. Be able to descriptively compare the performance of different programs and methods on one machine
3. Demonstrate advanced knowledge of the elements of parallel programming, parallel communication and system implementation

4. Recall the history of parallel systems, principles of parallel algorithms and describe the developments in the field of parallel computing.

UNIT-1
Introduction to Parallel Computing:
Scope of Parallel Computing, Implicit Parallelism: Trends in Microprocessor Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Routing Mechanisms for Interconnection Networks, Impact of Process-Processor Mapping and Mapping Techniques.

UNIT-2
Principles of Parallel Algorithm Design:
Preliminaries, Decomposition Techniques,
Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

UNIT-3
Basic Communication Operations:
One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations.

UNIT-4
Analytical Modelling of Parallel Programs:
Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost-Optimal, Execution Time, Asymptotic Analysis of Parallel Programs, Other Scalability Metrics.

UNIT-5
Programming Using the Message-Passing Paradigm:
Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topologies and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators.

Reference Books/Text Books:
1. Introduction to parallel computing by Ananth Grama, Anshul Gupta, Gorge Karypis, Vipin Kumar, Pearson

12968PE103B System Design with embedded Linux Credits 04

Course Objectives:
1. Familiarize students with the Linux operating system, including its architecture, kernel, file system, and basic command-line operations.
2. Teach students how to customize the Linux kernel to meet the specific requirements of embedded systems. This may involve configuring and building a custom kernel.

3. Discuss the configuration and usage of bootloaders like U-Boot for embedded Linux systems, including bootloader customization and management.
4. Enable students to develop and deploy applications on embedded Linux systems. This includes writing software in languages like C, C++, and Python.

Course Outcomes:

1. Learn how to adapt and configure the Linux kernel for embedded systems, including cross-compilation and kernel customization.
2. Learn to customize and configure bootloaders (e.g., U-Boot) to support specific embedded hardware platforms.

UNIT I

Embedded OS fundamentals

Introduction: Operating System Fundamentals, General Linux Architecture, Linux Kernel, Linux file systems, ROOTFS, Sysfs and Procfs, Embedded Linux: Booting Process in Linux, boot loaders, U-boot, Kernel Images, Linux File systems. GNU Tools: gcc, gdb, gprof, Makefiles

UNIT II

Embedded C programming

Review of data types –scalar types-Primitive Types-Enumerated Types-Subranges, Structure types-character strings –arrays- Functions Introduction to Embedded C-Introduction, Data types Bit manipulation, Interfacing C with Assembly.
Embedded programming issues - Re-entrancy, Portability, Optimizing and testing embedded C programs. Modelling Language for Embedded Systems: Modelling and Analysis of Real-Time and Embedded systems

UNIT III

Embedded applications using Data structures

Linear data structures– Stacks and Queues implementation of stacks and Queues Linked List - Implementation of linked list, Sorting, Searching, Insertion and Deletion,
Nonlinear structures – Trees and Graphs Object Oriented programming basics using C++ and its relevance in Embedded systems.

UNIT IV

Scripting languages for embedded systems

Shell scripting, Programming basics of Python, Comparison of scripting languages

References/Text Book(s)

1. C Programming language, Kernighan, Brian W, Ritchie, Dennis M
2. “Embedded C,” Michael J. Pont, Addison Wesley

12968PE103C CAD for Digital Systems Credits 04

Course Objectives:

1. To prepare the student to understand the VHDL language feature to realize the complex digital systems.
2. To design and simulate sequential and concurrent techniques in VHDL
3. To explain modeling of digital systems using VHDL and design methodology
4. To explain predefined attributes and configurations of VHDL.

5. To Understand behavioral, non-synthesizable VHDL and its role in modern design

Course Outcomes:

1. Learner will be able to demonstrate, simulate, verify, and synthesize with hardware description languages.
2. Learner will be able to understand and use major syntactic elements of VHDL - entities, architectures,
3. Processes, functions, common concurrent statements, and common sequential statements
4. Learner will be able to design digital logic circuits in different types of modeling
5. Learner will be able to demonstrate timing and resource usage associated with modeling approach.
6. Learner will be able to use computer-aided design tools for design of complex digital logic circuits.

UNIT I

An overview of design procedures for system design using CAD tools. Design verification tools. Examples using commercial PC based VLSI CAD tools. Design methodology based on VHDL. Basic concepts and structural descriptions in VHDL.

UNIT II

Characterizing hardware languages, objects and classes, signal assignments, concurrent and sequential assignments. Structural specification of hardware.

UNIT III

Design organization, parameterization and high-level utilities, definition, and usage of subprograms, packaging parts and utilities, design parameterization, design configuration, design libraries. Utilities for high-level descriptions.

UNIT IV

Data flow and behavioral description in VHDL- multiplexing and data selection, state machine description, open collector gates, three state bussing, general dataflow circuit, updating basic utilities. Behavioral description of hardware.

UNIT V

CPU modeling for discrete design- Parwan CPU, behavioral description, bussing structure, data flow, test bench, a more realistic Parwan.

UNIT VI

Interface design and modeling. VHDL as a modeling language.

Text Book/ References:

1. Z.Navabi, “VHDL Analysis and Modeling of Digital Systems”, (2/e), McGraw Hill.
2. Dewey, “Analysis and Design of Digital Systems with VHDL,” CL-Engineering
3. Z.Navabi,”VHDL: modular design and synthesis of cores and systems”, McGraw
4. H. Roth, Jr., L.K.John, “Digital Systems Design Using VHDL - Thomson Learning EMEA,” Limited, 2008.
5. Recent literature in Analysis and Design of Digital Systems using VHDL.

12968PE103D Smart Antennas Credits 04

Course objectives:

1. A To provide in-depth understanding of modern antenna concepts, and practical antenna design for various applications
2. To provide in-depth understanding of smart antenna concept with a view that the student can further explore the topic for research purpose.

Course Outcomes:

1. Learner will be able to compare the performances of digital radio receivers and software radios.
2. Learner will be able to understand the CDMA spatial processors to analyze the multi-cell systems.
3. Learner will be able to analyze the channel models for smart antenna systems.
4. Learner will be able to understand the environmental parameters for signal processing of smart antenna systems.
5. Learner will be able to evaluate the requirements for the design and implementation of smart antenna systems

UNIT I:

Introduction to Smart Antennas, Need for Smart Antennas, Smart Antenna Configurations.

UNIT II:

Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Mutual Coupling Effects, DOA Estimation Fundamentals, Introduction to Array Response Vector, Received Signal Model, The Subspace Based Data Model, Signal Autocovariance Matrices.

UNIT III:

Conventional DOA Estimation Methods: Conventional Beam forming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, The MUSIC Algorithm, The ESPRIT, Algorithm, Uniqueness of DOA Estimates

UNIT IV:

Beam forming Fundamentals, The Classical Beam Former-Statistically Optimum Beam forming Weight Vectors, The Maximum SNR Beam former, The Multiple Side Lobe Canceller and the Maximum, SINR Beam former- Minimum Mean Square Error (MMSE).

UNIT V:

Direct Matrix Inversion, (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beam forming, The Least Mean Square (LMS) Algorithm, The Recursive Least Squares (RLS) Algorithm, Space–Time Processing: Introduction, Discrete Space–Time Channel and Signal Models, Space–Time, Beam forming, Inter symbol and Co-Channel Suppression, ISI Suppression, CCI, Suppression

UNIT VI:

Data Rates in MIMO Systems, Single-User Data Rate Limits, Multiple Users Data Rate Limits, Data Rate Limits Within a Cellular System, MIMO in Wireless Local Area Networks, Mobile Stations' Smart Antennas, Combining Techniques, Selection (Switched) Diversity,

Maximal Ratio Combining, Adaptive Beam forming or Optimum Combining, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains

Reference Books/Text book(s)

1. A. Balanis, Antenna Theory and design, John Wiley and sons, 1997.
2. J. D. Kraus, antennas, Mc-Graw-Hill, 1988.
3. R. A. Sainathi, CAD of microstrip antennas for wireless applications, Artech House, 1996.
4. R. Garg, P. Bharhia, I. Bahl, and A. Ittipiboo, Microstrip antenna design handbook, Artech House.

12968PE103E ASIC Design Credits 04

Course Objectives:

1. To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
2. To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
3. To give the student an understanding of basics of System on Chip and Platform based design.
4. To give the student an understanding of High-performance algorithms

Course Outcomes:

1. Learner will be able to demonstrate VLSI tool-flow and appreciate FPGA and CPLD architectures
2. Learner will be able to understand the issues involved in ASIC design, including technology choice, design management and tool-flow.
3. Learner will be able to understand the algorithms used for ASIC construction
4. Learner will be able to understand Full Custom Design Flow and Tool used
5. Learner will be able to understand Semicustom Design Flow and Tool used - from RTL to GDS and Logical to Physical Implementation
6. Learner will be able to understand about STA, LEC, DRC, LVS, DFM
7. Learner will be able to understand the basics of System on Chip and on chip communication architectures appreciate high performance algorithms for ASICs

UNIT I

Introduction to Technology, Types of ASICs, VLSI Design flow, Design and Layout Rules, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects. Advanced FPGAs and CPLDs and Soft-core processors.

UNIT II

ASIC physical design issues, System Partitioning, Floor planning and Placement. Algorithms: K-L, FM, Simulated annealing algorithms. Full Custom Design: Basics, Needs & Applications. Schematic and layout basics, Full Custom Design Flow.

UNIT III

Semicustom Approach: Synthesis (RTL to GATE netlist) - Introduction to Constraints

(SDC), Introduction to Static Timing Analysis (STA). Place and Route (Logical to Physical Implementation): Floorplan and Power-Plan, Placement, Clock Tree Synthesis (clock planning), Routing, Timing Optimization, GDS generation.

UNIT IV
Extraction, Logical equivalence, and STA: Parasitic Extraction Flow, STA: Timing Flow, LEC: Introduction, flow and Tools used. Physical Verification: Introduction, DRC, LVS and basics of DFM.

UNIT V
System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures.

UNIT VI
High performance algorithms for ASICs/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC

References/Text Books

1. N. Jha & S.D. Gupta, "Testing of Digital Systems," Cambridge, 2003.
2. M.J.S. Smith: Application Specific Integrated Circuits, Pearson, 2003
3. Sudeep Pasricha and Nikil Dutt, On-Chip Communication Architectures System on Chip Interconnect, Elsevier, 2008
4. H. Gerez, Algorithms for VLSI Design Automation, John Wiley, 1999
5. Jan. M.Rabaey et al, Digital Integrated Circuit Design Perspective (2/e), PHI 2003
6. David A.Hodges, Analysis and Design of Digital Integrated Circuits (3/e), MGH 2004
7. Hoi-Jun Yoo, Kangmin Lee and Jun Kyong Kim, Low-Power NoC for High Performance SoC Design, CRC Press, 2008

12968PE103F VLSI Design Verification & Testing Credits 04

Course Objectives:

1. A Learn to use verification tools and experiment on actual circuits designed in industry

Course Outcomes:

1. Learner will be able to understand fundamentals of data converters and optimized their performances.
2. Learner will be able to understand the design methodology for mixed signal IC design using gm/Id concept
3. Learner will be able to analyze the design of current mirrors and operational amplifiers
4. Learner will be able to design the CMOS digital circuits and implement its layout.
5. Learner will be able to design the frequency and Q tunable time domain filters.

UNIT I
System Verilog (SV) - Data Types, Arrays, Structures, Unions, Procedural Blocks, Tasks & Functions, Procedural Statements, Interfaces, Basic OOPs, Randomization, Threads & Inter Process Communication, Advanced OOPs & Test bench guidelines, Advanced Interfaces

UNIT II

A Complete System Verilog Test Bench (SVTB), Functional Coverage in System Verilog, Interfacing with C, FSM Modeling with SV, Connecting Test bench & Design, Behavioral & Transaction Level Modeling with SV.

UNIT III

System Verilog Assertions (SVA) – Introduction to SVA, Building blocks, Properties, Boolean expressions, Sequence, Single & Multiple Clock definitions, Implication operators (Overlapping & Non-overlapping), Repetition operators, Built-in System functions ($past, $stable, $onehot, $onehot0, $isunknown), Constructs (ended, and, intersect, or, first_match, t throughout, within, disableiff, expect, matched, if –else), assertion directives, nested implication, formal arguments in property

UNIT IV

SVA using local variables, calling subroutines, SVA for functional coverage, Connecting SVA to the Design or Test bench, SVA for FSMs, Memories, Protocol checkers, SVA Simulation Methodology

UNIT V

Assertions: Practice & Methodology, Re-use of Assertions, Tracking coverage with Assertions, Using SVA with other languages.

UNIT VI

Functional Verification coverage using design, verification languages and implementation standards: Verilog IEEE 1364, VHDL IEEE 1076, System Verilog IEEE 1800, Property Specific Language (PSL) IEEE 1850, System C™ IEEE 1666, Encryption IEEE 1735, e Verification Language IEEE 1647, Open Verification Methodology (OVM) and Universal Verification Methodology (UVM).

References/Text Books

1. Stuart Sutherland, Simon Davidmann, System Verilog for design: a guide to using System Verilog for hardware design and modeling published by Springer, 2004 ISBN 1402075308, 9781402075308
2. System Verilog for Verification: A Guide to Learning the Test bench Language Features by Chris Spear Edition: 2, Published by Springer, 2008 ISBN 0387765298, 9780387765297
3. Srikanth Vijayaraghavan& MeyyappanRamanathan , A Practical guide for System Verilog Assertions Published by Springer, 2005 ISBN 0387260498, 9780387260495
4. Faisal I.Haque, Jonathan Michelson, KhizarA.Khan , The Art of Verification with System Verilog Assertions Published by Verification Central 2006 ISBN-13:978-0- 9711994- -5
5. Prakash Rashinkar, Peter Paterson, Leena Singh, System-on-a-Chip Verification: Methodology and Techniques, Published by Kluwer Academic Publishers 2004, New York, ISBN-0-306-46995-2.
6. Janick Bergeron, writing test benches using System Verilog, Published by Birkhäuser, 2006 ISBN 0387292217, 9780387292212
7. Ben Cohen, cohen, Venkataramanan, Kumari, SrinivasanVenkataramanan, Ajeetha Kumari SystemVerilog Assertions Handbook: --for Formal and

Dynamic Verification - Published by vhdlcohen publishing, 2005 (ISBN 0970539479, 9780970539472).
8. An Integrated Formal Verification solution DSM sign-off market trends, www.cadence.com.
9. Recent literature in Functional Verification using Hardware Verification Languages.

12968SE101	**Seminar I**	**Credits 02**

The seminar shall be on the state of the art in the area of the VLSI Design. The student shall submit the duly certified seminar report in standard format, duly signed by the concerned guide and the Head of the Department/Institute for satisfactorily completion of the work.

12968AU101	**YOGA for Stress Management**	**Audit**

Course Objectives:

1. Understand the physiological and psychological aspects of stress and its impact on overall well-being.
2. Learn and practice specific yoga postures, breathing exercises, and relaxation techniques to alleviate stress.
3. Explore the connection between mindfulness, meditation, and stress reduction, fostering mental clarity.
4. Discover holistic practices that promote better sleep, nutrition, and overall lifestyle habits for stress management.
5. Develop practical skills to manage stress in daily life, enhancing resilience and promoting emotional balance.

Course Outcomes:

1. Recognize the signs and sources of stress, understanding its effects on mental and physical well-being.
2. Master a variety of yoga techniques, including postures, breathing, and meditation, to effectively manage stress.
3. Acquire relaxation strategies that promote calmness, reduce anxiety, and enhance overall mental clarity.
4. Incorporate healthy habits inspired by yoga principles to foster better sleep, nutrition, and self-care routines.
5. Develop practical skills to navigate and cope with stress, enhancing emotional balance and promoting a more harmonious life.

UNIT I

Introduction to Yoga for Stress Management - 1
Introduction to Yoga for Stress Management - 2
Stress according to Western perspective
Stress Eastern Perspective
Developmental process: Western and Eastern Perspective
Stress Hazards and Yoga

UNIT II
Meeting the challenges of Stress - 1
Meeting the challenges of Stress - 2
Introduction to Stress Physiology
Stress, Appetite and Dietary management- Modern and Yogic perspective
Sleep and Stress: understanding the relationship for effective management of stress

UNIT III
Stress Assessment methods- a valuable tool toward stress management
Role of Yoga in prevention and management of stress related disorders – a summary of research evidence
Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 1
Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 2
Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 3

UNIT IV
Concept of stress and its management - perspectives from Bhagavad Gita - Part 1
Concept of stress and its management - perspectives from Bhagavad Gita - Part 2
Concept of stress and its management - perspectives from Bhagavad Gita - Part 3

UNIT V
Bio-Psycho-Socio-Spiritual model of stress management
Yoga practices for Stress Management
Breathing practices – 1
Hands in and out breathing, Hands stretch breathing, Ankle stretch breathing
Breathing practices – 2
Dog Breathing, Rabbit breathing, Tiger breathing, Sashankasana breathing
Breathing practices – 3
Bhujangasana breathing, Ardha Shalabhasana breathing (alternate legs), Straight leg raising (alternate legs), Straight leg raising (both legs), Sethubandhasana lumbar stretch, Instant Relaxation Technique (IRT)
Loosening Practices – 1
Shoulder Rotation, Side bending, standing twist, Hip rotation, Thigh strengthening
Loosening practices – 2
Chakki chalan, Bhunamasana Chalana, Alternative toe touching
Loosening practices – 3
Side leg raising, Pavana muktasana kriya: Wind releasing pose movements, Quick Relaxation Technique (QRT)

UNIT VI
Asana practices – 1
Tadasana, Ardhakati Chakrasana, Ardha Chakrasana, Trikonasana, Vrikshasana
Asana practices – 2
Vakarasana, Janu Sirshasana, Ushtrasana, Sashankasana,
Asana practices – 3
Ardhamatseyndrasana, Paschimottanasana, Poorvottanasana, Gomukhasana
Asana practices – 4
Makarasana, Bhujangasana, Salambha Shalabahasana, Dhanurasana
Asana practices – 5
Setubandhasana, Sarvangasana, Mastyasana, Deep Relaxation Technique (DRT)

Soorya Namaskar
Pranayama – 1
Kapalbhati kriya and Sectional Breathing
Pranayama – 2
Nadishuddhi Pranayama
Pranayama – 3
Bhramari, Sheetali, Sitkari and Ujjayi
Om Meditation
Cyclic Meditation
Integrated Yoga Module I
Integrated Yoga Module II
Integrated Yoga Module III

Textbooks / References:

1. H R Nagendra and R Nagarathna. Yoga for Promotion of Positive Health. Swami Vivekananda Yoga Prakashana. 2011.
2. Contrada, R., & Baum, A. (Eds.). The handbook of stress science: Biology, psychology, and health. Springer Publishing Company. 2010
3. Al'Absi, M. (Ed.). Stress and addiction: Biological and psychological mechanisms. Elsevier. 2011.
4. Van den Bergh, O. Principles, and practice of stress management. Guilford Publications. 2021.
5. Swami Muktibodhananda, Hatha Yoga Pradipika, Bihar Scool of Yoga, 1998
6. Swami Satyananda Saraswati, Four Chapters on Freedom, Bihar Scool of Yoga, 1975
7. Swami Tapasyananda, Srimad Bhagavat Gita, Sri Ramakrishna Math, 2012

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Yoga for Stress Management	Dr H R Nagendra, Dr Mithila M V, Dr Rajesh Nair	Swami Vivekananda Yoga Anusandhana Samsthana	https://onlinecourses.swayam2.ac.in/aic23_ge10/preview

SEMESTER II

12968PC102	Estimation and Detection Theory	Credits 04

Course Objectives:

1. To provide in-depth understanding basics of detection and estimation theory.
2. To be able to design and analyze optimum detection schemes
3. Learner will have basic knowledge of linear algebra.

Course Outcomes:

1. Acquire basics of statistical decision theory used for signal detection and estimation.
2. Examine the detection of deterministic and random signals using statistical models.
3. Examine the performance of signal parameters using optimal estimators.
4. Study different estimation schemes such as ML and MMSE estimators.

UNIT I
Linear Algebra
Vector space: linear dependence, Basis and dimension, vector subspace, inner product spaces, orthonormal basis, and Gram- Schmidt Process of orthogonalization, computation of linear dependence, linear transformation, and matrices, change of basis, orthogonal and unitary transformation, Eigenvalue, Eigen vectors and characteristics equation. Systems theory, stochastic processes, Gauss Markov models, representation of stochastic processes, likelihood, and sufficiency.

UNIT II
Binary Decision: Single Observation
Introduction to structure of decision and estimation problems. Maximum Likelihood decision criterion, Neyman-person criterion, Probability of error criterion, Bays risk criterion, Minmax criterion, problems.

UNIT III
Binary Decision: Multiple Observations
Vector observation, The general Gaussian problem, Waveform observations and additive Gaussian noise, problems.

UNIT IV
Multiple Decisions: Multiple Decision
Bays risk, Probability of error: General case, Probability of error: Gaussian case, Ensure decision problems.

UNIT V
Composite and Nonparametric Decision Theory
Composite decisions Sign test, Wilson test, problems.

UNIT VI
Fundamentals of Estimation
Maximum likelihood method, Bays cost method, Relationship of Estimation, Linear minimum, Variance and Least-square methods. Properties of Estimations: Unbiased estimators, efficient estimators, Asymptotic properties.

Textbooks / References:

1. James Melsa and David Cohn, Decision and Estimation Theory, Mc-Graw Hill
2. Harry L, Van Trees, Detection, Estimation, and Modulation Theory, John Wiley, and Sons Inc.

12968PC104 Analog & Digital VLSI Design Credits 04

Course objectives:

1. To understand different abstract levels in Verilog for modeling digital circuits.
2. To know the design of Analog CMOS circuits and memories and the various precautionary methods to be used in their design.

Course Outcomes:

1. Learner will be able to understand MOSFET device structures their physical operations, Current voltage characteristics. Fabrication process of MOS device, Making circuit with MOS devices their design equation. designing layout of such circuits, studying pass transistors.
2. The student will be able to understand CMOS analog circuits design.
3. Learner will be able to understand VHDL language for synthesizing Digital Circuits. Digital circuits include asynchronous and synchronous design issues and state machine synthesizing this circuits. Building state machines with Moore and mealy machines. Understanding how to write package, sub program and test benches.
4. Learner will be able to understand Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, and Applications of FPGAs.
5. Learner will be able to understand designing of SRAM and DRAM.
6. Learner will be able to implement Floor planning concepts, shape functions and floor plan sizing, understanding types of local routing problems Area routing, channel routing, global routing, algorithms for global routing.
7. Learner will be able to analyze Need of Design for Testability (DFT), Controllability, predictability, testability, built in Self-Test (BIST), Partial and full scan check. Understanding the system which connects host to target and need of boundary scan check, JTAG, Test Access Port (TAP) controller.

UNIT I

Introduction to VLSI Circuits

Introduction to MOSFETs: MOS Transistor Theory –Device Structure and Physical Operation, Current Voltage Characteristics, Fabrication, MOS Capacitor, Body Effect, Temperature Effects, Channel Length Modulation, Latch-up. MOS Inverter: MOS Transistors, MOS Transistor Switches, CMOS Logic, Circuit and System Representations, Design Equations, Transistor Sizing, Voltage Transfer Characteristics, Power Dissipation, Noise Margin, Power Delay Product, Energy dissipation. MOS Layers Stick/Layout Diagrams; Layout Design Rules, Issues of Scaling, Scaling factor for device parameters. Combinational MOS Logic Circuits: Pass Transistors/Transmission Gates; Designing with transmission gates: Primitive Logic
Gates.

UNIT II

Analog CMOS Design and Testability

Current sink and source, Current mirror. Active load, Current source, and Push-pull inverters. Common source, Common drain, Common gate amplifiers, Cascode amplifier, Differential amplifier, Operational amplifier, Types of faults, Need of Design for Testability (DFT), Testability, Fault models, Path sensitizing, Sequential circuit test, BIST, Test pattern generation, JTAG & Boundary scan, TAP Controller.

UNIT III

Digital Circuit Design using VHDL

Design of sequential circuits, asynchronous and synchronous design issues, state machine modeling (Moore and mealy machines), packages, sub programs, attributes, test benches.

UNIT IV

Programmable Logic Devices

Complex Programmable Logic Devices – Architecture of CPLD, Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, and Applications of FPGAs.

UNIT V

CMOS Subsystem Design

Semiconductor memories, memory chip organization, Random Access Memories (RAM), Static RAM (SRAM), standard architecture, 6T cell, sense amplifier, address decoders, timings. Dynamic RAM (DRAM), different DRAM cells, refresh circuits, timings.

Textbooks/ References:

1. Neil H. Weste and Kamran, Principles of CMOS VLSI Design, Pearson Publication
2. John F. Wakerly, Digital Design, Principles and Practices, Prentice Hall Publication
3. Douglas Perry, VHDL, McGraw Hill Publication.
4. Charles Roth, Digital System Design using VHDL, McGraw Hill Publication.
5. Data Sheets of PLDs.
6. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill Publication

12968PE102A	**Memory Technologies**	**Credits 04**

Course Objectives:

1. To master the fundamentals of multi-rate signal processing and demonstrate the ability to solve problems in sample rate conversion, filter banks, and trans multiplexers.

Course Outcomes:

1. Learner will have knowledge of Random-Access Memory Technologies
2. Learner will have knowledge of Non-volatile Memories
3. Learner will have knowledge of Memory Fault Modeling Testing and Memory Design for Testability
4. Learner will have knowledge of Semiconductor Memory Reliability

5. Learner will have knowledge of Radiation Effects
6. Learner will have knowledge of Advanced Memory Technologies

UNIT I
Random Access Memory Technologies:
SRAM – SRAM Cell structures, MOS SRAM
Architecture, MOS SRAM cell and peripheral circuit operation, Bipolar SRAM technologies, SOI technology, Advanced SRAM architectures and technologies, Application specific SRAMs, DRAM – DRAM technology development, CMOS DRAM, DRAM cell theory and advanced cell structures, BICMOS DRAM, soft error failure in DRAM, Advanced DRAM design and architecture, Application specific DRAM

UNIT II
Non-volatile Memories:
Masked ROMs, High density ROM, PROM, Bipolar ROM, CMOS PROMS, EPROM, Floating gate EPROM cell, One-time programmable EPROM, EEPROM, EEPROM technology and architecture, Non-volatile SRAM, Flash Memories (EPROM or EEPROM), advanced Flash memory architecture

UNIT III
Memory Fault Modeling Testing and Memory Design for Testability and Fault Tolerance:
RAM fault modeling, Electrical testing, Pseudo Random testing, Megabit DRAM Testing, non-volatile memory modeling and testing, IDDQ fault modeling and testing, Application specific memory testing, RAM fault modeling, BIST techniques for memory

UNIT IV
Semiconductor Memory Reliability:
General reliability issues RAM failure modes and
mechanism, Non-volatile memory reliability, reliability modeling and failure rate prediction, Design for Reliability, Reliability Test Structures, Reliability Screening, and qualification

UNIT V
Radiation Effects:
Radiation effects, Single Event Phenomenon (SEP), Radiation Hardening techniques,
Radiation Hardening Process and Design Issues, Radiation Hardened Memory characteristics, Radiation Hardness Assurance and Testing, Radiation Dosimetry, Water Level Radiation Testing and Test structures

UNIT VI
Advanced Memory Technologies and High-density Memory Packing Technologies:
Ferroelectric RAMs (FRAMs), GaAs FRAMs, Analog memories, magneto resistive RAMs (MRAMs), Experimental memory devices, Memory Hybrids and MCMs (2D), Memory Stacks and MCMs (3D), Memory MCM testing and reliability issues, Memory cards, High Density Memory Packaging Future Directions

Textbooks / References:
1. Ashok K. Sharma, Semiconductor Memories Technology 2002, Wiley.
2. Ashok K. Sharma, Advanced Semiconductor Memories – Architecture, Design and Applications - 2002, Wiley.

3. Chenming C Hu, Modern Semiconductor Devices for Integrated Circuits –1st Ed., Prentice Hall.

12968PE102B System on Chip Design Credits 04

Course Objectives:

1. To provide an in-depth understanding of what SoC is and what are the differences between SoC and Embedded System.
2. To provide an in-depth understanding of basics of System on Chip and Platform based design.
3. To provide an in-depth understanding of issues and tools related to SoC design and implementation.

Course Outcomes:

1. Learner will be able to interpret nature of hardware and software, its data flow modeling and implementation techniques.
2. Learner will be able to analyze the micro-programmed architecture of cores and processors.
3. Learner will be able to demonstrate system on chip design models.
4. Learner will be able to hypothesize and synthesize working of advanced embedded systems.
5. Learner will be able to develop design SOC controller.
6. Learner will be able to design, implement and test SOC model.

UNIT I

Basic Concepts: The nature of hardware and software, data flow modelling and implementation, the need for concurrent models, analyzing synchronous data flow graphs, control flow modelling and the limitations of data flow models, software and hardware implementation of data flow, analysis of control flow and data flow, Finite State Machine with data-path, cycle-based bit parallel hardware, hardware model, FSMD data-path, simulation and RTL synthesis, language mapping for FSMD.

UNIT II

Micro-programmed Architectures: limitations of FSM, Micro-programmed: control, encoding, data-path, Micro-programmed machine implementation, handling Micro-program interrupt and pipelining, General purpose embedded cores, processors, The RISC pipeline, program organization, analyzing the quality of compiled code,

UNIT III

System on Chip, concept, design principles, portable multimedia system, SOC modelling, hardware/software interfaces, synchronization schemes, memory mapped Interfaces, coprocessor interfaces, coprocessor control shell design, data and control design, Programmer's model.

UNIT IV

RTL intent: Simulation race, simulation-synthesis mismatch, timing analysis, timing parameters for digital logic, factors affecting delay and slew, sequential arcs, clock domain crossing, bus synchronization, preventing data loss through FIFO, Importance of low power, causes and factors affecting power, switching activity, simulation limitation, implication on synthesis and on backend.

UNIT V
Research topics in SOC design: A SOC controller for digital still camera, multimedia IP development image and video CODECS

UNIT VI
SOC memory system design, embedded software, and energy management techniques for SOC design, SOC prototyping, verification, testing and physical design.

Text Books/ Reference Books

1. Patrick R. Schaumont, A Practical Introduction to Hardware/Software Co design, Springer
2. Sanjay Churiwala, Sapan Garg, Principles of VLSI RTL Design a Practical Guide, Springer
3. Youn-Long Steve Lin, Essential Issues in SOC Design, Designing Complex Systems on Chip, Springer

12968PE102C Low Power VLSI Design Credits 04

Course Objectives:

1. A To match with todays need for low power circuit design for energy efficient Systems

Course Outcomes:

1. Learner will be able to classify causes for various power dissipation
2. Learner will acquire knowledge of Low-Power Design Approaches
3. Lerner will be able to use Switched Capacitance Minimization Approaches
4. Learner will be able to design low power adder networks
5. Learner will be able to design low power multiplier networks
6. Learner will have knowledge of low power memory technologies

UNIT I
Fundamentals:
Need for Low Power Circuit Design, Sources of Power Dissipation –
Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

UNIT II
Low-Power Design Approaches:
Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches.

UNIT III
Switched Capacitance Minimization Approaches:
System Level Measures, Circuit Level Measures, Mask level Measures.

UNIT IV
Low-Voltage Low-Power Adders:

Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Design Techniques –Trends of Technology and Power Supply Voltage, Low-Voltage Low-Power Logic Styles.

UNIT V
Low-Voltage Low-Power Multipliers:
Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh Wooley Multiplier, Booth Multiplier, Introduction to Wallace Tree Multiplier.

UNIT VI
Low-Voltage Low-Power Memories:
Basics of ROM, Low-Power ROM Technology,
Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM

Textbooks / References:

1. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits – Analysis and Design –TMH, 2011.
2. Kiat-Seng Yeo, Kaushik Roy, Low-Voltage, Low-Power VLSI Subsystems –TMH Professional Engineering.
3. Ming-BO Lin, Introduction to VLSI Systems: A Logic, Circuit and System Perspective –CRC Press, 2011
4. Anantha Chandrakasan, Low Power CMOS Design –IEEE Press/Wiley International, 1998.
5. Kaushik Roy, Sharat C. Prasad, Low Power CMOS VLSI Circuit Design John Wiley & Sons, 2000.
6. Gary K. Yeap, Practical Low Power Digital VLSI Design –Kluwer Academic Press, 2002.
7. A. Bellamour, M. I. Elamasri, Low Power CMOS VLSI Circuit Design –Kluwer Academic Press, 1995.
8. Siva G. Narendran, Anatha Chandrakasan, Leakage in Nanometer CMOS Technologies –Springer, 2005.

12968PE102D	**Multirate Signal Processing**	**Credits 04**

Course Objectives:

1. A To master the fundamentals of multirate signal processing and demonstrate the ability to solve problems in sample rate conversion, filter banks, and trans multiplexers.

Course Outcomes:

1. Learner will be able to develop efficient realizations for up sampling and Down sampling of signals using the polyphase decomposition
2. Learner will be able to design and implement Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters to meet specifications

3. Learner will be able to design digital filter banks based on the techniques presented
4. Learner will be able to analyze fundamental concepts of wavelets.
5. Learner will be able to distinguish between wavelets and multirate filter banks, from the point of view of implementation.

UNIT I

Fundamentals of Multirate Systems

Introduction, Basic multirate operations, Interconnection of building blocks, Polyphase representation, Multi stage implementation, Some application of multirate systems, Special filter, and filter banks.

UNIT II

Maximally Decimated Filter Banks

Introduction, Errors created in the QMF bank, A simple alias free QMF system, Power symmetric QMF banks, M-channel filter banks, Polyphase representation, Perfect reconstruction system, alias free filter banks, Tree structured filter banks, Trans multiplexer.

UNIT III

Para unitary Perfect Reconstruction Filter Banks

Introduction, Lossless transfer matrices, Filter banks properties induced by para unitariness, two channel FIR Para unitary QMF banks, two channel Para unitary QMF lattice, M – channel FIR Para unitary filter banks, Transform coding and LOT.

UNIT IV

Linear Phase and Cosine Modulated Filter Banks

Introduction, Some necessary conditions, Lattice structure for linear phase FIR PR banks, formal synthesis of linear phase FIR PR QMF Lattice. Pseudo QMF banks, Design of the pseudo QMF bank, Efficient polyphase structure, Cosine modulated perfect reconstruction system.

UNIT V

The Wavelet Transform and its Relation to Multirate Filter Banks

Introduction, Background and outline, short time Fourier transform, The Wavelet transform, DT orthonormal Wavelets, Continuous time orthonormal Wavelet basis.

UNIT VI

Multidimensional, Multivariable and Lossless Systems

Introduction, Multidimensional signals, Sampling a multidimensional Signals, Multirate fundamentals. Review of discrete time multi-input multi-output LTI System, ParaUNITary and lossless system.

Textbooks / References:

1. P.P.Vaidyanathan, PTR Prentice Hall, Englewood Cliffs , New Jersey, Multirate System and Filter Banks

2. N.J.Fliege, John Wiley & Sons, Multirate Digital Signal Processing
3. Raghuveer Rao, Ajit Bopardikar, Pearson Education Asia, Wavelet Transforms Introduction to Theory and Application
4. Sidney Burrus, R.A.Gopianath, Prentice Hall, Introduction to wavelet and wavelet Transform

12968PE102E Real Time embedded systems Credits 04

Course Objectives:

1. To provide understanding of the techniques essential to the design and implementation of device drivers and kernel internals of embedded operating systems.
2. To provide the students with an understanding of the aspects of the Real-time systems and Real-time Operating Systems.
3. To provide an understanding of the techniques essential to the design and implementation of real-time embedded systems.

Course Outcomes:

1. Learner will understand the Embedded Real Time software that is needed to run embedded systems
2. Learner will understand the open source RTOS and their usage.
3. Learner will understand the VxWorks RTOS and real-time application programming with it
4. Learner will be able to build device driver and kernel internal for Embedded OS & RTOS

UNIT I
Introduction:
Introduction to UNIX/LINUX, Overview of Commands, File I/O, (open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec.)

UNIT II
Real Time Operating Systems
Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization.

UNIT III
Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use

UNIT IV
Objects, Services, and I/O
Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem

UNIT V
Exceptions, Interrupts and Timers

Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

UNIT VI
Case Studies of RTOS
RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, Tiny OS, and Basic Concepts of Android OS.

Textbooks / References:
1. Qing Li, Elsevier, Real Time Concepts for Embedded Systems, 2011
2. Rajkamal, Embedded Systems- Architecture, Programming and Design, 2007, TMH.
3. Richard Stevens, Advanced UNIX Programming,
4. Dr. Craig Hollabaugh, Embedded Linux: Hardware, Software, and Interfacing.

12968OE102A New Labour Codes of India Credits 03

Course Objectives:
1. Gain a clear understanding of the key Labour Codes, namely the Code on Wages, Code on Social Security, Code on Occupational Safety, Health, and Working Conditions, and the Industrial Relations Code.
2. Explore the legal structure and scope of each Labour Code, understanding their applicability to different categories of workers and industries.
3. Examine the provisions related to wages, including wage definitions, payment structures, deductions, and methods for calculating wages
4. Analyse the components of social security as outlined in the Code on Social Security, including provident funds, health insurance, maternity benefits, and pensions.
5. Explore the mechanisms for resolving disputes and conflicts between employers and employees, including the role of labour courts, tribunals, and the appellate process.

Course Outcomes:
1. Understand the historical context and reasons behind the overhaul of labour laws in India.
2. Analyze the economic, social, and administrative motivations driving the implementation of the new labour codes.
3. Evaluate the impact of the new Industrial Relations Code on trade unions, collective bargaining, and dispute resolution mechanisms.
4. Analyze the potential effects of these provisions on both workers and employers.
5. Speculate on the possible evolution of labour practices and employer-employee relations in response to these codes.

UNIT I
History of Labour Laws
Introduction**,** Government Policies, History of Labour Laws in the Country, History: Previous Social Legislations in India, National Labour Commission Reports

UNIT II
Trade Unions

Evolution of Trade Unions in India, Constitutional Freedom to Form Association and Unions, International Labour Organization on Trade Unions, Trade Union – Definition, Registration, Cancellation, Management of Funds, Trade Union – Recognition, Immunities.

UNIT III
Strikes & Layoffs
Industrial Dispute – Introduction, Definitions, Resolution of Industrial Disputes, Concept of Workmen, Contract of service, Contract for service, Strike, Lock-out, Retrenchment, Closure of Undertakings, Industrial Employment (Standing Orders), Disciplinary Action and Procedures**.**

UNIT IV
Payment of Wages
The Code on Wages 2019 – An Introduction, Minimum Wages, Floor Wages, Central and State Advisory Board, Payment of Wages, Deductions & Recovery, Fines, Equal Remuneration, Bonus, Minimum Wage Fixing Convention, 1970, Protection of Wages Convention, 1949, Equal Remuneration Convention, 1951: International Instruments on Equality of Pay, Protection of Workers' Claims (Employer's Insolvency) Convention, 1992, Discrimination (Employment and Occupation) Convention, 1992

UNIT V
Social security & Insurance
Employees State Insurance, Different Benefits under the ESI Scheme, Employee's Provident Fund, Gratuity, Maternity Benefit, Social Security in case of Building and other Construction Workers, Social Security for Unorganized sector and Platform workers, Bonded Labour System Abolition and Regulation, Child Labour Prohibition, Plantation Labour.

UNIT VI
Factories & various types of workers
The Meaning of Factory, Manufacturing Process, Approval and Licensing of Factories, Role of Inspector-cum-facilitator and Other Authorities, Social Security Fund, Offences and Penalties, Contract Labour and Proposed ILO Convention, Inter-State Migrant Workers**,** Mines Workers, Beedi and Cigar Workers (Kerala & West Bengal Legislations), Audio-Visual workers, Cine-workers and Dock workers, The Effective Abolition of Child Labour (ILO: C029, C105, C138 & C182), The Governance Convention of ILO Labour Standards.

Textbooks / References:
1. Labour Law (Taxman)
2. E-book of the Ministry of Labour and Employment - https://labour.gov.in/e-book-1
3. Reading material prepared by the Course Co-ordinator.
4. Avtar Singh and Harpreet Kaur, Introduction to Labour and Industrial Laws, 2nd ed., Lexis Nexis Butterworths Wadhwa.

NPTEL platform:

NPTEL Course	**Name of Instructor**	**Host Institute**	**Link**
New Labour Codes of India	Prof. KD Raju	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc23_lw05/preview

12968OE102B Urban Utilities Planning: Water Supply, Sanitation and Drainage
Credits 03

Course Objectives:

1. To develop a clear understanding of the significance of water supply, sanitation, and drainage systems in urban areas.
2. To explore different sources of water supply for urban areas, including surface water, groundwater, and treated wastewater.
3. To delve into various sanitation systems, such as sewerage networks, on-site sanitation solutions, and wastewater treatment plants.
4. To learn about hydraulic calculations, pipe sizing, pump station design, and related technical aspects.

Course Outcomes:

1. Students should be able to demonstrate a clear understanding of the fundamental concepts related to water supply, sanitation, and drainage systems in urban settings.
2. Students should be capable of applying design principles to develop efficient and sustainable water supply, sanitation, and drainage systems that meet the needs of urban populations while considering factors such as population growth, climate change, and land use.
3. Students should be able to outline strategies for the effective management, operation, and maintenance of water supply, sanitation, and drainage infrastructure to ensure long-term sustainability and functionality.

UNIT I
Urban Utilities
Urban utilities planning: Introduction, Urban Water Supply, Collection of water.

UNIT II
Water Storage & Distribution
Pumping and storage, Water supply Distribution system and Plans, Water Quality, testing, treatment, and cost.

UNIT III
Sanitation
Sanitation and Drainage Fundamentals, Water carriage system, Sewer design,

UNIT IV
Sewage treatment
Sewer appurtenances and master plans, Sewage treatment, drainage, and recharge

Textbooks / References:

1. Water Supply Engineering, S. K. Garg (18th ed.), Khanna Publishers.
2. Water Supply and Sanitary Engineering, G. S. Birdie & J. S. Birdie (8th ed.), Dhanpat Rai Publishing Company, New Delhi.
3. Stormwater drainage manual Planning, Design and Management, Drainage services department, Government of the Hong Kong Special Administrative Region.

NPTEL platform:

NPTEL Course	Name of	Host Institute	Link

	Instructor		
Urban Utilities Planning: Water Supply, Sanitation and Drainage	Prof. Debapratim Pandit	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc23_ar08/preview

12968OE102C Environment and Development Credits 03

Course Objectives:

1. To help students comprehend the complex interconnections between environmental factors and development processes, highlighting how they can either support or impede each other.
2. To identify and analyze key environmental challenges arising from development activities, such as pollution, resource depletion, deforestation, loss of biodiversity, and climate change.
3. To study the effect of climate change on environment.
4. To analyze real-world case studies of both successful and unsuccessful attempts to integrate environmental considerations into development projects and policies

Course Outcomes:

1. Demonstrate a deep understanding of the complex interrelationships between environmental factors and socioeconomic development, including how they influence and shape each other.
2. Identify and critically analyze key environmental challenges resulting from development activities, and evaluate their impacts on ecosystems, natural resources, and human well-being.

UNIT I

Environmental movement

Introduction: Development, economic growth and sustainable development, Basic ecosystem ecology, Environmentalism, Environmental Movement, Environmentalism in the global south,

UNIT II

Social ecology

Approaches to environment: Ecofeminism, Feminist political ecology, Marxism and ecology, Debates on environmental ethics: Deep ecology, Gandhi and ecology, social ecology.

UNIT III

Impact of Religion on environment

Religion, environment, and conservation: Religion, environment and historical roots of ecological crisis, Biodiversity conservation ethics in Buddhism and Hinduism, Christian religion in the age of ecological crisis

UNIT IV

Natural Resources & development

Natural resource management, Common property vs. private property, Livelihoods, forests, and conservation, Displacement, dispossession, and development: Conservation-induced

displacement, Environment impact assessment and national rehabilitation & resettlement policy, Dispossession, and land acquisition.

UNIT V
Gender & Development, Climate change
Development theory and gendered approach to development, Gender, environment & sustainable development.
Environment and climate change: Climate change interventions and policy framework, Eastern Himalayas, and climate change.

UNIT VI
Belief and local knowledge of environment
Belief and knowledge systems, biodiversity conservation and sustainability: Ecological knowledge, biodiversity conservation and sustainability, Traditional religion and conservation of nature in Northeast India: Case study
Local knowledge in the environment-development discourse: Indigenous knowledge, environment and development, Relevance of indigenous knowledge: case study

Textbooks / References:

1. Arnold, David, and Guha, Ramchandra, (eds.), 1997. Nature, Culture and Imperialism, New Delhi: Oxford University Press.
2. Baviskar, Amita. 1997. In the Belly of the River: Tribal Conflicts over Development in the Narmada Valley, OUP, Delhi.
3. Barnhill, David Landis & Roger S. Gottlieb. (eds.) 2001. Deep Ecology and World Religions: New Essays on Sacred Grounds. State Univ. of New York Press, Albany.
4. Bicker, Alan, Paul Sillitoe and Johan Pottier. 2004. Development and Local Knowledge: New Approaches to Issues in Natural Resources Management, Conservation and Agriculture. Routledge, London & New York.
5. Esteva, G. 1997. 'Development' in W. Sachs, ed., The Development Dictionary, Orient Longman, pp. 8-34.
6. Gadgil, Madhav and Guha, Ramchandra. 1995. Ecology and Equity: The use and Abuse of Nature in Contemporary India, New Delhi: Oxford University.
7. Gottlieb, Roger S. 2004. This Sacred Earth: Religion, Nature, Environment. Routledge, New York, and London.
8. Merchant, Carolyn. 1994. Ecology: Key Concepts in Critical Theory, Humanities Press, New Jersey.
9. Ramakrishnan, P.S. 1992. Shifting Agriculture and Sustainable Development: An Interdisciplinary Study from North-Eastern India, Man and the Biosphere Series, Volume 10, UNESCO.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Environment and Development	Prof. Ngamjahao Kipgen	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc21_hs83/preview

12968OE102D	**Entrepreneurship**	**Credits 03**

Course Objectives:

1. To understand the role of entrepreneurs in driving innovation and economic growth.
2. Guide students through the process of developing a comprehensive business plan, including market research, financial projections, competitive analysis, and risk assessment.
3. Provide students with essential financial literacy skills, including budgeting, financial forecasting, and understanding different funding options such as bootstrapping, loans, venture capital, and angel investment.
4. Guide students through the process of developing, prototyping, and refining their products or services to meet customer needs and expectations.

Course Outcomes:

1. Students will be able to generate innovative business ideas by identifying market gaps, customer needs, and emerging trends.
2. Students will be capable of developing comprehensive business plans that encompass market research, financial projections, and strategic goals.
3. Students will gain skills in budgeting, financial forecasting, and managing financial resources for their entrepreneurial ventures.
4. Students will be able to identify and manage potential risks associated with entrepreneurship, including financial, operational, and market risks.

UNIT I

Entrepreneurial Journey, Entrepreneurial Discovery, Ideation and Prototyping,

UNIT II

Testing, Validation and Commercialisation, Disruption as a Success Driver

UNIT III

Technological Innovation and Entrepreneurship – 1, Technological Innovation and Entrepreneurship – 2, Raising Financial Resources.

UNIT IV

Education and Entrepreneurship, Beyond Founders and Founder-Families, India as a Start-up Nation

UNIT V

National Entrepreneurial Culture, Entrepreneurial Thermodynamics,

UNIT VI

Entrepreneurship and Employment, Start-up Case Studies

Textbooks / References:

1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel.
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries.
3. India as Global Start-up Hub: Mission with Passion by C B Rao.
4. Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future by Ashlee Vance.

5. Steve Jobs by Walter Isaacson.
6. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker.
7. The Innovator's Solution: Creating and Sustaining Successful Growth by Clayton M Christensen.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Entrepreneurship	Prof. C Bhaktavatsala Rao	IIT Madras	https://onlinecourses.nptel.ac.in/noc20_mg35/preview

12968OE102E Research Methodology Credits 03

Course Objectives:

1. To develop a research orientation among the scholars and to acquaint them with fundamentals of research methods.
2. To develop understanding of the basic framework of research process.
3. To identify various sources of information for literature review and data collection.
4. To understand the components of scholarly writing and evaluate its quality.

Course Outcomes:

1. Learner will learn the meaning, objective, motivation, and type of research
2. Learner will be able to formulate their research work with the help of literature review
3. Learner will be able to develop an understanding of various research design and techniques
4. Learner will have overview knowledge of modelling and simulation of research work
5. Learner will be able to collect the statistical data with different methods related to research work
6. Learner will be able to write their own research work with ethics and non-plagiarized way.

UNIT I
Philosophy of Science (subjective versus objective, materialism versus idealism, causality, etc.) Logical Reasoning (inductive logic, deductive logic, syllogistic logic)

UNIT II
History of development of science and the influence of philosophy, What Scientists Actually do

UNIT III
Forming a Hypothesis, Techniques of Scientific Measurement

UNIT IV
Testing of hypothesis, Methods of Theoretical Research

UNIT V
The Art of Scientific Communication, Presentation in Seminars and Conferences, Sponsored Research, Ethical Conduct in Science

Textbooks / References:

1. Soumitro Banerjee, Research Methodology for Natural Sciences, IISc Press, 2022.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Research Methodology	Prof. Soumitro Banerjee	IISER Kolkata	https://onlinecourses.nptel.ac.in/noc22_ge08/preview

12968MP102 Mini-Project Credits 02

The mini project shall be based on the recent trends in the industry, research and open problems from the industry and society. This may include mathematical analysis, modelling, simulation, and hardware implementation of the problem identified. The mini project shall be of the student's choice and approved by the guide. The student must submit the report of the work carried out in the prescribed format signed by the guide and Head of the department/institute.

12968AE102A
Indian Knowledge System (IKS): Concepts and Applications in Engineering
Credits 03

Course Objectives:

1. Introduce students to the foundational concepts, philosophies, and components of Indian knowledge systems, including ancient scriptures, philosophies, and traditional practices.
2. Introduce students to Vedic mathematical principles and computational techniques from ancient Indian texts, demonstrating their practical use in engineering calculations.
3. Explore the potential benefits of incorporating yogic and meditative practices into engineering to enhance focus, creativity, and overall well-being.
4. Study architectural concepts from Indian traditions and evaluate how they can inform modern urban planning and sustainable architecture.
5. Encourage students to draw inspiration from IKS to develop innovative engineering solutions that align with ancient wisdom while meeting contemporary needs.

Course Outcomes:

1. Gain a comprehensive understanding of the philosophical, scientific, and technological aspects of Indian Knowledge Systems and their historical development.
2. Understand the philosophical underpinnings of IKS, including concepts like dharma, karma, and holistic thinking, and explore their relevance to engineering.
3. Understand Vedic mathematical principles and computational methods, and their potential relevance in solving modern engineering problems.
4. Investigate the connections between yoga, meditation, and stress management, and their potential impact on mental well-being in engineering contexts.
5. Reflect on the ethical, cultural, and social dimensions of integrating IKS concepts into engineering practices and applications.

UNIT I

Indian Knowledge System – An Introduction & Vedic Corpus

What is IKS? Why do we need IKS? Organization of IKS, Historicity of IKS, Some salient aspects of IKS,

Introduction to Vedas, A synopsis of the four Vedas, Sub-classification of Vedas, Messages in Vedas, Introduction to Vedāṅgas, Prologue on Śikṣā and Vyākaraṇa, Basics of Nirukta and Chandas, Introduction to Kalpa and Jyotiṣa, Vedic Life: A Distinctive Features.

UNIT II

Number system & Mathematics

Number systems in India - Historical evidence, Salient aspects of Indian Mathematics, Bhūta-Saṃkhyā system, Kaṭapayādi system, Measurements for time, distance, and weight, Piṅgala and the Binary system.

Introduction to Indian Mathematics, Unique aspects of Indian Mathematics, Indian Mathematicians and their Contributions, Algebra, Geometry, Trigonometry, Binary mathematics, and combinatorial problems in Chandaḥ Śāstra, Magic squares in India

UNIT III

Engineering Technology: Metal & Other applications

Wootz Steel: The rise and fall of a great Indian technology, The Indian S & T heritage, Mining and ore extraction, Metals and metalworking technology, Iron and steel in India, lost wax casting of idols and artefacts, Apparatuses used for extraction of metallic components.

Irrigation systems and practices in South India, literary sources for science and technology, Physical structures in India, irrigation and water management, dyes and painting technology, the art of making perfumes, Surgical techniques, shipbuilding, sixty-four art forms (64 Kalās) status of Indigenous S & T.

UNIT IV

Town Planning and Architecture:

Perspective of Arthaśāstra on town planning, Vāstu-śāstra – The science of architecture eight limbs of Vāstu, town planning, temples in India: Marvelous stone architecture for eternity, temple architecture in India, Iconography.

UNIT V

Knowledge Framework and classifications:

Indian scheme of knowledge, The knowledge triangle, Prameya – A vaiśeṣikan approach to physical reality, Dravyas – the constituents of the physical reality, Attributes – the properties of substances and Action – the driver of conjunction and disjunction, Sāmānya, viśēṣa, samavāya, Pramāṇa – the means of valid knowledge, Saṃśaya – ambiguities in existing knowledge, Framework for establishing valid knowledge, Deductive or inductive logic framework, Potential fallacies in the reasoning process, Siddhānta: established tenets in a field of study.

UNIT VI

Linguistics

Introduction to Linguistics, Aṣṭādhyāyī, Phonetics, word generation, computational aspects, Mnemonics, Recursive operations, Rule based operations, Sentence formation verbs and prefixes, role of Sanskrit in natural language processing.

Textbooks / References:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Indian Knowledge System (IKS): Concepts and Applications in Engineering	Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan	Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan	https://onlinecourses.swayam2.ac.in/imb23_mg53/preview

12968AE102B
Indian Knowledge System (IKS): Humanities and Social Sciences
Credits 03

Course Objectives:

1. Introduce students to the diverse range of Indian philosophical, cultural, and social knowledge systems that have evolved over millennia.
2. Encourage students to critically compare Indian knowledge systems with other global philosophies and social theories, fostering a nuanced understanding.
3. Study Vedic texts, ancient scriptures, and philosophical treatises to understand the core ideas and insights that inform Indian knowledge systems.
4. Investigate the intersections of spirituality, psychology, and well-being in Indian knowledge systems, exploring practices like meditation, yoga, and mindfulness.
5. Study the role of language, symbols, and communication in Indian knowledge systems, including Sanskrit as a language of knowledge transmission.

Course Outcomes:

1. Recognize the interdisciplinary nature of IKS, integrating traditional knowledge with contemporary concepts in humanities and social sciences.
2. Explore India's rich cultural heritage, including literature, art, music, dance, and rituals, and analyze their significance in shaping identity and social cohesion.
3. Explore Indian philosophical schools and their insights into consciousness, self-awareness, and psychological well-being.
4. Analyze India's cultural diversity, pluralism, and the coexistence of various belief systems, contributing to tolerance and social harmony.

UNIT I
Indian Knowledge System – An Introduction & Vedic Corpus

What is IKS? Why do we need IKS? Organization of IKS, Historicity of IKS, Some salient aspects of IKS,

Introduction to Vedas, A synopsis of the four Vedas, Sub-classification of Vedas, Messages in Vedas, Introduction to Vedāṅgas, Prologue on Śikṣā and Vyākaraṇa, Basics of Nirukta and Chandas, Introduction to Kalpa and Jyotiṣa, Vedic Life: A Distinctive Features.

UNIT II

Philosophical Systems

An introduction to philosophical systems, development of philosophy unique features of philosophy, Sāṅkhya approach of philosophy, Introduction to Yoga, tenet of Nyāya philosophy principles of Vaiśeṣika, doctrine of Pūrva-Mīmāṃsā Darśana, thesis of Vedānta and synopsis of Advaita philosophy of Viśiṣṭādvaita.

UNIT III

Wisdom through ages

Gateways of ancestral wisdoms, introduction to Purāṇa, the Purāṇic repository, Issues of interest in Purāṇas, Introduction to Itihāsas, Key messages in Itihāsas, Wisdom through Nīti-śāstras, Wisdom through Subhāṣita.

UNIT IV

Health Wellness and Psychology:

Introduction to health, Āyurveda: approach to health, Sapta-dhātavaḥ: seven-tissues, role of agni in health, tri-doṣas, Āyurveda: definition of health, Psychological aspects of health, disease management elements, Dinacaryā: daily regimen for health & wellness, Importance of sleep, Food intake methods and drugs, Approach to lead a healthy life, Indian approach to psychology, the tri guṇa system & holistic picture of the individual, the Nature of Consciousness, consciousness studies and issues

UNIT V

Linguistics:

Introduction to Linguistics, Aṣṭādhyāyī, phonetics, word generation, computational aspects, mnemonics, recursive operations, rule-based operations, sentence formation, verbs and prefixes, role of Sanskrit in natural language processing.

UNIT VI

Governance and Public Administration:

Introduction to raja dharma, Arthaśāstra: a historical perspective, Elements of a kauṭilyan state, The king & the amātya, Janapada & durga, treasury and the state economy (Kośa), danda, Mitra, the administrative setup, relevance of Arthaśāstra, public administration in Epics.

Textbooks / References:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.
2. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
3. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
4. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
5. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.
6. Dasgupta,S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.

7. PLofker, K. (1963). Mathematics in India, Princeton University Press, New Jeresy, USA"

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Indian Knowledge System(IKS): Humanities and Social Sciences	Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan	Indian Institute of Management Bangalore (IIMB), Chanakya University, Bangalore	https://onlinecourses.swayam2.ac.in/imb23_mg55/preview

12968AU102 Disaster Management Audit

Course Objectives:

1. Mastering strategies to manage disasters and ensure public safety during emergencies.
2. Identifying hazards, vulnerabilities, and crafting plans to reduce disaster impact.
3. Collaborative Skills: Working across disciplines to address complex disaster challenges.
4. Developing, improving, and implementing disaster management policies. Community Empowerment: Educating and engaging communities for proactive disaster readiness.

Course Outcomes:

1. Learners will be able to understand the basic concept of disaster(s) and disaster management, their significance, and types.
2. Learners will develop the analytical skills to study relationship between vulnerability, disasters, disaster prevention and risk reduction
3. Learners will gain a preliminary understanding of approaches to Disaster Risk Reduction (DRR)
4. Learners will be empowered with the awareness of institutional processes in the country for Disaster Management

UNIT I

Disaster Management: Disaster and Disaster Management – Concepts, Issues Concerned with Disaster Management.
Disaster Management: Phases of Disaster Management, Phases of Disaster Management
Types of Disasters: Bhopal Disaster: A Case Study, Types of Disasters-An Introduction, Natural Disaster, Man-made Disaster

UNIT II

Types of Disasters: Slow onset Disasters & Rapid onset Disasters, Simple and Complex, Tsunami: A Case Study Disasters, Tsunami: A Case Study, Cyclone Phallin 2013: A Case Study

UNIT III

Disaster Management in India -An Over View: Evolution of Disaster Management in India, Disaster and Disaster Management in India, National institute of Disaster Management, National Disaster Management Act 2005.

UNIT IV

Disaster Management in India -An Over View: The National Policy on Disaster Management, 2009.

Refugee Problem: National Plan on Disaster Management 2016, Refugee Problems, Impact of Disaster on the lives of Refugees.

Refugee Problem: Problems of Women and Children during disasters, Principles Of Psychosocial Care, Issues And Recovery During Emergency.

Refugee Problem: Relationship between Disasters, Development and Vulnerabilities, Relationship between Disasters, Development and Vulnerabilities.

UNIT V

Refugee Problem: Equity Issues in Disaster.

Refugee Problem: Issues of Rehabilitation and Resettlement among the Disaster Survivors, Stakeholders in Disaster Relief Management - An Introduction.

Stakeholders in Disaster Relief Management: Central Government.

Stakeholders in Disaster Relief Management: State Government, District Administration.

Armed Forces.

UNIT VI

Stakeholders in Disaster Relief Management: Para-Military Forces, Fire Services.

Disaster Risk Reduction: Disaster Risk Reduction Strategies, Risk Reduction Preparedness Plans.

Disaster Risk Reduction: Action Plans and Procedures, Early Warning Systems, Components of Disaster Relief, Factors contributing to Vulnerability.

Disaster Risk Reduction: Disaster Risk Reduction - Master Planning for the Future, Capacity Building Rehabilitation measures and long-term reconstruction, Understanding Kerala Disaster 2018.

Textbooks / References:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
5. Encyclopaedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006
6. Encyclopaedia of Disasters – Environmental Catastrophes and Human Tragedies, Vol. 1 & 2, Angus M. Gunn, Greenwood Press, 2008
7. Disasters in India Studies of grim reality, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur.
8. Management of Natural Disasters in developing countries, H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi, 2006, 201 pages
9. Natural Disasters, David Alexander, Kluwer Academic London, 1999, 632 pages
10. Disaster Management Act 2005, Publisher by Govt. of India
11. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management
12. NIDM Publications
13. High Power Committee Report, 2001, J.C. Pant

14. Disaster Mitigation in Asia & Pacific, Asian Development Bank
15. National Disaster Management Policy, 2009, GoI
16. Disaster Preparedness Kit, American Red Cross

NPTEL platform:

NPTEL Course	**Name of Instructor**	**Host Institute**	**Link**
Disaster Management	Naveen Kumar Nanjundan	University Of Hyderabad	https://onlinecourses.swayam2.ac.in/cec19_hs20/preview

SEMESTER III

12968OE201A	Student Psychology	Credits 03

Course Objectives:

1. Gain an understanding of prominent learning theories and models, enabling you to grasp the foundational concepts that influence effective teaching and learning.
2. Acquire skills to assess and appreciate diverse student characteristics, including learning styles, cultural backgrounds, and individual differences that impact learning.
3. Gain proficiency in understanding, administering, and interpreting psychological tests and inventories to assess cognitive abilities, personality traits, and emotional development in learners.
4. Examine psychological theories of motivation and cultivate the skills needed to apply motivational strategies that enhance student engagement, commitment, and achievement.
5. Investigate the stages of physical, cognitive, emotional, and social development in individuals, equipping you to design instructional methods that support comprehensive growth.
6. Acquire an understanding of NLP concepts and techniques that can be used to improve communication, establish rapport, and optimize teaching and learning experiences.

Course Outcomes:

1. Understanding of Psychological Factors: Gain a comprehensive understanding of the psychological factors that influence students' learning, behaviour, and overall well-being in educational settings.
2. Recognition of Diverse Student Needs: Develop the ability to recognize and appreciate the diverse cognitive, emotional, and social needs of students, enabling tailored support and fostering inclusive learning environments.
3. Application of Psychological Strategies: Apply psychological theories and principles to address various challenges in student development, including motivation, learning difficulties, and behavioural issues.
4. Competence in Student Assessment: Acquire skills in utilizing psychological assessment tools to evaluate students' cognitive abilities, emotional states, and learning styles, informing instructional strategies and support plans.
5. Promotion of Positive Learning Experiences: Learn to create positive and conducive learning experiences by integrating insights from student psychology, fostering engagement, motivation, and holistic growth among learners.

UNIT I
Teaching Learning Process

UNIT II
Student Characteristics, Types and Problems

UNIT III
Psychological Tests and Inventories, Student Motivation

UNIT IV
Physical and Cognitive Development

UNIT V
Emotional and Social Development

UNIT VI
Neuro-Linguistic Programming, Counselling Skills, and Summary

Textbooks / References:

1. Sharma, R.A. (2007). Training Technology. Meerut: Surya Publications.
2. Sharma, R.A. (2007). Psychology of Teaching-Learning Process. Meerut: Surya Publications.
3. B.Mukhopadhyay(1997). Motivation in Educational Management. New Delhi: Sterling Publishers.
4. Barki & Mukhopadhyay. (1995). Guidance and Counselling. New Delhi: Sterling Publishers.
5. Agochya, D. (2010). Life competencies for adolescents. New Delhi: Sage Publications.
6. Davies, I.K. (1971). Management of Learning. Berkshire: McGraw Hill.
7. Dusay. (1980). Egograms. New York: harper & Row.
8. Goleman, D. (1996). Emotional Intelligence. New York: Bantom Books.
9. Anastasi. (2016). Psychological Testing. New Delhi: Pearson Education. Psychological Tests.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Student Psychology	Dr. S. Renukadevi	NITTTR, Chennai	https://onlinecourses.swayam2.ac.in/ntr19_ed23/preview

12968OE201B Business To Business Marketing (B2B) Credits 03

Course Objectives:

1. Develop a comprehensive understanding of the unique characteristics, dynamics, and complexities that define business-to-business (B2B) marketing, including the role of intermediaries, supply chains, and collaborative relationships.
2. Learn how to segment B2B markets based on factors such as industry, company size, and purchasing behaviour. Understand the significance of effective market segmentation in tailoring marketing strategies to specific B2B customer segments.
3. Explore the elements of the B2B marketing mix, including product/service offerings, pricing strategies, distribution channels, and promotional approaches. Develop the ability to design marketing strategies that align with the unique needs and preferences of B2B customers.
4. Gain insights into relationship-building strategies in B2B contexts. Learn how to nurture long-term, mutually beneficial partnerships with B2B clients through effective communication, trust-building, and value delivery.
5. Acquire skills in B2B sales processes, negotiations, and contract management. Understand the intricacies of negotiation dynamics, procurement processes, and key decision-making factors in B2B transactions.

Course Outcomes:

1. Foundational Knowledge: Gain a strong grasp of the core concepts and theories that form the basis of B2B marketing, enabling practical application.
2. Market Analysis Expertise: Develop skills to analyse B2B markets, segment customers effectively, and make informed marketing decisions.
3. Strategic Implementation: Acquire the ability to design and execute B2B marketing strategies tailored to the unique needs of business customers.
4. Relationship Management: Learn how to build and nurture enduring relationships with B2B clients through effective communication and collaboration.
5. Sales and Negotiation Proficiency: Master the art of B2B sales, negotiation strategies, and contract management for successful transactions.

UNIT I

Introduction to B2B Marketing: Business marketing, Classifying goods for the business market, Business market customers, Market structure, Environment and Characteristics of Business Marketing, Strategic role of marketing, Commercial enterprises, Commercial and institutional customers, B2B vs B2C Marketing.

Organizational Buying and Buyer Behaviour: Organizational buyers' decision process - A Stepwise Model and A Process Flow Model, Organizational and business markets - Government as a customer - Commercial enterprises - Commercial and institutional customers, Value analysis, Buygrid framework, Strategic procurement.

UNIT II

B2B Marketing Strategy: Strategy making and strategy management process, Industrial product strategy– Managing Products for Business Markets-Managing Services for Business Markets-Managing Business Market Channels the Growth-Share Matrix, Multifactor Portfolio Matrix, The Balanced Scorecard.

B2B Marketing STP: Market Segmentation, bases for segmenting business markets, basic framework of segmentation, choosing target segments and positioning.

UNIT III

Business Marketing Communications- B2B Advertising, Digital marketing, - Trade shows, exhibitions, business meets - Managing the sales force - Deployment analysis, Direct marketing

Demand forecasting: industrial market, Forecasting- meaning, importance and relevance, issues related to forecasting, forecasting measurement models, sales force forecasting, estimating segment demand, Collaborative approach to estimate demand, qualitative and quantitative forecasting methods.

UNIT IV

Product management: (existing and new) in industrial market, role of product in the industrial market, new product development, industrial product life cycle, product evaluation matrix, techniques for identifying new products QFD, perceptual mapping, reverse engineering, fish bone diagram, role of service and maintenance in industrial markets, customer experience life cycle, service quality.

Pricing: Pricing strategies; The pricing policy; Price on the Internet; Financial marketing, competitive bidding, commercial terms and conditions, role of leasing.

UNIT V

Buyer seller relationship, types of relationships, transactional and collaborative relationships, influencing industrial customers, role of service in industrial markets. CRM.

B2B marketing research, challenges in B2B research, developing a marketing information system, role of qualitative research techniques in B2B research.

UNIT VI

Business marketing channels and participants - Channel design and management decisions - B2B logistics management, types of industrial middlemen and intermediaries, marketing logistics and physical distribution.

Strategic decision making in industrial markets, strategic planning at corporate levels, allocation of resources, portfolio analysis, developing SBU'S objectives and goals, implementing and controlling marketing plan. Marketing through electronic commerce.

Textbooks / References:

1. Business Market Management Understanding, Creating and Delivering Value by James C. Anderson, Das Narayandas, James A. Narus and D.V.R. Seshadri Pearson, 2010 3rd edition
2. Business Marketing Management b2b By Hutt and Speh South-Western CENGAGE Learning www.cengagebrain.com 2013
3. B2B Brand Management by Kotler and Pfoertsch Springer www.springer.com 2006
4. Business Marketing: Text and Cases by Krishna K Havaldar, McGrawhill Publications, 2014 4th edition.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Business To Business Marketing (B2B)	Prof. J. K. Nayak	IIT Roorkee	Business To Business Marketing (B2B) – Course (nptel.ac.in)

12968OE201C Organizational Behaviour Credits 03

Course Objectives:

1. Explore how personality, motivation, perception, attitudes, and emotions impact employee performance and job satisfaction.
2. Study group formation, communication, decision-making, conflict resolution, and leadership's role in fostering teamwork.
3. Learn about the role of organizational culture in shaping behaviour, and develop skills to manage and align culture with goals.
4. Gain insights into leadership styles, communication, and team management for enhancing performance and satisfaction.
5. Navigate change, promote inclusivity, and address diversity-related challenges to cultivate adaptability and resilience in the workplace.

Course Outcomes:

1. Develop a grasp of how individual factors influence workplace behaviour, impacting job satisfaction and performance.

2. Acquire skills to foster productive group dynamics, facilitating better communication, decision-making, and conflict resolution.
3. Understand the role of organizational culture, and learn to manage and cultivate cultures aligned with organizational goals.
4. Gain insights into diverse leadership styles, enhancing the ability to manage teams and guide them towards success.
5. Develop the capacity to navigate change, promote diversity, and create an inclusive work environment, fostering resilience.

UNIT I

Introduction – a) defining organization, behavior and organizational behavior, b) assumptions of OB, c) principles of OB, d) levels of OB, e) scope of OB, f) OB and Human Resource Management, g) Applications of OB, h) Historical developments of OB, i) emerging concerns

Perception and Learning – a) understanding perception, b) Basic elements of perception, c) Principles of perceptual selection, d) Perceptual grouping, e) Social Perception, f) Self-perception and identity, g) attribution of causality, h) Perceptual biases in social perception, i) Implications for human resource management, j) defining learning, k) classical and operant conditioning l) learning in organizations.

UNIT II

Personality – a) Defining Personality, b) History of the concept, c) Key assumptions, d) biological and social determinants, e) Theories – Intrapsychic theory, social learning theory, self-theory, Trait, and type theories f) Related concepts (locus of control, dogmatism, authoritarianism, Machiavellianism), g) measuring personality.

Attitudes – a) Definition, b) Key elements of attitudes, c) Attitudes and related concepts (Values, opinion, belief, and ideology), e) Characteristics of attitudes, f) Attitude formation, g) Attitude measurement, h) Changing attitudes, i) Attitudes at workplace (job satisfaction, work attitude and organizational commitment), j) Prejudice and discrimination at workspace.

UNIT III

Emotions in workplace - a) Definition, b) Types of emotions, c) Related concepts (mood, temperament), d) Stress in workplace, e) General Adaptation Syndrome, f) Managing Stress, g) Psychosomatic disorders and stress h) emotional labor and emotional contagion.

Motivation – a) Definition, b) Process of motivation, c) Types of motives, d) Motivators at workplace, e) Motivation theories (Process and Content theories).

UNIT IV

Interpersonal Dynamics – a) Definition, b) Psychological Contract, c) Trust and trust building, d) Prosocial behaviour, e) Cooperation Vs Competition f) Conflict management, g) Levels and types of conflict at workplace, h) Conflict management Styles, i) Managing Negotiations

Power and Leadership - a) Defining Power, b) Sources of Power, c) Organizational politics, d) Leadership e) Managers Vs Leaders, f) Trait and Type approach to leadership g) Leadership style, h) Leadership Grid, i) Contingency Theories j) Contemporary issues

UNIT V

Team Dynamics – a) Groups and Teams, b) Types of Teams, c) Stages in group development, d) problems in team work (Free riding, social loafing, group think), e) Cross-cultural virtual teams.

Organizational culture – a) Defining culture, b) levels of culture, c) cultural dimensions, d) high and low context cultures, e) Strong and weak organizational cultures, f) Expressions of organizational culture, g) Impact of culture on individuals, h) Organizational cultural change

UNIT VI

Organization Change – a) Change in Organizations, b) Nature of the chance process, c) Types of chance, d) Impact of change, e) Managing resistance to change, f) Organizational Development interventions

Organizational Structure and Design – a) Basic dimensions of structure, b) Departmentalization, c) Organizational life cycle, d) Organizations as socio-technical systems, e) Organizational design and its impact on employees, f) Organizational boundary spanning.

Textbooks / References:

1. Behaviour in Organizations by Jerald Greenberg and Robert A. Baron, PHI learning private Ltd, New Delhi (Ninth Edition).
2. Understanding Organizational Behaviour by Udai Pareek, Oxford University Press (Third Edition).
3. ORGB by Nelson, Quick and Khandelwal, Cengage Learning New Delhi (second edition).

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Organizational Behaviour	Prof. M. P. Ganesh	IIT Hyderabad	Organizational Behaviour – Course (nptel.ac.in)

12968OE201D Principles of Economics Credits 03

Course Objectives:

1. Introduce essential economic terms and concepts for analysing real-world situations.
2. Understand market dynamics, supply and demand, and resource allocation.
3. Study national indicators, inflation, unemployment, and government policies' effects.
4. Learn to make informed choices using opportunity cost, utility, and cost analysis.
5. Explore global interdependencies, trade, exchange rates, and policy impacts.

Course Outcomes:

1. Grasp key economic principles, like supply and demand, opportunity cost, and marginal analysis, forming a foundation for economic understanding.
2. Gain insights into market structures, pricing mechanisms, and factors influencing consumer and producer behaviour.
3. Understand the role of government interventions, regulations, and fiscal/monetary policies in shaping economic outcomes.
4. Learn how societies allocate scarce resources efficiently, exploring topics like production, distribution, and factors of production.
5. Develop analytical thinking by applying economic principles to real-world scenarios, making informed personal and business decisions.

UNIT I
Principles of Economics, Thinking like an Economist; Interdependence and the gains from Trade.

UNIT II
Market forces of supply and Elasticity, Application of elasticity; supply, demand, and government policies

UNIT III
Consumer and producer surplus; cost of taxation and international trade, Externalities, and cost of production

UNIT IV
Competitive market and monopoly market, Game theory and oligopoly, measures national income, measuring cost of living

UNIT V
Production and growth; Saving, Investment and the financial system, the monetary system, Money growth and inflation

Textbooks / References:

1. N. Gregory Mankiw, Principles of Economics.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Principles Of Economics	Prof. Sabuj Kumar Mandal	IIT Madras	Principles Of Economics – Course (nptel.ac.in)

12968OE201E Intellectual Property & Rights Credits 03

Course Objectives:

1. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.
2. To get registration in our country and foreign countries of their invention, designs and thesis or theory written by the students during their project work and for this they must have knowledge of patents, copy right, trademarks, designs and information Technology Act.
3. Further teacher will have to demonstrate with products and ask the student to identify the different types of IPR's.

Course Outcomes:

1. The students once they complete their academic projects, they get awareness of acquiring the patent.
2. They also learn to have copyright for their innovative works.
3. They also get the knowledge of plagiarism in their innovations which can be questioned legally.

UNIT I

Introduction to IPR: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights, Introduction to TRIPS and WTO, Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade; Secret and trade dress, Design, Layout Design, Geographical Indication, Plant. Varieties and Traditional Knowledge.

UNIT II

Patent Rights and Copy Rights— Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.

UNIT III

Copy Right—Origin, Definition &Types of Copy Right, Registration procedure, Assignment & licence, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.

UNIT IV

Trade Marks: Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties. Domain Names on cyber space.

UNIT V

Design- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.

UNIT VI

Basic Tenants of Information Technology Act-2000, IT Act - Introduction, E-Commerce and legal provisions, E- Governance and legal provisions, Digital signature, and Electronic Signature. Cybercrimes.

Textbooks / References:

1. Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
2. Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L. Wadehra
3. IPR by P. Narayanan
4. Law of Intellectual Property, Asian Law House, Dr. S.R. Myneni.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Intellectual Property & Rights	Prof. Feroz Ali	IIT Madras	https://onlinecourses.nptel.ac.in/noc23_hs55/preview

12968OE201F Introduction to Public Administration Credits 03

Course Objectives:

1. Define public administration and explain its role in society.
2. Identify and analyze the different types of public organizations.
3. Apply public administration theories and principles to real-world problems.
4. Develop the skills and knowledge necessary to pursue a career in public administration.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Define public administration and explain its role in society.
2. Identify and analyze the different types of public organizations.
3. Apply public administration theories and principles to real-world problems.
4. Develop the skills and knowledge necessary to pursue a career in public administration.

UNIT – I

Public Administration: Meaning Nature, Scope and Significance of Public, Administration. Difference between Public and Private Administration, Administration as an Art or Science, New Public Administration, New Public Management, E-Governance: Concept, Rationale and significance.

UNIT – II

Theories of Organization – Classical, Neo classical and Modern theory, Approaches to the study of Public Administration: Structural – functional, systems, approach, Behavioral approach, Public Choice approach, Bureaucracy: Meaning types and Weberian model of Bureaucracy.

UNIT – III

Organization: formal and informal organizations, Principles of organization – Hierarchy, Span of control, unity of command and Coordination.

UNIT IV

Concepts of Public Administration: Power, Authority, and responsibility, Decision Making: Meaning, Classification and Essentials of decision making, Process of decision making, techniques of decision making, approaches to decision making.

UNIT – V

Good Governance: Concept, characteristics, elements. Issues and Challenges, Leadership: Development of leadership, Qualities of leadership, Accountability, and control –Executive, Legislative, Judicial. Citizen and Administration: Issues and problems, Methods to promote good relationship.

References/Textbooks:

1. Felix, A. Nigro and C. Nigro Modern Public Administration (New York: Lloyd Harper and Row, Latest edition)
2. John Pfiffiner and Frank Sherwood Administrative Organization (New Delhi: Prentice Hall, Latest ed.).

3. Peter F. Drucker Management: Tasks, Responsibilities, Practices (Bombay: Allied Publishers, latest ed.).
4. H. Koontz and Cyril O'Donnell Principles of Management, (Tokyo: McGraw Hill, latest ed).
5. Amitai Etzioni Modern Organizations (New Delhi: Prentice Hall, latest ed.).
6. Robert T. Golembiewsky Public Administration as a Developing Discipline (New York: Marcel, latest ed.).
7. Mohit Bhattacharya Public Administration (Calcutta: World Press, latest ed).
8. Mamta Mokta, S.S.Chauhan, S.K. Mahajan and Simmi Agnihotri Challenges in Governance(ed) Anamica Publishers,New Delhi 2011
9. C.P. Bhambri Public Administration (Theory and Practice (Meerut: Educational Publishers, latest ed.).
10. Bertram Gross The Managing of Organisations (London: Free Press, latest ed.).
11. W.M. Newman, C. Summer and E.Warren Management Concepts, behaviour & practice, edu. Publishers Meerut.
12. P. Herseay and K.H. Blanchard Management of Organisational Behaviour (New Delhi:latest ed.).
13. Nicholas Henry Public Administration and Public Affairs, (New Jersey: Prentice Hall, latest ed.).
14. Herbert G. Hicks and Ray C. Gutlet Organisations: Theory and Behaviour (New York: McGraw Hill, latest ed.).
15. Ramesh, K. Arora (ed.) Perspective in Administrative Theory (New Delhi: Associated, latest ed.).
16. S.L. Kaushik and Pardeep Sahni (eds.) Public Administration in India: Emerging Trends (Allahabad: Kitab Mehal, latest ed.).
17. J.S. Vickers and George K. Yarrow Privatization: An Economic Analysis (Cambridge: MIT Press, latest ed.).
18. David Osborne and T. Gaebler Re-inventing Government: How the Entrepreneurial Spirit is Transforming the Public Sector (New York: Addison Wesley, latest ed.).

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Introduction to Public Administration	By Prof. Y. Pardhasaradhi	Osmania University Hyderabad.	https://onlinecourses.swayam2.ac.in/cec21_hs06/preview

12968MD201A Design of Mechatronic Systems Credits 03

Course Objectives:

1. Introduce students to the interdisciplinary nature of mechatronics, emphasizing the integration of mechanical engineering, electronics, control systems, and computer science.
2. Familiarize students with a variety of sensors and actuators commonly used in mechatronic systems, and explain their principles of operation and selection criteria.
3. Provide an understanding of control system theory, enabling students to design and implement closed-loop control strategies for mechatronic systems.
4. Introduce software development concepts, including programming languages, real-time operating systems, and software architecture for mechatronic applications.

5. Demonstrate techniques for integrating mechanical components, electronics, and software modules seamlessly, ensuring proper communication and synchronization.

Course Outcomes:

1. Apply knowledge to select appropriate sensors and actuators based on system requirements, considering factors such as accuracy, range, and compatibility.
2. Analyze and process sensor data using signal processing techniques, demonstrating the capability to extract meaningful information from noisy sensor measurements.
3. Proficiently program microcontrollers and embedded systems to interface with sensors, actuators, and other hardware components.
4. Integrate mechanical components and subsystems with electronics and software, ensuring seamless communication and optimal functionality.

UNIT I

Introduction: Elements of mechatronics system: Sensor, actuator, plant, and controller. Applications of mechatronics system. Systems like CDROM, scanner opened to see what's there inside and why? Integrated mechanical-electronics design philosophy. Examples of real-life systems. Smart sensor concept and utility of compliant mechanisms in mechatronics

UNIT II

Microprocessor building blocks, combinational and sequential logic elements, memory, timing, and instruction execution fundamentals with example of primitive microprocessor. Microcontrollers for mechatronics: Philosophy of programming interfaces, setting sampling time, and getting started with TIVA programming. programming different interfaces PWM, QEI etc. Mathematical modeling of mechatronic systems,

UNIT III

Modeling friction, DC motor, Lagrange formulation for system dynamics. Dynamics of 2R manipulator, Simulation using MATLAB, Selection of sensors and actuators.

UNIT IV

Concept of feedback and closed loop control, mathematical representations of systems and control design in linear domain. Basics of Lyapunov theory for nonlinear control, notions of stability, Lyapunov theorems and their application

UNIT V

Trajectory tracking control development based on Lyapunov theory, Basics of sampling of a signal, and signal processing.

UNIT VI

Digital systems and filters for practical mechatronic system implementation. Research example/ case studies of development of novel mechatronics system: 3D micro-printer, Hele Shaw system for microfabrication.

Textbooks / References:

1. Devdas Shetty, Richard A. Kolk, "Mechatronics System Design," PWS Publishing company.

2. Boukas K, Al-Sunni, Fouad M "Mechatronic Systems Analysis, Design and Implementation," Springer,
3. Sabri Cetinkunt, "Mechatronics with Experiments," 2nd Edition, Wiley.
4. Janschek, Klaus, "Mechatronic Systems Design," Springer.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Design Of Mechatronic Systems	Prof. Prasanna Gandhi	IIT Bombay	Design Of Mechatronic Systems – Course (nptel.ac.in)

12968MD201B Ethical Hacking Credits 03

Course Objectives:

1. Introduce students to the concept of ethical hacking, its importance in cybersecurity, and the role of ethical hackers in identifying vulnerabilities.
2. Provide an overview of cybersecurity principles, threats, and attacks, highlighting the need for ethical hacking to strengthen defences.
3. Teach students a structured approach to hacking, including reconnaissance, scanning, gaining access, maintaining access, and covering tracks.
4. Cover essential network concepts to help students understand how networks function, including protocols, IP addressing, and network architecture.

Course Outcomes:

1. Gain a comprehensive understanding of ethical hacking concepts, methodologies, and its role in enhancing cybersecurity.
2. Acquire a solid grasp of cybersecurity principles, types of threats, and the importance of proactive defence strategies.
3. Develop proficiency in various hacking techniques, including reconnaissance, scanning, exploitation, and post-exploitation activities.
4. Perform effective vulnerability assessments on systems and networks, identifying potential security weaknesses and exposures.
5. Demonstrate the ability to conduct penetration tests, simulating real-world attacks to evaluate the strength of security measures.

UNIT I

Introduction to ethical hacking. Fundamentals of computer networking. TCP/IP protocol stack.
IP addressing and routing. TCP and UDP. IP subnets. Routing protocols. IP version 6.

UNIT II

Installation of attacker and victim system. Information gathering using advanced google search, archive.org, net craft, whois, host, dig, dnsenum and NMAP tool**.**

UNIT III
Vulnerability scanning using NMAP and Nessus. Creating a secure hacking environment. System Hacking: password cracking, privilege escalation, application execution. Malware and Virus. ARP spoofing and MAC attack.

UNIT IV
Introduction to cryptography, private-key encryption, public-key encryption. Cryptographic hash functions, digital signature and certificate, applications. Steganography, biometric authentication, network-based attacks, DNS, and Email security.

UNIT V
Packet sniffing using Wireshark and Burp suite, password attack using burp suite. Social engineering attacks and Denial of service attacks. Elements of hardware security: side-channel attacks, physical inclinable functions, hardware trojans.

UNIT VI
Different types of attacks using Metasploit framework: password cracking, privilege escalation, remote code execution, etc. Attack on web servers: password attack, SQL injection, cross site scripting.

Textbooks / References:

1. Data and Computer Communications -- W. Stallings.
2. Data Communication and Networking -- B. A. Forouzan
3. TCP/IP Protocol Suite -- B. A. Forouzan
4. UNIX Network Programming -- W. R. Stallings
5. Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin
   Cryptography and Network Security: Principles and Practice -- W. Stalling

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Ethical Hacking	Prof. Indranil Sengupta	IIT Kharagpur	Ethical Hacking – Course (nptel.ac.in)

12968MD201C Sustainable Power Generation Systems Credits 03

Course Objectives:

1. The course content is designed to provide comprehensive knowledge of various renewable energy systems. Specifically, in this course, the design and analysis of renewable energy power plants will be discussed.
2. The concepts will be illustrated with practical examples, schematics and block diagrams wherever required. Enough numerical problems with solutions will be discussed in the course.
3. This course is specifically designed for undergraduate and postgraduate students of Energy Engineering and Technology.
4. Further, the course will be very much useful for students and researchers from varied academic backgrounds for the synthesis of novel energy conversion devices and processes.

Course Outcomes:

1. Explain the principles of sustainability in the context of power generation and understand its significance in the global energy transition.
2. Identify and describe various renewable energy sources, including solar, wind, hydro, geothermal, and biomass, and explain their potential for power generation.
3. Compare and contrast the advantages and limitations of different sustainable power generation technologies, considering factors such as efficiency, scalability, reliability, and intermittency.
4. Analyse the environmental, social, and economic impacts of both conventional and sustainable power generation methods, and evaluate their contributions to mitigating climate change and reducing pollution.

UNIT I

Introduction to power generation:

Global and Indian scenario, an overview of current technologies available for power generation, Concept of the renewable energy- based power plant

Solar Thermal Power Generation:

Fundamentals of Solar thermal energy conversion, solar thermal based power plant design and analysis (flat plate and concentrator), ORC, RC, and Stirling engine.

UNIT II

Solar Photovoltaic Power Generation:

Fundamentals of Solar photovoltaic energy conversion, Solar PV power plant design, Performance analysis of standalone and grid connected PV systems.

Wind Power Generation:

Introduction to wind turbine, classification and analysis of different components, Theory, design, and analysis of wind turbines (horizontal axis and vertical axis) and wind farms.

UNIT III

Hydro Power Generation:

Introduction to hydro power plant, overview of micro, mini and small hydro power plants, hydraulic turbines, Selection and design criteria of pumps and turbines, Brief theory, design, and analysis of hydro power plants

Biomass Power Generation:

Fundamentals of bioenergy production technologies through different routes, design, and analysis of biochemical and thermochemical reactors for clean power generation and value-added products, IGCC.

UNIT IV

Hydrogen energy and fuel cells

Importance, various routes of hydrogen generation, basic principle, and design of different types of fuel cells and their applications, prospects, IGFC

Week 8: Module-8: Geothermal Energy

Fundamentals, classification, theory, design, and analysis of geothermal power plant

UNIT V

Ocean Thermal Energy

Fundamentals, classification, theory, design, and analysis of ocean thermal power plant

Week 10: Module-10: Wave and Tidal Energy

Fundamentals, classification, theory, design, and analysis of wave and tidal power plant

UNIT VI

Energy Storage

Different modes of energy storage; design and analysis of different technologies for thermal, mechanical, and electro-chemical energy storage systems

Week 12: Module-12: Energy Economics

Cost analysis, interest, accounting rate of return, Payback, Discounted cash flow, Net present value, Internal rate of return, Inflation, and life cycle analysis of energy systems.

Textbooks / References:

1. J. Twidell, T. Weir, Renewable Energy Resources, Taylor and Francis, 4th Edition, 2021.
2. G. Boyle (Editor), Renewable Energy: Power for a Sustainable Future, Oxford University press, 3rd Edition, 2012.
3. G. N. Tiwari, Solar Energy, Fundamentals, Design, Modeling and Applications, Narosa, 2002.
4. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, 4th Edition, 2013.
5. R. Gasch, J. Twele, Wind Power Plants: Fundamentals, Design, Construction and Operation, Springer, 2nd Edition, 2012.
6. P. Breeze, Hydropower, Elsevier, 1st Edition, 2018.
7. S. C. Bhattacharyya, Energy Economics Concepts, Issues, Markets and Governance, springer, 2nd Edition, 2019.
8. S.p Sukhatme and J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Private Limited, 3rd Edition, 2010.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Sustainable Power Generation Systems	Dr. Pankaj Kalita	IIT Guwahati	Sustainable Power Generation Systems – Course (nptel.ac.in)

12968MD201D Components and Applications of Internet of Things Credits 03

Course Objectives:

1. The objective of this course is to learn about Basics of IoT, Components of IoT including Sensors and actuators, computing, and communication systems.
2. It will also cover IoT Protocols, Security of IoT, Cloud based design and AI/Deep learning-based analytics.

Course Outcomes:

1. Identify IoT Components: Recognize and classify key components of IoT systems, including sensors, actuators, communication protocols, and data processing units.
2. Explore IoT Communication: Understand various wireless and wired communication technologies used in IoT networks and their suitability for different application scenarios.

3. Design IoT Applications: Create IoT solutions by integrating hardware and software components, demonstrating proficiency in prototyping, programming, and data handling.
4. Analyse Data from IoT Devices: Collect, analyse, and interpret data generated by IoT devices to extract meaningful insights and support informed decision-making.

UNIT I
Basics of IoT
Introduction to Internet of things, Various sensors, and sensing techniques. Technological trends in IoT. impact of IoT on society. Review of various IoT application domain including agriculture, healthcare, manufacturing, device management, and vehicle to vehicle communication and wearable computing devices.

UNIT II
Microcontroller and Interfacing Techniques for IoT Devices
Introduction to IoT and architecture layers, IoT smart devices, Typical embedded computing systems, Introduction to ARM architecture and programming method, Embedded system development: a case study, Introduction to interfacing techniques.

UNIT III
IoT Protocols & Security
Networking and basic networking hardware. Networking protocols, Interaction between software and hardware in an IoT device. IoT components and technologies to secure systems and devices.
Various security issues related to the IoT and security architectures. Hardware security threats and security vulnerabilities; protecting physical hardware

UNIT IV
Location Tracking
Introduction to device localization and tracking; different types of localization techniques: time-of-arrival (TOA) based, time-difference-of-arrival (TDOA) based, angle-of-arrival (AOA) based, received signal strength (RSS) based, Radio-Frequency Identification (RFID) based and fingerprinting based; Monte-Carlo tracking; Kalman filter based tracking; Cramer-Rao lower bound (CRLB) for device location estimator; Device diversity/heterogeneity issue in IoT networks.

UNIT V
Deep learning for IoT
This topic will focus how to build good model from the past data to predict correctly when the system is provided with a data-point. In this course mostly, supervised learning will be considered. Basics of neural network, activation functions, back-propagation, etc. will be covered. At the end some of the challenges in the context of IoT will be mentioned.

UNIT VI
IoT Applications
Smart grid: Introduction to smart grid, Integration of IoT into smart grid, Standardization activities for IoT aided smart grid, Applications of IoT aided smart grid, Architectures for IoT sided smart grid, Prototypes, Applications of big data and cloud computing, Open Issues, and challenges.

IoT-based Smart Home and Nano-grid Monitoring System
Sensor-Controller Coordination of a DC Microgrid in IoT Platform, Cyber physical system, dc microgrid, dc–dc power converter, distributed energy generator, sensor control and controller design. Low-Cost DC Nano-grid with Smart Remote Monitoring Unit, DC-DC converter modelling, closed loop control, placement of IoT devices, sensors, micro grid, solar energy, low-cost communication system design.
Introduction, objective, components of home monitoring system, control, and management, Zigbee, Wireless Sensor Network (WSN), Internet of Things (IoT).

Internet of Robotic Things (IoRT):
Introduction to stationary and mobile robots; Brief introduction to localization, mapping, planning, and control of robotic systems; Introduction to cloud-enabled robotics; Applications of IoT in robotics; Architectures for IoRT; Examples and case studies; Open issues and challenges.

Textbooks / References:
It will be provided in each of the lecture sessions.
(Refer **NPTEL** platform)

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Components And Applications of Internet of Things	Dr. Sanjoy Kumar Parida	Indian Institute of Technology Patna	https://onlinecourses.swayam2.ac.in/arp20_ap03/preview

12968MD201E Linear Algebra Credits 03

Course Objectives:
1. Understand the fundamental principles of vector spaces and matrices.
2. Develop the ability to solve systems of linear equations using various methods.
3. Learn how to analyse and manipulate linear transformations and their properties.
4. Apply linear algebra concepts to solve real-world problems in fields such as physics, engineering, and computer science.

Course Outcomes:
1. Students will demonstrate proficiency in performing matrix operations and solving linear equations in diverse mathematical contexts.
2. Students will apply linear algebra concepts to model and solve practical problems across multiple disciplines.
3. Students will analyse and interpret geometric transformations through the lens of linear transformations.
4. Students will develop critical thinking and problem-solving skills by using linear algebra as a foundation for advanced mathematical and scientific studies.

UNIT I
Vectors, vector spaces, span, linear independence, bases
Dimension, linear transformations

UNIT II
Null spaces, range, coordinate bases
Matrix multiplication, Invertibility, Isomorphisms

UNIT III
Coordinate change, products and quotients of vector spaces, duality
Review of elementary row operations, rank, determinants

UNIT IV
Eigenvalues, Eigenvectors
Diagonalization

UNIT V
Characteristic polynomials, inner products, and norms
Orthogonal bases, orthogonalization, orthogonal complements
Adjoints, normal and self-adjoint operators
Spectral theorem for normal and self-adjoint operators

References/Textbooks:

1. Bhattacharya P.B., Jain S.K. and Nagpaul S.R., First Course in Linear Algebra, Wiley Eastern Ltd., 1991.
2. Friedberg S.H, Insel A.J. and Spence L.E., Linear Algebra, 4th Edition, Prentice-Hall of India, New Delhi, 2004.
3. Hoffman K. and Kunze R., Linear Algebra, 2nd Edition, Prentice-Hall of India, New Delhi, 2000.
4. Kalman D., A singularly valuable decomposition; the SVD of a matrix, The College Math. Journal, Vol .27, No.1, (1996).
5. Kumaresan, S., Linear Algebra-A Geometric approach, Prentice-Hall of India, New Delhi, 2001.
6. Lay D.C., Linear Algebra and Its application, 3rd edition, Pearson Education (Singapore) Pvt. Ltd., Delhi, 2003.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Linear Algebra	Prof. Pranav Haridas	Kerala School of Mathematics	https://onlinecourses.nptel.ac.in/noc20_ma21/preview

12968MD201F Artificial Intelligence and Machine Learning Credits 03

Course Objectives:

1. Apply AI techniques to solve the given problems.
2. Implement trivial AI techniques on relatively large system
3. Explain uncertainty and Problem-solving techniques.
4. Compare various learning techniques.

Course Outcomes:

This course will enable students to

1. Identify the AI based problems.
2. Apply techniques to solve the AI problems.
3. Define learning and explain various logic inferences.
4. Discuss different learning techniques.

UNIT I

Introduction to AI and State space search, Introduction to unguided and guided search

UNIT II

Problems in search and solutions, Genetic algorithms, Neural Networks, BPNN, learning process in BPNN

UNIT III

Some other search methods and Admissibility, Planning, Game Playing

UNIT IV

Minimax and other game playing algorithms , using predicate logic for Knowledge Representation

UNIT V

Resolution and non-monotonic reasoning, Strong methods for Knowledge Representation; Fuzzy logic and CD, Scripts, and Introduction to Expert systems, Developing expert systems and Machine learning

Text/Reference Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition
2. E. Rich, K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw Hill.
3. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hal of India.
4. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem Solving," Fourth Edition, Pearson Education,2002.
5. N.P. Padhy "Artificial Intelligence and Intelligent Systems," Oxford University Press-2015.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Artificial Intelligence and Machine	By Prof. Bhushan Trivedi	GLS University	https://onlinecourses.swayam2.ac.in/cec21_cs08/preview

Learning			

12968SE201 Seminar II Credits 02

The seminar shall be on the state of the art in the area of the VLSI or communication of student's choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

12968PR201 Project I Credits 10

Project-I is an integral part of the final project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation that may include mathematical model/SRS/UML/ERD/block diagram/ PERT chart, and layout and design of the proposed system/work. As a part of the progress report of project-I work; the candidate shall deliver a presentation on progress of the work on the selected dissertation topic.

It is desired to publish the paper on the state of the art on the chosen topic in international conference/ journal.

The student shall submit the duly certified progress report of project -I in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.

SEMESTER IV

12968PR202	Project II	Credits 20

In Project - II, the student shall complete the remaining part of the project which will consist of the simulation/ analysis/ synthesis/ implementation / fabrication of the proposed project work, work station, conducting experiments and taking results, analysis and validation of results and drawing conclusions.

It is mandatory to publish the paper on the state of the art on the chosen topic in international conference/ journal.

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.