SNJB's

Late Sau. Kantabai Bhavarlalji Jain

College of Engineering

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

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ESTD - 1928

SNJB

Curriculum and Evaluation Scheme for Third Year B. Tech. in Electronics & Telecommunication Engineering with Multidisciplinary Minor and Honor

To be implemented for 2024-28 Batch

(With Effect from Academic Year 2026-27)

CHAIRMAN
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LSKBJ COLLEGE OF ENGINEERING
Chandwad Dist.Nashik

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Chandwad
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Pin-423101

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Chandwad Dist.Nashik

Vision of the Institute

Transform young aspirant learners towards creativity and professionalism for societal growth through quality technical education.

Mission of the Institute

1. To transfer the suitable technology, particularly for rural development.
2. To enhance diverse career opportunities among students for building a nation.
3. To acquire the environment of learning to bridge the gap between industry and academics.
4. To share values, ideas, and beliefs by encouraging faculties and students for the welfare of society.

Vision of the Electronics & Telecommunication Engineering Department

To prepare Electronics & Telecommunication Engineers for the benefit of the society.

Mission of the Electronics & Telecommunication Engineering Department

1. To provide quality education to students
2. To enrich the skill in collaboration with industry for better career opportunity
3. To inculcate ethics, values and environment awareness

Program Outcomes (POs) for an engineering graduate:

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes

PSO1: Apply their skills in designing, implementing and testing electronic systems.

PSO2: Demonstrate proficiency in use of modern electronic design automation (EDA) tools.

PSO3: Communicate and work effectively as individuals and as team members.

GENERAL COURSE STRUCTURE

A. Definition of Credit:

Table 1: Credit Definition

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

B. Range of Credits: (B.Tech. or Equivalent) in Tech. with Multidisciplinary Minor:

In the light of the fact that a typical NEP Compliant Model Four-year Undergraduate degree program in Technology has about 176 credits, the total number of credits proposed for the four-year B.Tech. in **Computer Engineering** with Multidisciplinary minor degree is kept as **172.**

Table 2: Range of Credits

Course Category		Credits As PER NEP Guidelines	Proposed Credits
Basic Science Course	BSC/ESC	14-18	15
Engineering Science Course		16-12	14
Programme Core Course (PCC)	Program Courses	44-56	47
Programme Elective Course (PEC)		20	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses	14	17
Open Elective (OE) Other than a particular program		8	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	8	8
Ability Enhancement Course (AEC)	Humanities Social Science and Management (HSSM)	4	6
Entrepreneurship/Economics/ Management Courses		2	4
Indian Knowledge System (IKS)		2	2
Value Education Course (VEC)		4	5
Research Methodology(RM)	Experiential Learning Courses	4	4
Community Engagement Project (CEP)/ Field Project (FP)		2	2
Project		4	5
Internship/ OJT		12	12
Co-curricular Courses (CC)	Liberal Learning Courses	4	3
Total Credits		**160-176**	**172**

C. Semester wise Credit Distribution Structure for Four Year B. Tech in Computer Engineering with Multidisciplinary Minor:

Table3: Semester-wise Credit Distribution Structure

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	8	7	-	-	-	-	-	-	15
Engineering Science Course		7	7	-	-	-	-	-	-	14
Programme Core Course (PCC)	Program Courses	-	3	11	8	9	4	9	3	47
Programme Elective Course (PEC)		-	-	-	-	6	5	6	3	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses	-	-	3	3	3	2	3	3	17
Open Elective (OE) Other than a particular program		-	-	-	3	2	3	-	-	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2	-	2	-	2	-	-	8
Ability Enhancement Course (AEC)	Humanities Social Science and Management (HSSM)	1	-	1	2	2	-	-	-	6
Entrepreneurship/Economics/ Management Courses		-	-	2	2	-	-	-	-	4
Indian Knowledge System (IKS)		2	-	-	-	-	-	-	-	2
Value Education Course (VEC)		-	-	3	2	-	-	-	-	5
Research Methodology	Experiential Learning Courses	-	-	-	-	-	4	-	-	4
Community Engagement Project (CEP)/ Field Project (FP)		-	-	2	-	-	-	-	-	2
Project		-	-	-	-	-	2	3	-	5
Internship / OJT		-	-	-	-	-	-	-	12	12
Co-curricular Courses (CC)	Liberal Learning Courses	1	2	-	-	-	-	-	-	3
Total Credits (Major)		**21**	**21**	**22**	**22**	**22**	**22**	**21**	**21**	**172**

Students can opt for any of the following as per the rules and regulations given by the institute:

1. B. Tech with Multidisciplinary Minor = Total 172 Credits
2. **B. Tech with Multidisciplinary Minor and Honor = Total 190 Credits**

HONORS

- In addition to 172 credits of B. Tech Programmes (Bachelor of Technology) i.e. Major in which the student has taken admission, a student may opt for Honors in the same Tech. discipline/branch / Emerging Areas.
- A student is required to earn an additional 18 credits in the same Tech. discipline/ branch / Emerging Areas for Honors distributed over semesters III to VIII.
- The total number of credits required to complete the Honors in the same Tech. discipline/ Emerging Areas is 18 credits, in addition to 172 credits in Major.
- Students will have to compulsorily choose Honors from the same Tech. discipline/branch.
- Honors Degree in the Bachelor of Engineering programme shall be awarded to students earning additional total credits of all six semesters from the second year to final year, i.e., 18 Credits, in addition to 172 credits or 130 credits respectively. The student admitted in the first year must earn 172 credits and 130 credits admitted in lateral entry (admitted after Diploma or B.Sc.) in the second year.
- Minor Courses can be completed through an online platform.

The student has to choose One Honor out of the Two Honor groups provided below

Honors offered by Electronics & Telecommunication Engineering are as follows:

Table 4: Honors

Sr No	Name of Honors Offered by Department
A.	VLSI Design
B.	Robotics

The detailed syllabus structure for the same is as follows:

Table 5A: Specialization Honors in VLSI Design

Sr. No	Category	SEM	Course Code	Course Name	Teaching Scheme				
					Hours				Credits
					L	T	P	Total Hours	
01	HOC	III	24-HOC-ET-2-01A	VLSI Technology	3	-	-	3	3
02	HOC	IV	24-HOC-ET-2-02A	VLSI Design Flow	3	-	-	3	3
03	HOC	V	24-HOC-ET-3-03A	VLSI Testing & Testability	3	-	-	3	3
04	HOC	VI	24-HOC-ET-3-04A	Digital CMOS Design	3	-	-	3	3
05	HOC	VII	24-HOC-ET-4-05A	Analog CMOS Design	3	-	-	3	3
06	HOC	VIII	24-HOC-ET-4-06A	Low Power VLSI Design	3	-	-	3	3
Total					**18**	**-**	**-**	**18**	**18**

Table 5B: Specialization Honors in Robotics

Sr. No	Category	SEM	Course Code	Course Name	Teaching Scheme				
					Hours				Credits
					L	T	P	Total Hours	
01	HOC	III	24-HOC-ET-2-01B	Introduction to Robotics	3	-	-	3	3
02	HOC	IV	24-HOC-ET-2-02B	Fundamental of Power Electronics	3	-	-	3	3
03	HOC	V	24-HOC-ET-3-03B	Robotics: Basics and Selected Advanced Concepts	3	-	-	3	3
04	HOC	VI	24-HOC-ET-3-04B	Wheeled Mobile Robots	3	-	-	3	3
05	HOC	VII	24-HOC-ET-4-05B	Mechanism And Robot Kinematics	3	-	-	3	3
06	HOC	VIII	24-HOC-ET-4-06B	Advanced Robotics	3	-	-	3	3
Total					**18**	-	-	**18**	**18**

#Note for NPTEL/SYAYAM: Approved courses and platforms will be enlisted timely by authorities along with rules and regulations

Honors Syllabus for SEM V

24-HOC-ET-3-03A: VLSI Testing & Testability

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 3	**Examination Scheme:** **SEE** : 100 Marks

Prerequisites Courses: 24-PCC-E T-1-01: Digital Dessign, 24-HOC-ET-2-01A: VLSI Technology, 24-HOC-ET-2-02A: VLSI Design Flow

Companion Course: - Nil

Course Objectives: The course is intended to introduce the testing philosophy of VLSI circuits, concept of fault modeling, test pattern generation and design for testable VLSI circuits.

Course Outcomes:
After completion of the course, learners should be able to

CONo	CO	BL
CO1	**Comprehend** the need and economics of testing VLSI circuits	2
CO2	**Apply** test patterns for stuck-at faults, evaluate fault coverage, understand limitations	3
CO3	**Apply** DFT techniques to make circuits testable; understand trade-offs of DFT	3
CO4	**Infer** on-chip test access port (TAP / JTAG)	2

Course Contents

Unit I	**Testing Philosophy**	**6 Hours**

Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends AffectingTesting, Types of Testing, Automatic Test Equipment, Electrical Parametric Testing, Test Economics, Yield, Defect Level as a QualityMeasure.

Case Studies: Improving Yield and Testing Efficiency in High-Volume Memory Manufacturing

***Mapping of Course Outcomes**	**CO1**

Unit II	**Fault Modeling**	**7 Hours**

Defects, Errors, and Faults, Functional Versus Structural Testing, Levels of Fault Models , Various fault models, Single Stuck-at Fault, multiple stuck-at fault, Fault Equivalence, Fault Collapsing.

#Exemplar/Case Studies: Testing of a 2-bit Adder Using Structural Fault Models

***Mapping of Course Outcomes**	**CO2**

Unit III	**Automatic Test Pattern Generator**	**7 Hours**

Path sensitizing method, ATPG for Combinational Circuits - D-Algorithm – Generation of Complex Fault Models. Automatic Test-Pattern Generation Examples, FAN algorithm.		
#Exemplar/Case Studies: Generator test pattern for 2-bit Adder		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**DIGITAL DFT AND SCAN DESIGN**	**8 Hours**
Concept of design for testability, Need of Design for Testability (DFT), Testability measures: controllability and observability, DFT Basics, Scan cell design, Scan Architecture, Scan design rules, Overheads of Scan Design, Full scan, Partial-Scan Design, Variations of Scan.		
#Exemplar/Case Studies: Scan Architecture Design for a Microcontroller Core		
***Mapping of Course Outcomes**	**CO3**	
Unit V	**BUILT-IN SELF-TEST**	**7 Hours**
Introduction to Built-In Self-Test (BIST): Need,The Economic Case for BIST: Chip/Board Area Cost vs. Tester Cost , Chip/Board Area Cost vs. SystemDowntime Cost, Types of BIST, Random Logic BIST: BIST Process, BIST Implementations, BIST Pattern Generation, LFSR-based pattern generators, response compaction (e.g. MISR), Built-in Logic Block Observers, signature analysis, Memory BIST.		
#Exemplar/Case Studies: Logic BIST for Automotive Safety Controller		
***Mapping of Course Outcomes**	**CO4**	
Unit VI	**BOUNDARY SCAN STANDARD**	**7 Hours**
Bed of nails tester concept, Purpose of Standard , System Configuration with Boundary Scan:TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BSDLDescriptionComponents, Pin Descriptions.		
#Exemplar/Case Studies: JTAG Architecture Implementation in a Microcontroller-based Development Board		
***Mapping of Course Outcomes**	**CO3**	
Learning Resources		
Text Books		
T1. Michael Bushnel & Vishwani Agrawall, Essentials of Electronic for Digital, Memory & Mixed Signal VLSI Circuits, Kluwer Pub. **T2.** Miron Abramovivi, Melvin Breuer, Arthur Friedman, Digital Systems Testing and Testable Design, Jaico Publishing House		
Reference Books :		
R1. Stroud, A Designer's Guide to Built-in Self-Test, Kluwer Academic Publishers, 2002 **R2.** Laung-Terng Wang, Cheng-Wen Wu, and Xiaoqing Wen, VLSI Test Principles and Architectures, 2013, The Morgan Kaufmann		

Additional Resources: (Books, e-Resources)
MOOC Courses links : ● nptel.ac.in/courses/117105137 ● nptel.ac.in/courses/117103125

24-HOC-ET-3-03B: Robotics: Basics and Selected Advanced Concepts

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 3	**Examination Scheme:** **SEE** : 100 Marks

Prerequisites Courses: 24-HOC-ET-2-01B: Introduction to Robotics, 24-HOC-ET-2-02B: Fundamental of Power Electronics

Companion Course: Nil

Course Objectives:

- To introduce the fundamentals of robotics, classification, and elements of robotic systems.
- To develop mathematical foundations for robot kinematics and dynamics.
- To analyze serial and parallel manipulator structures with direct and inverse kinematics.
- To study Jacobian, velocity analysis, singularities, and statics of manipulators.
- To explore robot dynamics, motion planning, and control strategies.
- To understand selected advanced concepts such as redundancy resolution, flexible robots, and advanced nonlinear control.

Course Outcomes:
After completion of the course, learners should be able to

CONo	**CO**	**BL**
CO1	Identify basic structural elements of different types of robots.	**2**
CO2	Apply homogeneous transformation matrices and D-H conventions for robot modeling	**3**
CO3	Solve direct and inverse kinematics for serial and parallel manipulators	**3**
CO4	Analyze Jacobians, singularities, and statics for both serial and parallel manipulators	**4**
CO5	Derive and simulate robot dynamics using Lagrangian and recursive formulations	**3**
CO6	Apply motion planning, control methods, and advanced robotic concepts in real-world case studies	**3**

Course Contents

Unit I	**Basics of Robotics**	**7 Hours**

Introduction, Types and classification of robots, Main elements of a robot, Modelling and analysis of robot, Mathematical preliminaries, Homogeneous transformation, Elements of robot - joints, links, Examples of d-h parameters and link transformation matrices

#Exemplar/Case Studies: Study of KUKA & FANUC industrial robot applications

***Mapping of Course Outcomes**	**CO1**

Unit II	Kinematics of serial robots	7 Hours
Introduction, Direct kinematics of serial robots, Inverse kinematics of serial robots, "Inverse kinematics of serial robots with n 6", "Elimination theory & solution of non-linear equations, Inverse kinematics of a general 6r robot", Introduction, loop-closure equations		
#Exemplar/Case Studies: Study of Forward kinematics of a 2R planar manipulator		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Kinematics of parallel robots**	**7 Hours**
Direct kinematics of parallel manipulators, Mobility of parallel manipulators, Inverse kinematics of parallel manipulators, Direct kinematics of stewart platform manipulators, Sun tracking using 3-dof parallel manipulator, Stewart-gough platform-based force-torque sensor		
#Exemplar/Case Studies:Sun Tracking System Using a 3-DOF Parallel Manipulator		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Velocity, Jacobian and Statics**	**7 Hours**
Vibration isolation using a stewart-gough platform, Introduction, linear and angular velocity of links, Serial manipulator jacobian matrix, Parallel manipulator jacobian matrix, Singularities in serial and parallel manipulators, Statics of serial and parallel manipulators		
#Exemplar/Case Studies: Redundancy resolution in human arm		
***Mapping of Course Outcomes**	**CO4**	
Unit V	**Dynamics of Manipulators**	**7 Hours**
Hyper-redundant robots, Redundancy resolution in human arm, Flexible robots, Introduction, lagrangian formulation, Examples of equations of motion, Inverse dynamics & simulation of equations of motion, Recursive formulations of dynamics of manipulators		
#Exemplar/Case Studies: 4-DOF Robot Dynamics		
***Mapping of Course Outcomes**	**CO5**	
Unit VI	**Motion Planning & Control**	**7 Hours**
Motion planning, Control of a single link, Control of a multi-link serial manipulator, Control of a multi-link manipulator, Control of constrained and parallel manipulator, Cartesian control of serial manipulators, Force control of manipulators, hybrid position/force control of manipulators, Advanced topics in non-linear control of manipulators		
#Exemplar/Case Studies: Industrial Robotic Arm for Precision Assembly		
***Mapping of Course Outcomes**	**CO6**	

Learning Resources
Text Books
T1. : “Robotics: **Basics** and Selected Advanced Concepts”, Prof. Ashitava Ghosal, IISC Banglore, NPTEL Book
Reference Books :
R1: John J Craig, “Introduction to Robotics”, Prentice Hall International, 2005 **R2**: Robert J. Schilling, “Fundamentals of Robotics”, Pearson Education, 2013 **R3**: Ashitva Ghosal, “Robotics Fundamental Concepts and Analysis”, Oxford University Press, 2010 **R4**: S K Saha, “Introduction to Robotics”, Tata McGraw-Hill
MOOC Courses links : https://nptel.ac.in/courses/112108298

Honors Syllabus for SEM VI

24-HOC-ET-3-04A : Digital CMOS Design

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 3	**Examination Scheme:** **SEE**: 100 Marks

Prerequisites Courses: Nil

Companion Course: 24-PCC-ET-2-04: Analog circuits,24-HOC-ET-2-01A:VLSI Technology, 24-HOC-ET-2-02A: VLSI Design Flow

Course Objectives: The course on Digital CMOS Design aims to:

- Introduce students to the principles of CMOS technology and its applications in digital circuit design.
- Develop an understanding of CMOS transistor theory, static and dynamic characteristics, and layout techniques.
- Equip students with the skills to design, simulate, and optimize combinational and sequential circuits using CMOS logic.
- Foster knowledge of chip I/O pin protection & on chip clock distribution issues

Course Outcomes:
After completion of the course, learners should be able to

CO	Course Outcome	BL
CO1	**Explain** the fundamentals of CMOS technology, fabrication processes, and design methodologies	2
CO2	**Analyze and design** CMOS inverter circuit	3
CO3	**Design** combinational and sequential circuits using CMOS logic.	3
CO4	**Explain** chip I/O design & clock distribution issues	2

Course Contents

Unit I	**Introduction to CMOS Technology & VLSI Design**	**6 Hours**

Overview of CMOS Technology, Advantages of CMOS over N MOS, PMOS and Bipolar technologies, Classification of CMOS digital circuit types, A circuit design example, VLSI Design methodologies, Y chart & VLSI design flow, Design Hierarchy, Design Quality, Packaging Technology, EDA Tools. Fabrication process: CMOS n & p well process, Layout design rules.

Simulation/Case Studies: Case study on Moore's Law, Technology nodes in VLSI Fabrication, EDA Tools, IC packaging.

Mapping of Course Outcomes	**CO1**

Unit II	**CMOS Inverter & Static Characteristics**	**7 Hours**

MOSFET Scaling and small geometry effects, MOS Capacitances, CMOS inverter, Static characteristics of CMOS inverters, Noise margins, Static Power dissipation. Inverter sizing and Design consideration, Inverter with Tristate output.

Simulation/Case Studies: DC analysis of CMOS Inverter for varying threshold voltage and W/L ratio using SPICE.

Mapping of Course Outcomes	**CO2**	
Unit III	**Switching Characteristics and Interconnect Effects**	**7 Hours**
Introduction, Delay time, propagation delay, , Inverter design with delay constraints, CMOS ring oscillator, Interconnect parasitic-capacitance & resistance, calculation of interconnect delay : RC delay model, Elmore delay, Switching power dissipation of CMOS inverter, Power delay product and energy efficient design concepts.		
Simulation/Case Studies: Transient analysis, Analyse the effect of supply voltage, frequency, and load capacitance & Measure static and dynamic power dissipation in a CMOS inverter. simulate a CMOS-based ring oscillator to analyse frequency and delay characteristics.		
Mapping of Course Outcomes	**CO2**	
Unit IV	**CMOS Combinational Logic Design**	**7 Hours**
CMOS implementation of logic gates (NAND, NOR, XOR), Complex logic circuits, AOI & OAI topologies, transistor sizing and W/L calculation, CMOS full adder circuit, CMOS transmission gate. Logic gates, Mux & adder using TG.		
Simulation/Case Studies: Draw the layout of 2-input NAND gate/ combinational circuits and simulate using a layout tool.		
Mapping of Course Outcomes	**CO3**	
Unit V	**CMOS Sequential Logic Design & Semiconductor Memories**	**7 Hours**
SR Latches, clocked SR latch, clocked JK latch, CMOS D latch & edge triggered master slave D F/F. Timing diagram. Semiconductor Memories: **I**ntroduction-semiconductor memory type & characteristics, CMOS SRAM cell, operation-write, hold, read, leakage current, SRAM read/write circuits. Non-volatile memory, flash memory.		
Simulation/Case Studies: Draw the layout of sequential circuits and simulate using a layout tool.		
Mapping of Course Outcomes	**CO3**	
Unit VI	**Chip Input & Output**	**6 Hours**
Chip I/O requirements and challenges, ESD protection, input circuit, output circuit, protection circuits, on chip clock generation & distribution techniques-H tree, buffers, Latch up phenomenon & its prevention.		
Simulation/Case Studies: Case study on typical chip Input & output, clock generation & distribution circuit.		
Mapping of Course Outcomes	**CO4**	
Learning Resources		
Text Books		
T1 Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis & Design, MGH Education, India **T2** John P Uyemura, CMOS Logic Circuit Design, Springer		

Reference Books :
R1. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolić, "Digital Integrated Circuits: A Design Perspective" **R2.**Neil Weste and Kamran Eshraghian, "Principles of CMOS VLSI Design"**R3.**Neil Weste and David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective"
Additional Resources: (Books, e-Resources) ● CMOSedu.com by Jacob Baker ● "SPICE for Circuits and Electronics Using PSPICE" by Muhammad H. Rashid
MOOC Courses links : ● https://nptel.ac.in/courses/108106158 ● https://nptel.ac.in/courses/108107129

24-HOC-ET-3-04B: Wheeled Mobile Robots

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 3 Hours/Week	3	**SEE** :100 Marks

Prerequisites Courses: 24-HOC-ET-2-01B: Introduction to Robotics, 24-HOC-ET-2-02B: Fundamental of Power Electronics, 24-HOC-ET-3-03B: Robotics: Basics and Selected Advanced Concepts

Companion Course: Nil

Course Objectives:

- Introduce principles of locomotion and classifications of mobile robots and manipulators.
- Develop kinematic models of wheeled mobile robots and analyze mobility and maneuverability.
- Apply dynamic modeling methods to simulate robot motion.
- Explore navigation sensors and perception mechanisms for mobile robots.
- Implement algorithms for localization, mapping, motion control, and path planning.
- Examine modern applications, cooperative robotics, and challenges in autonomous systems.

Course Outcomes:
After completion of the course, learners should be able to

CONo	CO	BL
CO1	Explain locomotion mechanisms and types of mobile robots.	2
CO2	Apply kinematic models to determine mobility and maneuverability of wheeled mobile robots.	3
CO3	Demonstrate the use of Lagrange–Euler and Newton–Euler methods for dynamic modeling of robots.	3
CO4	Utilize appropriate sensors for mobile robot navigation and perception tasks.	3
CO5	Implement basic motion planning and SLAM techniques for mobile robots.	3
CO6	Assess modern mobile robotics applications and real-world challenges.	3

Course Contents

Unit I	Mobile Robots and Manipulators	7 Hours

Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots and water surface robots.

#Exemplar/Case Studies: Two-wheel Arduino robot car – shows differential drive & locomotion basics.

*Mapping of Course Outcomes	CO1

Unit II	Mobile Robot Kinematics	7 Hours

Kinematics of wheeled mobile robots, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots.		
#Exemplar/Case Studies: DIY acrylic chassis robot – simple forward & inverse kinematics study.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Mobile Robots Dynamics**	**7 Hours**
Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots		
#Exemplar/Case Studies: Self-balancing bot (Arduino + MPU6050 IMU) – demonstrates Newton–Euler dynamics in practice		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Sensors in Mobile Robots**	**7 Hours**
Sensors for mobile robot navigation: magnetic and optical position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems.		
#Exemplar/Case Studies: Ultrasonic sensor + IR sensor Arduino car – obstacle detection & simple mapping.		
***Mapping of Course Outcomes**	**CO4**	
Unit V	**Robot Navigation and Path Planning**	**7 Hours**
Robot navigation: Localisation, Error propagation model, Probabilistic map based localisation, Autonomous map building, Simultaneous localization and mapping (SLAM), :Motion and path planning: collision free path planning and sensor-based obstacle avoidance, Motion control of mobile robots: Motion controlling methods		
#Exemplar/Case Studies: Line follower robot using IR sensors – practical motion control.		
***Mapping of Course Outcomes**	**CO5**	
Unit VI	**Modern Robotics Applications and challenges**	**7 Hours**
Introduction to modern mobile robots: Swarm robots, cooperative and collaborative robots, mobile manipulators, autonomous mobile robots		
#Exemplar/Case Studies: Cooperative delivery using multiple small robots (2–3 Arduino cars)		
***Mapping of Course Outcomes**	**CO6**	
Learning Resources		
Text Books		

T1. "WHEELED MOBILE ROBOTS" By Prof. Asokan Thondiyath, IIT Madras and Prof. Santhakumar Mohan, IIT Palakkad
Reference Books :
R1. John J Craig, "Introduction to Robotics", Prentice Hall International, 2005 **R2**.Robert J. Schilling, "Fundamentals of Robotics", Pearson Education, 2013 **R3**.Ashitva Ghosal, "Robotics Fundamental Concepts and Analysis", Oxford University Press, 2010 **R4.** S K Saha, "Introduction to Robotics", Tata McGraw-Hill
MOOC Courses links : https://nptel.ac.in/courses/112106298