AMRITA VISHWA VIDYAPEETHAM | School of Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

B.TECH

AUTOMATION AND ROBOTICS
2025

CURRICULUM & SYLLABUS
(2025 admission onwards)
(S1-S3)

B.Tech Programme
AUTOMATION AND ROBOTICS

Programme Overview

Most industries have adopted Robotics and Automation to enhance productivity with high reliability, which demands a specialized workforce. Automation and robotics were being increasingly adopted across various industries, including manufacturing, healthcare, agriculture, and logistics. This trend is expected to continue, leading to a growing demand for skilled automation and robotics engineers. The fourth industrial revolution, often referred to as Industry 4.0, involves the integration of digital technologies, automation, and smart systems into the manufacturing environment. Automation and robotics engineers play a crucial role in designing and implementing these advanced manufacturing processes. The integration of Artificial Intelligence (AI) with robotics and automation systems was becoming more prevalent. Engineers with expertise in AI, machine learning, and computer vision were likely to be in high demand. In order to foster Engineering graduates at par with the current industry practices and requirements, this undergraduate programme on B.Tech in Automation and Robotics is conceived. The curriculum for this undergraduate programme provides the necessary foundation in mathematics, computer programming, machine learning, etc., thereby enabling students to pursue the programme. The skill set required for automation and robotics engineers was evolving, with an increasing emphasis on software development, data analytics, and interdisciplinary collaboration. Engineers with a broad skill set that includes both hardware and software expertise were likely to be more competitive. This programme encompasses the essential courses necessary to build competence in understanding and solving challenges in the design and implementation of Automation and Robotics solutions in industries. The extensive syllabus for this programme has been framed to capture the current trends in the industry, accentuating the need for a skilled and specialized workforce.

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
C	-	Credits
RAI	-	Robotics and Artificial Intelligence
ENG	-	Engineering Sciences
SCI	-	Basic Sciences (including Mathematics)
GEC	-	General Engineering (including programming foundations)
HUM	-	Humanities (including Languages and others)
PRJ	-	Project Work (including mini project/internship)
CSE	-	Computer Science and Engineering
CUL	-	Cultural Education
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
MAT	-	Mathematics
MEE	-	Mechanical Engineering
ELE	-	Electives (Professional electives, Free electives, Open Electives)
ADC	-	Audit Courses (P/F)
LIV	-	Live-in-Labs
ADM	-	Amrita Darshanam

Program Educational Objectives (PEOs) - Program educational objectives are the broad statements describing the career and professional accomplishments the program prepares graduates to achieve. Student outcomes are statements that describe what students are expected to know or be able to do by the time they complete an academic program.

Knowledge and Attitude Profile (WK) - WK refers to the Knowledge and Attitude Profile, which aligns with the Washington Accord's standards for engineering education.

Program Outcomes (POs) – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude, and behavior that students acquire through the program. The NBA has defined the Program Outcomes for each discipline.

Program Specific Outcomes (PSOs) – Program Outcomes are statements describing what students are expected to acquire specific knowledge, skills, and attitudes through the program. PSOs are written by the department offering the program.

Course Outcomes (COs) – Statements that describe what students are expected to know and can do at the end of each course. These relate to the skills, knowledge, and behavior students acquire in their progress through the course.

VISION AND MISSION OF THE DEPARTMENT

Vision

To transform our students into outstanding mechanical engineers with strong domain knowledge and skills, society-centric research intent, and exemplary ethical values, making them the most desired professionals by research institutions, industry, and society.

Mission

- To develop in each student a profound understanding of fundamentals, motivation for continuous learning, and practical problem-solving skills for building a successful career.
- To create and share technical knowledge and collaborate with Industry and Institutions for the betterment of society.
- To imbibe ethical values, leadership skills, and entrepreneurial skills in students.
- To sustain a conducive environment to involve students and faculty in research and development.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1: Apply their Knowledge in Science, Mathematics, and Engineering to address Industrial and Societal problems with a strong emphasis on creativity, confidence, ethics, and responsibility.

PEO2: Apply the latest computational, analytical, and simulation tools and techniques to develop and improve products and processes.

PEO3: Solve multidisciplinary problems by working in cross-functional teams.

PEO4: Develop and upgrade technical, intellectual, and emotional skills for life-long learning to compete in a rapidly evolving world.

PEO5: Nurture entrepreneurial ventures and foster research activities that support sustainable economic development to enhance the quality of life.

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost,re- use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and

sustainable development.
WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9: Ethics, inclusive behavior, and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability, etc., with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES (POS)

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 to 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 (PSO)

PSO1 – Apply knowledge acquired in the field of kinematics, dynamics, robotics, and control systems to develop automation and robotic systems aligning with the changing requirements of industry.
PSO2 – Extend and implement innovative thinking on the design of smart products and processes with the aid of modern tools.
PSO3 – Design and implement autonomous systems for emerging domains like manufacturing, automotive, health care, industrial safety, and for hazardous natural environments.

CREDIT STRUCTURE OF THE PROGRAMME

Categories of Courses & Credit Breakups

S.No.	CATEGORY	Semester wise Credits									% share
		S1	S2	S3	S4	S5	S6	S7	S8	Total	
1.	Humanities & Social Science Courses	5	4	1	3	2	2	-	-	17	11
2.	Basic Science (including Mathematics), General Engineering courses, Basic programming	15	13	10	3	3	-	-	-	44	27
3.	Engineering Core Courses	2	4	8	17	15	14	3	-	60	37
4.	Professional Elective Courses, Free Electives & Open Elective Courses, Live-in-Labs	-	-	2	-	5	6	9	-	22	14
5.	Project work, Seminar, and Internship in Industry or elsewhere	-	-	-	-	-	3	5	10	18	11
6.	Audit Courses [Environmental Sciences, Research Methodology, Indian Constitution]	-	-	ES/LS	IC	-	-	-	-	-	-
Total		**22**	**21**	**21**	**23**	**24**	**23**	**18**	**10**	**162**	**100**

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CURRICULUM

BTECH - AUTOMATION & ROBOTICS (2025 admission onwards)

SEMESTER I

Cat	Course Code	Name of the course	L-T-P	Credit	Self-Learning, Hrs./ Week
SCI	23MAT133	Multivariable Calculus	2-1-0	3	2
GEC	25ARE101	Introduction to Data Structures with C	2-0-2	3	2
SCI	25PHY104	Engineering Physics C	3-0-0	3	-
ENG	25ARE102	Introduction to Automation and Robotics	2-0-0	2	2
GEC	25ARE103	Electrical and Electronics Engineering	2-0-2	3	2
GEC	23MEE102	Engineering Graphics and 3D Modeling	2-0-2	3	2
HUM	23ENG101	Technical Communication	2-0-2	3	2
HUM	22ADM101	Foundation of Indian Heritage	2-0-2	2	-
		Total Credits		**22**	

SEMESTER II

Cat	Course Code	Name of the course	L-T-P	Credit	Self-Learning, Hrs./ Week
SCI	23MAT128	Linear Algebra	2-1-0	3	2
GEC	25ARE111	Engineering Dynamics	3-0-0	3	2
SCI	25CHY116	Engineering Chemistry C	3-0-0	3	-
GEC	25ARE112	Programming In C++	2-0-2	3	2
ENG	25ARE113	Actuators and Drives	3-0-0	3	2
GEC	25ARE181	Manufacturing Practice Lab	0-0-2	1	2
ENG	25ARE182	Embedded Robotics Lab	0-0-2	1	2
HUM	22ADM111	Glimpses of Glorious India	2-0-2	2	-
HUM	22AVP103	Mastery Over Mind	1-0-2	2	-
		Total Credits		**21**	

SEMESTER III

Cat	Course Code	Name of the Course	LTP	Credit	Self-Learning, Hrs./ Week
SCI	26MAT201	Probability and Statistics	3-0-0	3	2
GEC	26ARE201	Mechanics of Materials	3-0-0	3	2
ENG	26ARE202	Robot Kinematics	3-0-2	4	4
SCI	26ARE203	Data Analytics	2-0-2	3	2
ENG	26ARE204	Fluid Power Automation	3-0-0	3	-
ELE		Free Elective I	2-0-0	2	2
ENG	26ARE281	Fluid Power Automation Lab	0-0-2	1	2
GEC	26ARE282	Design Thinking - A	0-0-2	1	2
HUM	23LSE201	Life Skills for Engineers I	1 0 2	P/F	-
HUM	22ADM211	Leadership Lessons from Ramayana	1-0-0	1	-
		Total credits		**21**	

Course Evaluation Pattern

<table>
<tr><td>Course Type</td><td>Int : Ext</td><td colspan="6">Evaluation Scheme</td><td colspan="2">Total (100)</td></tr>
<tr><td colspan="10">Theory, Lab integrated and Pass/Fail (P/F) Courses</td></tr>
<tr><td rowspan="2">L T P</td><td rowspan="5">60 : 40</td><td>CA1</td><td>CA2</td><td>MT</td><td>CA3</td><td>CA4</td><td>ES</td><td colspan="2">Internal (60)</td><td>External (40)</td></tr>
<tr><td>Q1/A1</td><td>Q2/A2</td><td>Exam</td><td>Q3/A3</td><td>Q4/A4</td><td>Exam/ Project*</td><td colspan="2">CA1+CA2+CA3+CA4</td><td>ES</td></tr>
<tr><td>X 0 0</td><td rowspan="4">7.5</td><td rowspan="4">7.5</td><td rowspan="4">30</td><td rowspan="4">7.5</td><td rowspan="4">7.5</td><td rowspan="4">40</td><td colspan="2" rowspan="4">60</td><td rowspan="4">40</td></tr>
<tr><td>X Y 0</td></tr>
<tr><td>X 0 Z</td></tr>
<tr><td>P/F</td></tr>
<tr><td colspan="10">Lab Based Courses</td></tr>
<tr><td rowspan="2">0 0 Z</td><td rowspan="3">60 : 40</td><td colspan="2">6 weeks Task or Exp. (CA1)</td><td rowspan="2">MT</td><td colspan="2">6 weeks Task or Exp. (CA2)</td><td>ES</td><td colspan="2">Total (100)</td></tr>
<tr><td colspan="2">No. of Task based on the course</td><td colspan="2">No. of Task based on the course</td><td>Exam/ Project*</td><td colspan="2">Internal (60)</td><td>External (40)</td></tr>
<tr><td>1 0 Z</td><td colspan="2">20</td><td>20</td><td colspan="2">20</td><td>40</td><td colspan="2">CA1+MT+CA2</td><td>ES</td></tr>
<tr><td colspan="10">Project / Internship</td></tr>
<tr><td rowspan="2">PRJ</td><td rowspan="4">60 : 40</td><td colspan="5">CA (60)</td><td>ES (40)</td><td colspan="2">Total (100)</td></tr>
<tr><td colspan="8">Mini Project / Project Phase 1 & Phase 2</td></tr>
<tr><td></td><td colspan="5">Based on Review by panel of experts</td><td>External review</td><td colspan="2">CA+ES</td></tr>
<tr><td></td><td colspan="8">Internship</td></tr>
<tr><td></td><td colspan="5">External report (Industry / Research Organization)</td><td>Presentation & Internship Report</td><td colspan="2">CA+ES</td></tr>
</table>

Notes

L	:	Lecture	T	:	Tutorial
P	:	Practical	Int	:	Internal
Ext	:	External	CA	:	Continuous Assessment
MT	:	Mid-Term	ES	:	End Semester Examination
Exp.	:	Experimental work	X	:	No. of Lecture hours per week
Y	:	No. of Tutorial hours per week (1)	Z	:	No. of practical hours per week
Q	:	Quiz	A	:	Assignment

* : Project component (in-lieu of end semester examination) only for the selected courses as decided by the department level committee

SYLLABUS

(S1- S3)

SEMESTER I

23MAT133	MULTI VARIABLE CALCULUS	L-T-P-C: 2-1-0-3

Course Objectives

- To understand parameterisation of curves and to find arc lengths.
- To familiarise oneself with the calculus of multiple variables.
- To use important theorems in vector calculus in practical problems.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the basic concepts of vector-valued functions, limits, derivatives, and their geometrical interpretations.
CO2: Understand the concept of scalar and vector fields.
CO3: Understand and apply the concepts of extreme values and Lagrange multipliers for simple optimization problems.
CO4: Understand and apply the concepts of line and double integrals to various problems, including Green's theorem for the plane
CO5: Understand the concepts of surface integrals, divergence theorem, and Stokes theorem.

CO-PO Mappings

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3	1		1						1			
CO2	1	2	2		1						1			
CO3	3	2	2		1						1			
CO4	2	2	2		1						1			
CO5	2	2	1		1						1			

Syllabus

Unit 1

Limits and continuity of Functions of Several Variables, Partial derivatives, Differentiability of Functions, Chain rule. Directional derivatives, Gradient and tangent planes, Extreme values and saddle points, Lagrange multipliers.

Unit 2

Line integrals, Vector fields, Circulation and Flux, Path independence, Potential Functions and Conservative Fields. Green's Theorem in a Plane.

Unit 3

Parameterized Surfaces, Surface Areas and Surface Integrals, Orientation of Surfaces. Stoke's Theorem and Divergence Theorem.

Note: Students should be encouraged to use software tools as part of their learning/assignments

Text Books

'Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.
'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

References

'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, Third Edition, 2002.
'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.
'Advanced Engineering Mathematics', Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.

25ARE101	INTRODUCTION TO DATA STRUCTURES WITH C	L-T-P-C: 2-0-2-3

Course objectives

- Familiarize data structures and algorithms.
- Learn data types and structures using C language
- Enable writing programs to solve practical engineering problems

Course outcomes

At the end of the course, the student will be able to

CO1: Develop and use the programming constructs to write and debug programs
CO2: Analyse performance of algorithms using arrays, pointers, strings, etc.
CO3: Implement stack, and queue data structures
CO4: Develop computer programs using frequent design patterns and program constructions.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	1				1				1			
CO2	1	2	1				1				1			
CO3	2	2	2				2				1			
CO4	2	3	2				1				1			

Syllabus

Unit 1

Introduction and Review of C language constructs. Data types, variables, operations, statements – conditional, expressions, Functions – inter function communication, standard functions, scope. Recursion – recursive definition, recursive solution, designing recursive functions, limitations of recursion. Arrays – 1D numeric, searching and sorting, 2D numeric arrays.

Lab:

1. Write a C program using conditional statements to develop a simple calculator application.
2. Write a C program with functions to perform payroll computation for employees.
3. Write a C program using recursion to solve the Tower of Hanoi problem.
4. Write a C program to implement searching and sorting for a student marks database using 1D arrays.
5. Write a C program to perform matrix addition and multiplication using 2D numeric arrays.

Unit 2

Review of programming concepts, Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic. Strings: fixed length and variable length strings, strings and characters, string manipulation functions, sorting of strings. Structures: structure vs array comparison, complex structures, structures and functions, Union. Files and streams, file input output, command line arguments

Lab:

1. Write a C program using pointers and dynamic memory allocation to manage a student record system.
2. Write a C program to implement arrays of pointers and pointer arithmetic for matrix operations.
3. Write a C program to perform string manipulation for text processing applications.
4. Write a C program using structures and unions to store and display employee details.
5. Write a C program for file input and output to maintain a simple inventory management system

Unit 3

Data abstraction – Abstract Data Types (ADTs) and supporting language features. Lists, arrays, linked list, double and circular linked list. Stacks, queues – priority queues and applications. Hashing-hash tables, hash functions, separate chaining, open addressing, probing – linear and quadratic, rehashing and double hashing. Algorithms and comparison.

Lab:

1. Write a C program to implement a singly, doubly, and circular linked list with insertion and deletion operations.
2. Write a C program to implement stack and queue using arrays and linked lists.
3. Write a C program to implement a priority queue with insertion and deletion operations.
4. Write a C program to implement hash table with separate chaining and open addressing (linear and quadratic probing).

Text Books

E Horowitz, S. Sahani and Susan Anderson Freed. Fundamentals of Data Structures in C, University Press.2007
Gilberg and Forouzan. Data Structure – A Pseudo code approach with C, Thomson publication. 2007

Reference Books

Tanenbaum. Data Structure in C, PHI, 1989, Pearson publication.
Nell Dale, C++ Plus Data Structures 6th edition. 2016
Byron Gottfried. Programming With C. Fourth Edition, McGrawHill,; 2018
Pai. Data Structures and algorithms: concepts, techniques and algorithms. Tata McGraw Hill.2017

25PHY104	ENGINEERING PHYSICS C	L-T-P-C: 3-0-0-3

Course Objectives

- To impart knowledge on the fundamental concepts of Classical and Modern Physics and their applications in the field of Engineering.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the fundamental concepts of Electrodynamics and solve numerical problems.

CO2: Understand wave motion, its characteristics, conceptualize the wave equation mathematically, and apply in real life problems in sciences and engineering.

CO3: Introduced to the basics of Optics, the phenomenon of interference, and the basics of lasers.

CO4: Understand fundamental laws dealing with Fluids at rest and Fluids in motion

CO5: Comprehend the elements of Statistical mechanics and its applications to materials properties.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2							2			
CO2	3	3	2	2							2			
CO3	3	3	3	3							2			
CO4	3	3	2	3							2			
CO5	3	3	2	2							2			

Syllabus

Unit 1

ELCTROMAGNETICS: Review of electric potential, boundary conditions, Poisson's and Laplace equation, Laplace equation in one, two and three dimensions, Boundary conditions and Uniqueness theorem, Conductors and second Uniqueness theorem, Review of Electrostatics and Magnetostatics, Maxwell's equations, Maxwell's equations: Electrodynamics before Maxwell, Maxwell's correction to Ampere's law, Magnetic charge.

Unit 2

WAVE MOTION: Definition of a plane progressive wave. Attenuation of waves. Representation of waves using complex numbers. Differential equation of a plane progressive wave. Phase velocity. Phase and phase difference. Phenomenon of interference and diffraction- Solution of the differential equation of a plane progressive wave. Differential equation of 2-dimensional wave motion.

Unit 3

OPTICS: Wave nature of light, Spatial and temporal coherence (qualitative treatments), Wave division interference –Young's experiment, Interference pattern from double slit- Intensity distribution, Fresnel's double mirror, Fresnel's biprism, Amplitude division interference: fringes from equal thickness films, unequal thickness film , phase change on reflection, Michelson's Interferometer**.** Origin of lasing- types of lasers and its applications

Unit 4

FLUIDS: Fluids at rest- Pascal's principle-Archimedes principle-Equation of continuity- Fluids in motion- Bernoulli's Equation-Applications and problems

Unit 5

STATISTICAL MECHANICS: Microstates and Macro states, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Fermi level and its significance.

Text Book/ References

Introduction to Electrodynamics – David J. Griffiths, 4th Ed., Pearson Publication, 2015.
Richard Wolfson, "Essential University Physics", Vols. 1 and 2. Pearson Education, Singapore, 2011.
Halliday D., Resnick R. and Walker J., "Fundamentals of Physics", Wiley Publications, 2008.
Crawford Jr Waves, F.S. – "Berkeley Physics Course", 2008.
Sears and Zemanski, "University Physics", Pearson, 2011.
M. W. Zemansky and R. H. DittmanAmit K. Chattopadhyay, Heat and Thermodynamics, 8th edition, Tata McGraw-

Hill,2011.
A.K. Ghatak, Introduction to Modern optics, 5th Ed., Tata McGraw Hill, 1977.
Hecht, Optics, 4th Ed., Pearson Education, 2008.

25ARE102 INTRODUCTION TO AUTOMATION AND ROBOTICS L-T-P-C: 2-0-0-2

Course Objectives

- To provide foundational knowledge of automation and robotics, including system components, classifications, and modes of operation.
- To familiarize students with real-world applications of automation and robotics, incorporating emerging technologies like AI, IoT, and cyber-physical systems.

Course Outcomes

At the end of the course, the student will be able to

CO1: Explain the fundamental concepts and evolution of automation systems, including differences between hard and soft automation.

CO2: Describe the structure and classification of robots, along with the basic concepts like degrees of freedom, workspace, and autonomy levels.

CO3: Analyse the role of sensors, actuators, controllers, and different types of automation

CO4: Evaluate real-world case studies involving robotics and automation, and understand ethical, societal, and technological impacts.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2									2	2	
CO2	3	2	2									2	2	
CO3	3	2	2									2	2	
CO4	3	2	2		2							2	2	

Syllabus

Fundamentals of Automation: Evolution and history, Hard vs soft automation- components of automated system – sensors, actuators and controllers – Introduction to open and closed loop system –Batch and continuous automation – current and future trends in automation.

Introduction to robotics: Definition and structure of a robot – Classification- industrial, service, mobile, and aerial. Robot anatomy – links, joints, actuators, and end-effector. Concept of degree of freedom, workspace, and configuration space. Levels of robot autonomy. AI integration in automation and robotics.

Applications: A few case studies in Industrial automation and Robotics, a pick and place robot, and human-robot interaction. Cyber-physical systems, IoT in automation. Ethical and societal aspects of robotics.

Text/ Reference Books

Craig, John J., Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson Education, 2017.
Frank Lamb, Industrial Automation: Hands-On, McGraw-Hill Education, 2013.

25ARE103 ELECTRICAL AND ELECTRONICS ENGINEERING L-T-P-C: 2-0-2-3

Course Objectives

- Understand and apply the basic laws of electrical engineering in analysing DC and AC circuits.
- Gain foundational knowledge of analog electronic components and their applications.
- Realize logic circuits for standard and other specific logical operations.

Course Outcomes

At the end of the course, the student will be able to

CO1: Analyse the DC circuits and verify them through practical lab experiments.
CO2: Evaluate the behaviour of RLC circuits for the sinusoidal power supply.
CO3: Analyse various electronic components and design analog circuits for robotics applications.
CO4: Develop various digital logic circuits for real-world applications.

CO-PO Mappings

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3		
CO2	3	2										3		
CO3	3		1	1								1		1
CO4			3										1	3

Syllabus

Unit 1: Basics of Electrical Engineering: DC Fundamentals

Review of Electrical Engineering: Law of Resistance, Ohm's Law. Series-Parallel Combination: Voltage Divider and Current Divider Rules. Sources: Concept of Current and Voltage Sources, Source Transformation. Circuit Analysis: Mesh Analysis using KVL, Node Analysis using KCL.

Lab: Construction and Analysis of Resistive Network, Verification of Voltage and Current Divider.

AC Fundamentals

AC Generation: Faraday's Laws of Electro-magnetic Induction, Definition of Self and Mutual Inductances, AC Components: Inductive and Capacitive Reactance, Series-Parallel Combination of R, L, C. AC Analysis: Instantaneous & RMS values.

Lab: Construction and Analysis of RLC Network

Unit 2: Basics of Electronics Engineering: Analog Fundamentals

Analog Components: PN Junction Diode: Characteristics, Bridge Rectifiers, BJT: Construction, Transistor as a Switch. Analog Computing: Operational Amplifiers – Inverting and Non-inverting amplifier.

Lab: Characteristics of PN Junction Diode, Transistor as a Switch, Realization of Inverting and Non-Inverting amplifiers using Op-Amp

Unit 3: Basics of Electronics Engineering: Digital Fundamentals

Digital Components: Basic and Universal Gates. Digital Analysis: Boolean Algebra, Truth Tables, Logic Expression Simplification using K-map.

Digital Design: Design of combinational circuits – adders and subtractors; overview of sequential circuits; introduction to the Arithmetic Logic Unit (ALU).

Lab: Realization of combinational and sequential logic circuits

Text Books

Lawrence M. Thompson Dean Ford, CAP, PE, 'Basic Electricity and Electronics for Control - Fundamentals and Applications', Fourth Edition, ISA, 2023
Alexander C K and Sadiku M N O, "Fundamentals of electric circuits", 5th edition, New York, McGraw-Hill, 2013.
Adel S. Sedra, Kenneth Carless Smith, Tony Chan Carusone, "Microelectronic Circuits" 7th Edition, Oxford University Press, 2020
Hirak Sarkar, "Beginner's Guide to Electronics and Robotics",LAP Lambert Academic Publishing (2024)

References

Edward Hughes. "Electrical Technology".7th Edition, Pearson Education Asia, 2011
Vincent Del Toro, 'Electrical Engineering Fundamentals', Prentice Hall of India Private Limited, 2003, 2nd Edition.
Michael Tooley B. A., "Electronic circuits: Fundamentals and Applications", 3rd Edition, Elsevier Limited, 2006.

23MEE102	ENGINEERING GRAPHICS AND 3D MODELING	L-T-P-C: 2-0-2-3

Course objectives

- To understand the BIS and its importance in Technical Drawings.
- To acquire proficiency in orthographic and isometric projection techniques for 2D representation of 3D objects.
- To appreciate the significance of 3D modeling in engineering design and drafting.
- To familiarize with 3D modeling software.
- Develop lateral surface development principles for creating 2D representations of 3D objects.

Course outcomes

At the end of the course, the student will be able to

CO1: Demonstrate proficiency in using BIS for drafting.
CO2: Construct engineering drawings using principles of orthographic and isometric projection.
CO3: Develop models using principles of lateral surface development.
CO4: Create proficiency in developing 3D solid models using the software.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	3		1		3	3	3		1	1	2	
CO2	3	2	3	1	2			3	3		1	1	2	
CO3	3	3	3	1	3	1	1	3	2		1	1	2	
CO4	3	2	3	1	2		1	3	2		1	1	2	

Syllabus

Unit 1

Introduction to Engineering Graphics and 3D Modeling.
Introduction to BIS of Engineering Drawing - Significance of 3D modeling - Introduction to 3D Modeling Software

Unit 2

Orthographic and Isometric Projections in 3D.
Understanding orthographic projections of points, lines, planes, and solids in 3D - Developing 2D projections of 3D models. Developing sectional views of 3D models of solids - Developing isometric projections from 3D models of solids - Real-world applications of orthographic projections

Unit 3

Development of Lateral Surfaces.
Developing lateral surfaces of right regular prisms, cylinders, pyramids, and cones - Understanding the development of surfaces in 3D models - Real-world applications of surface development

Unit 4

Advanced 3D Modeling Techniques.
Advanced modeling techniques in 3D Modeling Software - Creating complex 3D models using multiple tools and techniques. - Applications of advanced 3D modeling techniques in various industries - Exporting 3D models for prototyping and manufacturing

Note: The course is designed to provide students with a comprehensive understanding of engineering graphics, including 2D and 3D modeling techniques. The course will also cover various real-world applications of these techniques and how they are used in different industries. Students will be expected to complete assignments and projects using 3D Modeling Software (Autodesk® Fusion 360®). The classroom learning will be supplemented with a workbook, where the students shall have manual drawing practice for all projection-related topics.

Text Books

Basant Agarwal and C M Agarwal., "Engineering Drawing," 2e, McGraw Hill Education, 2015
Autodesk Fusion 360: A Power Guide for Beginners and Intermediate Users by John Willis, Sandeep Dogra, and Cadartifex, 4e, CADArtifex

Reference Books

Jain, Maheshwari, Gautam (2021), Engineering Graphics & Design, Khanna Book Publishing.
Autodesk Fusion 360 For Beginners: Part Modeling, Assemblies, and Drawings – Tutorial Book
Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing.
John K.C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009

Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson.

23ENG101	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-2-3

Course Objectives

- To introduce the students to the fundamentals of mechanics of writing
- To facilitate them with the style of documentation and specific formal written communication
- To initiate in them the art of critical thinking and analysis
- To help them develop techniques of scanning for specific information, comprehension and organization of ideas
- To enhance their technical presentation skills

Course Outcomes

At the end of the course, the student will be able to

CO1: To gain knowledge about the mechanics of writing and the elements of formal correspondence
CO2: To understand and summarize technical documents
CO3: To apply the basic elements of language in formal correspondence
CO4: To interpret and analyze information and to organize ideas in a logical and coherent manner
CO5: To compose project reports/ documents, revise them for language accuracy, and make technical presentations

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1									2	3				
CO2				1					2	3				
CO3									2	3				
CO4				1					2	3				
CO5									2	3				

Syllabus

Unit 1

Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal), prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers, and sentence linkers. General Reading and Listening comprehension - rearrangement & organization of sentences.

Unit 2

Different kinds of written documents: Definitions, descriptions, instructions, recommendations, user manuals, reports, and proposals.
Formal Correspondence: Writing Formal Letters.
Mechanics of Writing: impersonal passive & punctuation.
Scientific Reading & Listening Comprehension.

Unit 3

Technical paper writing: documentation style - document editing – proofreading - Organising and formatting
Mechanics of Writing: Modifiers, phrasal verbs, tone and style, and graphical representation.
Reading and listening comprehension of technical documents.
Mini Technical project (10 -12 pages).
Technical presentations.

Reference Books

Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002
Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003
Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan & Bacon, 1999.
Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.
Michael Swan. '' Practical English Usage'', Oxford Univ. Press, 2000

22ADM101	FOUNDATIONS OF INDIAN HERITAGE	L-T-P-C: 2-0-1-2

Course Objectives

- To introduce students to the depths and richness of the Indian culture and knowledge traditions.
- To enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- To equip students with a knowledge of their country and its eternal values.

Course Outcomes

At the end of the course the student will be able to

CO1: Increase student understanding of true essence of India's cultural and spiritual heritage. Emancipating Indian histories and practices from manipulation, misunderstandings, and other ideological baggage thus, shows its contemporary relevance.

CO2: Understand the ethical and political strategic concepts to induce critical approach to various theories about India.

CO3: Familiarize students with the multi-dimension of man's interaction with nature, fellow beings and society in general.

CO4: Appreciate the socio-political and strategic innovations based on Indian knowledge systems. Gives an understanding of bringing Indian teaching into practical life

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1				2				2						
CO2		1				1	1	3						
CO3						1	2	3						
CO4	3					3	3	3						

Syllabus

Unit 1

Educational Heritage of Ancient India
Life and Happiness
Impact of Colonialism and Decolonization
A timeline of Early Indian Subcontinent

Unit 2

Pinnacle of Selflessness and ultimate freedom
Indian approach towards life
Circle of Life
Ocean of love; Indian Mahatmas.

Unit 3

Man's association with Nature
Celebrating life 24/7.
Metaphors and Tropes
Become A Strategic Thinker (Games / Indic activity)
India: In the Views of Other Scholars and Travellers

Unit 4

Personality Development Through Yoga.
Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness
Conversations on Compassion with Amma

Text Book

Foundations of Indian Heritage- In house publication

SEMESTER II

23MAT128	LINEAR ALGEBRA	L-T-P-C: 2-1-0-3

Course Objectives

- Understand the basic concepts of vector space, subspace, basis and dimension.
- Familiarize with the inner product space, finding the orthogonal vectors using inner product.
- Understand and apply linear transform for various matrix decompositions.

Course Outcomes

At the end of the course the student will be able to

CO1: Understand the basic concepts of vector space, subspace, basis and dimension.
CO2: Understand the basic concepts of inner product space, norm, angle, orthogonality and projection and Gram-Schmidt process.
CO3: Understand the concepts of linear transformations, the relation between matrices and linear transformations.
CO4: Understand the concepts of Eigenvalues and Eigenvectors.
CO5: Understand various matrix decompositions like, QR, Jordan and SVD.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1		1						1	1		
CO2	3	3	2		1						1	1		
CO3	3	3	2		1						1	1		
CO4	3	2	1		1						1	1		
CO5	3	1	2		1						1	1		

Syllabus

Review: Matrices and Systems of linear Equations.

Unit 1

Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis - Dimension - Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process - Change of basis.
Orthogonal complements - Projection on subspace - Least Square Principle

Unit 2

Linear Transformations: Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation.

Unit 3

Eigen values and Eigen vectors: Definitions and properties of eigenvalues and Eigen vectors. Positive definite, negative definite and indefinite. Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices. Diagonalisation and its applications, Jordan form and rational canonical form and introduction to singular value decomposition.

Note: Students should be encouraged to use software tools as part of their learning/assignments

Text Book

Howard Anton and Chris Rorrs, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.

Reference Books

D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
Gilbert Strang, "Linear Algebraand its Applications", Third Edition, Harcourt College Publishers, 1988.
Kenneth Hoffman and Ray Kunze, Linear Algebra, Pearsons, 2015.

25ARE111	ENGINEERING DYNAMICS	L-T-P-C: 3-0-0-3

Course Objectives

- To develop a comprehensive understanding of the motion of particles and rigid bodies in two and three dimensions using principles of kinematics and kinetics.
- To apply Newtonian mechanics and energy/momentum principles to solve engineering problems involving dynamic systems, including rotational and gyroscopic motion.

Course Outcomes

CO1: Analyze the rectilinear and curvilinear motion of particles and rigid bodies using tangential, normal, and polar coordinate systems.
CO2: Apply Newton's laws of motion, D'Alembert's principle, and work-energy methods to solve problems in dynamics.
CO3: Evaluate linear and angular momentum for particles and rigid bodies, including the application of conservation principles.
CO4: Compute mass moment of inertia and analyze three-dimensional motion and gyroscopic effects in rigid bodies.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2									3	2	
CO2	3	2	2									3	2	
CO3	3	2	2									3	2	
CO4	3	2	2									3	2	

Syllabus

Review of statics (6 hrs)
Kinematics of particles and rigid bodies – Rectilinear and curvilinear motion of particles – Tangential, normal and polar components – Rigid body kinetics – rotation about a fixed axis – general plane motion – Angular velocity and acceleration vectors – Relative velocity and instantaneous center of rotation.(12 hrs)
Kinetics of particles and rigid bodies – Newton's laws of motion for particles and rigid bodies – Concept of force, moment, torque and inertia – D'Alembert's principle – Work, energy and power equations – Linear and angular momentum – conservation of momentum.(15 hrs)
Three dimensional dynamics of rigid bodies – Mass moment of inertia, concept and computation – translation, rotation and general motion. Angular momentum in 3 dimension – Momentum and energy equations - Gyroscopic motion. (10 Hrs)

Text Books/ References

J.L. Meriam and L.G. Kraige, Engineering Mechanics: Dynamics, Wiley.
R.C. Hibbeler, Engineering Mechanics: Dynamics, Pearson.
A. Bedford and W. Fowler, Engineering Mechanics: Dynamics, Pearson.

25CHY116	ENGINEERING CHEMISTRY-C	L-T-P-C: 3-0-0-3

Course objectives

This course is designed to impart strong foundation in physical, inorganic and polymer chemistry, with a specific focus on applications relevant to robotics and smart materials. The course enables interdisciplinary integration of chemistry concepts with mechanical and electronic systems in robotics by connecting fundamental chemical principles to real-world technological applications.

Course Outcomes

After the completion of this course, student will be able to

CO1: Understand the structure and classification of solids and interpret the X-ray diffraction of known solids.

CO2: Apply the electrochemical principles in the design and functioning of batteries, fuel cells, and corrosion prevention in robotics

CO3: Apply thermodynamic laws to predict feasibility and energy changes in chemical systems.

CO4: Understand the role of polymers in robotics with emphasis on mechanical responsiveness, self-healing and artificial muscle systems

CO5: Understand the fundamental concepts of chemistry in designing and developing chemical systems for robotic application.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1		1										
CO2	3	1			1						1			
CO3	3	1		1										
CO4	3	1			1						1			
CO5	3	1			1									

Syllabus

Unit 1: Solid state

Crystalline and amorphous solids – Molecular Solids, Ionic Solids, Atomic Solids. crystal structure – unit cells – identification of crystal planes- the seven crystal systems and their Bravais lattices, X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), metallic and ionic crystals - close packing of spheres – hexagonal, cubic and body centred cubic packing. Molecular crystals. Band theory.

Unit 2: Electrochemistry

Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, Balancing oxidation–reduction Equations - Voltaic (or Galvanic) Cells - Electrochemical Cell Notation - Standard Electrode Potentials - Predicting the Spontaneity - Cell Potential, Free Energy, and the Equilibrium Constant - Concentration Cells, Batteries -Dry-Cell Batteries, Li-MnO_2 cell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell - construction and working of PEMFC. Electrolysis - Stoichiometry of Electrolysis – Corrosion.

Unit 3: Thermochemistry and Thermodynamics

First law of Thermodynamics - Quantifying Heat and Work - Measuring ΔE for Chemical reactions: Enthalpy: Exothermic and Endothermic Processes - Stoichiometry – Thermochemical Equations - Constant-Pressure Calorimetry: Hess's law and other relationships - Enthalpies of reaction - Standard Heats of Formation.

Spontaneous and Nonspontaneous Processes - Entropy and the Second law of - Thermodynamics - Heat Transfer and Changes in the Entropy of the Surroundings - Gibbs Free Energy - Entropy Changes in Chemical reactions - Free Energy Changes in Chemical Reactions - Free Energy Changes for Nonstandard States: Free Energy and Equilibrium.

Unit 4: Polymers for robotics

Mechanically responsive materials for robotics – cyclodextrin based artificial muscles – introduction – artificial muscle regulated by cross-linking density. Mechanochromic polymers as stress sensing soft materials – Introduction, classification, Mechanochromism based on radical type mechanochromophores. Self-healing polymers – introduction, types of self-healing polymers, types of chemistry involved in self-healing polymeric systems.

Text Books

Principles of Chemistry: A molecular approach, 3rd Edition. Nivaldo J Tro, Pearson Education, Inc.2016.
Elements of Physical Chemistry, (7th Edition), Peter Atkins and Julio de Paula, Oxford University Press, 2017.

Reference Books

Chemistry: The Molecular Nature of Matter and Change With Advanced Topics, (8 nd Edition), Martin S. Silberberg and Dr., Patricia Amateis, McGrawHill, 2017.
Chemistry, (8th Edition), Steven S. Zumdahl, Susan A. Zumdahl, Brooks/Cole Cengage learning, 2010.
Electrochemical Methods second edition, A.J. Bard and L.R. Faulkner, John Wiley and Son, 2001.
Hideko Koshima, Mechanically Responsive Materials for Soft Robotics, Wiley-VCH Verlag GmbH, 2020.
Wolfgang H. Binder, Self-Healing Polymers, Wiley-VCH Verlag GmbH, 2013
Sabu Thomas and Anu Surendran, Self-healing polymer based systems, Elsevier, 2020.

25ARE112	PROGRAMMING IN C++	L-T-P-C: 2-0-2-3

Course Objectives

- Learn Object-Oriented software using the Unified Modelling Language
- Create objects and interact among objects using C++
- Implementing advanced data structures Using STL

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the object-oriented concepts

CO2: Understand the creation and access of class and objects

CO3: Design object-oriented systems using UML

CO4: Understand inheritance with the usage of early and late binding, exception handling and generic programming

CO5: Develop computer programs that implement appropriate data structure algorithms for problem-solving and performance-critical applications using the Standard Template Library.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1							2	2			1	1
CO2	2	3	2	1	3				2	2			1	1
CO3	1	2	2	1					2	2			1	1
CO4	1	2	2	1					2	2			1	1
CO5	2	3	2	2	3				2	2			1	1

Syllabus

Unit 1

Overview of Object-Oriented Concepts: Encapsulation, data hiding, reading and writing objects, inheritance, and polymorphism.

UML and Object-Oriented software development: Use case diagrams for functional modeling; class diagrams for simple class design.

Programming in C++: A brief recap of imperative C concepts, followed by objects and classes, transitioning from structures to classes, input/output operations, access specifiers, and static members.

Unit 2

Member Functions: Accessors, mutators, auxiliary functions, constructors, copy constructors, copy assignment operators, destructors, new and delete operators, function overloading, constant variables and methods.

Inheritance: Access control and specialization via overriding, visibility, types of inheritance, friend functions and classes, and type casting.

Unit 3

Polymorphism: Virtual functions, abstract classes, virtual function tables, and exception handling.

Pointers and Data Structures in C++: Review of pointers , binary trees and tree traversals using C++.

Standard Template Library (STL): Implementation of binary search trees using STL.

List of experiments:

- Programming in C++ using classes and objects
- Programming in C++ using member functions, constructors, and destructors
- Designing UML class diagrams
- Programming in C++ using inheritance
- Programming in C++ using function overloading
- Programming in C++ using friend functions
- Programming in C++ using virtual functions
- Programming in C++ with exception handling
- Programming in C++ using pointers and function pointers
- Programming in C++ Binary Search Tree with the Standard Template Library (STL)
- Developing robotic applications using C++

Text Book / Reference Books

Walter Savitch, "Problem Solving with C++: Global Edition", 10th edition, Pearson Education, January 2018.

Bjarne Stroustrup, "Programming: Principles and Practice Using C++", Second edition, Addison Wesley, 2014.

Stanley B Lippman, Josee Lajoie, Barbara E. Moo, C++ Primer, Sixth edition, Addison Wesley, 2015

25ARE113	ACTUATORS AND DRIVES	L-T-P-C: 3-0-0-3

Course Objectives

- Introduction of electrical and non-electrical actuators.
- Sizing of pneumatic and hydraulic actuators.
- The terminology, characteristics and construction of electrical actuators.
- The classification of electric drives and their performance characteristics.
- Selection of actuators and drives for robotics and automation applications

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the concepts of hydraulic, pneumatic and electrical actuators to industrial applications.
CO2: Determine the specifications of hydraulic, pneumatic actuators for a given application.
CO3: Evaluate the performance characteristics of electrical actuators.
CO4: Select suitable actuators and drives for robotics and automation applications.
CO5: Analyze the performance characteristics of drives for different actuators.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3										1		
CO2	3	3									1	1		
CO3	3	3	1									1		
CO4	3	3	1								1	1		
CO5	3	3	2		1						1	1	1	1

Syllabus

Unit 1

Pneumatic Actuators and Hydraulic Linear Actuator types - Single acting, Double Acting, Diaphragm, tandem, telescopic cylinder and cylinders with cushions. Rotary Actuator types - gear, vane, screw, piston types. Sizing of Actuators for industrial applications, Valves, Electro-hydraulic and Electro-pneumatic control devices. Symbols and circuits.

Unit 2

Introduction to Electrical actuators, Solenoids, Rotating electrical machines, operating principles, main terminology and industrial standards. DC, BLDC, Stepper, Servo motor, Synchronous, Induction: principle of operation, main characteristics and construction, Types, Starting, Speed Control and braking, Efficiency, Testing, Selection considerations – direction controllers.

Unit 3

Drives: Introduction, classification of electric drives, Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics, steady state stability and transient stability. Electrical drives for DC, BLDC, VFD, stepper, synchronous, induction motors: Basic characteristics, Operating modes, Different control schemes. Gear boxes and harmonic drives. Case study/projects – automation and robotics applications.

Text Books

S. R. Deb; Sankha Deb. Robotics Technology and Flexible Automation, Second Edition McGraw-Hill Education: New York,2010.
Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2016.
Nathan Ida, Sensors, Actuators, and Their Interfaces- A multidisciplinary introduction, 2nd Edition, IET Digital Library,2020.
Pillay. S.K, A First Course on Electric Drives, Wilely Eastern Limited, Bombay, 2012
Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.
Jagadeesha T., "Hydraulics and Pneumatics", 1st edition, I K International Publishing House, New Delhi, 2015.

25ARE181	MANUFACTURING PRACTICE LAB	L-T-P-C: 0-0-2-1

Course Objectives

- Understand and practice general safety procedures in a manufacturing environment.
- Develop proficiency in CAD modelling and additive manufacturing techniques.
- Gain practical experience in dismantling, measuring, and assembling mechanical products.
- Fabricate basic sheet metal components using appropriate tools and techniques.
- Perform fundamental metal joining operations such as welding and soldering safely.

Course Outcomes

After successful completion of the course, Students will be able to:
CO1: Follow and implement safety procedures in a laboratory environment.
CO2: Design and fabricate simple models using Additive Manufacturing.
CO3: Disassemble, measure, sketch, and reassemble product assemblies.
CO4: Perform basic sheet metal operations to fabricate simple geometries.
CO5: Carry out basic metal joining operations such as welding and soldering.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1		1			1	1		2			
CO2	2	2	1		3	1	1	1	2	1	3			
CO3	2	3	2			1		1	3	3	2			
CO4	3	3	3			1	1	1	3	3	2			
CO5	3	3	3			1	1	1	3	3	2			

Syllabus

Workshop Safety Measures and Practices - Proper training and supervision before operating unfamiliar or complex equipment.

a. Additive Manufacturing Laboratory

Introduction to digital manufacturing. Introduction to Additive Manufacturing - types – additive manufacturing applications - Materials for 3D printing, CAD Modelling for Additive Manufacturing, Slicing and STL file generation- G code generation - 3D printing of simple geometries.

b. Product Laboratory

Study of typical mechanical assemblies. Disassembly of products/subassemblies and measurement of components. Freehand sketching and preparation of BOM. Reassembly and functional verification.

c. Sheet Metal Laboratory

Introduction to sheet metal tools and safety. Marking, cutting, bending, and joining of sheet metal. Surface development of simple geometries. Fabrication of basic sheet metal components and finishing techniques.

d. Metal Joining Laboratory

Introduction to metal joining: welding and soldering basics. Manual arc welding practice: butt and lap joints. Soldering of wires and small components. Safety practices for welding and soldering.

Reference Books:

Laboratory Manual.

List of Equipment required for meeting the COs

a) Additive Manufacturing Laboratory

1. Fused filament 3D printing machines
2. Modelling software & Computers (Minimum i5 Processor)
3. Slicing software

b) Product Lab

1. Tools for assembly/disassembly
2. Precision measuring instruments
3. Sample mechanical assemblies

c) Sheet Metal Lab

1. Marking and measuring tools
2. Cutting tools: shear cutter, hand snips
3. Bending tools: press brake, mallet, hammers
4. Finishing tools: files, grinders
5. Anvil and bench vice

d) Metal Joining Lab

1. SMAW welding machine with electrodes
2. Soldering equipment
3. Protective gear and safety equipment

S.No.	List of Exercises	CO mapping
1.	**General Workshop Safety Measures and Practices**	**CO01**
2.	**Additive Manufacturing Laboratory** 1. Introduction to sketching and CAD modeling for Additive Manufacturing. 2. Conversation of CAD Model to STL file, slicing, and G-code generation 3. Prototyping using 3D printing	**CO01** **CO02**
3.	**Product Lab** 1. Disassembly and measurement of assemblies 2. Sketching and BOM preparation, 3. Reassembly and testing	**CO01** **CO03**
4.	**Sheet Metal Lab** 1. Surface development and fabrication of simple components 2. Marking and cutting 3. Bending operations	**CO01** **CO04**
5.	**Metal Joining Lab** 1. Manual arc welding practice: butt and Lap joint. 2. Soldering practice- wire joints	**CO01** **CO05**

25ARE182	EMBEDDED ROBOTICS LAB	L-T-P-C: 0-0-2-1

Course Objectives

- Understand essential of embedded CPUs used in robotics.
- Gain proficiency in selecting suitable components for embedded robotic applications.
- Program microcontrollers using Arduino for sensor and actuator control.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand essential embedded system architectures used in robotics.
CO2: Select appropriate embedded components based on robotic application requirements.
CO3: Develop and simulate arduino-based programs for robotic applications.
CO4: Interface GPIOs, timers, and communication protocols in embedded robotics.

CO-PO Mappings

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3		
CO2	3		3									3	2	2
CO3		3	2									2		
CO4		3	2									2		

Syllabus

Components of an Embedded System in Robotics

Principles of essential CPU architectures and component selection for robotics applications, microcontrollers, microprocessors, digital signal processors (DSPs), system-on-chip (SoC), single-board computers (SBCs), graphics processing units (GPUs), field-programmable gate arrays (FPGAs), and neural processing units (NPUs) for advanced robotics tasks.

Lab:

Study of Components of Embedded Systems in Robotics

Demonstration of Single-Board Computers (SBCs) in Robotics with Application Example

Demonstration of Graphics Processing Units (GPUs) for Robotic Applications

Microcontroller Programming using Arduino

Introduction to the Arduino board; Arduino IDE; basics of Arduino programming; integration of input and output devices; communication interfaces for embedded robotics applications.

Lab:

- TinkerCAD-Based Simulation of Embedded Robotics Circuits
- GPIO Interfacing Using Arduino for Digital Input/Output Control
- Timer Programming with Arduino for Real-Time Embedded Tasks
- Serial Communication Interfaces on Arduino
- Sensor and Actuator Interfacing with Arduino for Robotic Applications
- Wireless Communication between Arduino Boards using RF/Bluetooth modules

Textbooks / References

Bräunl, T, "Embedded Robotics: From Mobile Robots to Autonomous Vehicles with Raspberry Pi and Arduino" (2nd ed.). Springer, 2022.

Cheich, M, "Arduino Book for Beginners". Open Hardware Design Group LLC, 2021.

Blum, J. "Exploring Arduino: Tools and Techniques for Engineering Wizardry" (2nd ed.). Wiley,2019.

Wild, J, "Arduino Step by Step: The Ultimate Beginner's Guide with Basics on Hardware, Software,Programming & DIY Projects". 3Dtech,2022.

https://www.tinkercad.com/

https://www.arduino.cc/

22ADM111	GLIMPSES OF GLORIOUS INDIA	L-T-P-C: 2-0-1-2

Course Objectives

- The course aims at introducing Bhārath in nutshell to the student, which includes the sources of Indian thoughts, eminent personalities who shaped various disciplines, India's significant contribution to the mankind, the current stature of Indian in the geopolitics and Indian approach to science and ecology.

Course Outcomes

At the end of the course the student will be able to

CO1: Recognise the call of Upanishads and outstanding personalities for confronting the wicked in the real world while admiring the valour, pursuit and divinity in both classical and historical female characters of India.

CO2: Introduce Acharya Chanakya, his works, and his views on polity and nation to find synchrony between public and personal life, alongside understanding India's cultural nuances and uniqueness concerning the comprehension of God across major global communities.

CO3: Appreciate Bhagavad Gita as the source of the Indian worldview through the various Yogic lessons enshrined in it, making it one of India's numerous soft powers, and understand the faith-oriented mechanism of preserving nature.

CO4: informed about the enormous contribution of Indian civilisation over two and half millennia to humanity, develop awareness about India's approach toward science, devoid of dogmas, and rooted in humanism.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1			1	2				2						
CO2	2	1				1		3	1					
CO3	2		1	2	1	1		3						
CO4	2			3				3	2					

Syllabus

Unit 1

Face the Brutes
Role of Women in India
Acharya Chanakya
God and Iswara

Unit 2

Bhagavad Gita: From Soldier to Samsarin to Sadhaka
Lessons of Yoga from Bhagavad Gita
Indian Soft powers
Preserving Nature through Faith

Unit 3

Ancient Indian Cultures (Class Activity)
Practical Vedanta
To the World from India (For Continuous Assessment)
Indian Approach to Science

Text Book / Reference Book(s)

Reference Course material
Textbook Name: Glimpses of Glorious India- In-house publication

22AVP103	MASTERY OVER MIND	L-T-P-C: 1-0-2-2

Course Objectives

- To Mastery Over Mind (MAOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3)
- It gives an introduction to immediate and long-term benefits of MAOM meditation and equips every attendee to manage stressful emotions and anxiety, in turn facilitating inner peace and harmony.
- This course will enhance the understanding of experiential learning based on the University's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

Course Outcomes

At the end of the course, the student will be able to
CO1: To be able to describe what meditation is and to understand its health benefits
CO2: To understand the causes of stress and how meditation improves well-being
CO3: To understand the science of meditation
CO4: To learn and practice MAOM meditation in daily life
CO5: To understand the application of meditation to improve communication and relationships
CO6: To be able to understand the power of meditation in compassion-driven action

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1							1	2	2		2			
CO2			2		2			2	2		2			
CO3					2		2	2	2		2			
CO4			3		3	2	3	3	3		3			
CO5			2		2		2	2	3		3			
CO6			2				2	2	3		3			

Syllabus

Unit 1

Describe Meditation and Understand its Benefits (CO1)
A: Importance of meditation. How does meditation help to overcome obstacles in life (Pre-recorded video with Swami Shubhamritananda Puri)
Reading 1: Why Meditate? (Swami Shubamritananda ji)

Unit 2

Causes of Stress and How Meditation Improves Well-being (CO2)
A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation. (Pre-recorded video with Dr. Ram Manohar)
B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. (Pre-recorded video with Prof Udhaykumar)
Reading 1: Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress. Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in-depth/meditation/art-20045858 (PDF provided)
Reading 2: 'Efficient Action.' Chapter 28 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 3

The Science of Meditation (CO3)
A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method? (Pre-recorded video with Dr. Shyam Diwakar)
B: How meditation helps humanity according to what we know from scientific research (Pre-recorded video with Dr. Shyam Diwakar)
Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)
Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 4
Practicing MA OM Meditation in Daily Life (CO4)
Guided Meditation Sessions following scripts provided (Level One to Level Five)
Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)
Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 5
Improving Communication and Relationships (CO5)
How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in the workplace. (Pre-recorded video with Dr Shobhana Madhavan)
Reading 1: Seppala E (2022, June 30th) 5 Unexpected Ways Meditation Improves Relationships a Lot. Psychology Today. https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways- meditation-improves-relationships-lot
Reading 2: 'Attitude.' Chapter 53 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 6
Meditation and Compassion-driven Action (CO6)
Understand how meditation can help to motivate compassion-driven action. (Pre- recorded video with Dr. Shobhana Madhavan)
Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know?. Current Opinion in Psychology, 44, 151-156.
Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritanandamyi Mission Trust

Text Books / Reference Books:
Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math
The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas
Dhyana Yoga-Holy Gita Swami Chinmayanda
Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
Mind: It's Mysteries and control-Swami Sivananda Saraswati
Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
Books on Amma's teachings like Awaken children, From Amma's Heart etc.
The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.
Allen, Cynthia (2020) The Potential Health Benefits of Meditation
Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today
Sharma, Hari (2022) Meditation: Process and Effects
Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress.
Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: Current Opinion in Psychology

SEMESTER – III

26MAT201	PROBABILITY AND STATISTICS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the basic concepts of probability for modelling uncertainty in engineering systems.
- To develop the ability to analyse discrete and continuous random variables and standard probability distributions relevant to engineering applications.
- To enable students to apply statistical techniques such as regression, estimation, and hypothesis testing for data-driven engineering decision-making.

Course Outcomes

At the end of the course the student will be able to

CO1: Apply the basic concepts of probability, conditional probability, and Bayes' theorem to solve engineering problems involving uncertainty.

CO2: Analyse discrete and continuous random variables and apply standard probability distributions to model automation and engineering systems.

CO3: Apply correlation and linear regression techniques to analyse engineering data and interpret relationships among variables.

CO4: Evaluate sampling distributions and estimate population parameters using point and interval estimation methods.

CO5: Understand the concepts and perform appropriate hypothesis tests for small and large samples.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2		1	1						1	1		
CO2	3	2		2	2						1	2	1	1
CO3	2	3	1	3	2				1		1	2	2	1
CO4	3	3		3	2						1	1	1	
CO5	3	3		3	2				1		1	2	1	1

Syllabus

Unit-1

Fundamental of probability: sample space, events, axioms of probability, theorems, conditional probability, Bayes' Theorem. Random variables: discrete and continuous variables, probability mass function, probability density function, cumulative distribution function, mathematical expectation, moments, moment generating functions. Standard probability distributions: Binomial, Poisson, Exponential, Normal distributions- definitions, parameters, mean, variance, moment generating functions, Chebyshev's theorem – Plotting probability distribution & parameter estimation using software tools.

Unit-2

Two-dimensional random variables: Joint, marginal and conditional probability distributions for discrete case. Correlation and Regression: Scatter diagram, Karl Pearson's correlation coefficient, properties of the correlation coefficient, simple linear Regression, least squares method for estimation of regression coefficients, and properties of least square estimators. Applications of correlation and regression in engineering and automation to perform data analysis using software tools

Unit-3

Sampling distributions: concept, sampling distributions of sample mean and sample variance, Central limit theorem.
Standard sampling distributions: Chi-square, t and F distributions – definitions, basic properties and applications
Theory of estimation: point estimation, properties of estimators, unbiased estimators, maximum likelihood estimation, and interval estimation.
Testing of Hypothesis: null and alternative hypotheses, level of significance, Type I and Type II errors, large sample and small sample tests for mean and variance, and tests based on Chi-square distribution.
Use of computational tools to conduct simple statistical analysis

Text Books

Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2019) John Wiley and Sons Inc

Reference Books

J. Ravichandran, "Probability and Random Processes for Engineers", (2015) First Edition, IK International.
Walpole, Ronald E., Myers, Raymond H., Myers, Sharon L., Ye, Keying E. Probability & Statistics for Engineers & Scientists, (2016) Global Edition. United Kingdom: Pearson Education.
Sheldon M Ross, Introduction to Probability and Statistical Inference, (2020) 6th Edition, Academic Press.

26ARE201	MECHANICS OF MATERIALS	L-T-P-C: 3-0-0-3

Course Objectives

- To develop a fundamental understanding of stress, strain, and material behavior under axial, torsional, and bending loads.
- To enable students to analyze structural members such as bars, beams, shafts, and columns for strength, stability, and deformation.

Course Outcomes (COs):

At the end of the course, the student will be able to

CO1: Apply fundamental principles to evaluate the stress–strain behavior of linear elastic materials under axial loading conditions.

CO2: Analyze torsional loading in circular shafts to determine torsional strength and angle of twist.

CO3: Construct shear force and bending moment diagrams and evaluate bending stress and deflection in beams.

CO4: Analyze stress transformation on inclined planes and construct Mohr's circle to determine principal stresses and maximum shear stresses.

CO5: Evaluate the critical buckling load of columns using Euler's and Rankine's formulae under different end conditions.

CO/PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	1							1	3	1	1
CO2	3	3	2	1							1	3	1	1
CO3	3	3	2	2	1						1	3	1	1
CO4	3	3	2	2	1						1	3	1	1
CO5	3	3	2	2	1						1	3	1	1

Syllabus

Unit 1 :

Simple Stress and Strain:

Introduction; mechanical properties of materials; normal and shear stress; strain and its types; Hooke's law; Poisson's ratio; stress–strain behavior of structural steel and nonferrous materials; volumetric strain and its expression; elastic constants and their interrelationships; principle of superposition; stress and strain analysis in composite and tapering bars; statically indeterminate members; thermal stresses; strain energy and impact loading.

Torsion of circular shafts:

Introduction to torsion; pure torsion; torsion equation for solid and hollow circular shafts; shear stress distribution; strength and stiffness of shafts; angle of twist; torsional rigidity and polar modulus; power transmission by shafts.

Unit 2 : Bending moment and Shear force in beams:

Types of beams, supports, and loadings; definition of shear force and bending moment; sign conventions; relationship between load, shear force, and bending moment; construction of shear force diagrams (SFD) and bending moment diagrams (BMD) for cantilever, simply supported, and overhanging beams under point loads and uniformly distributed loads (UDL); theory of simple bending; bending stress distribution in beams; deflection of beams and its significance in beam design. Use of computational tools for plotting shear force & bending moment diagrams

Unit 3

Compound Stresses:

Introduction; stress components on inclined planes; general two-dimensional state of stress; principal planes and principal stresses; Mohr's circle of stress; theories of failure.

Elastic Stability of Columns:

Introduction; classification of short and long columns; Euler's theory of column buckling; assumptions and derivation of Euler's buckling load for different end conditions; effective length, slenderness ratio, and radius of gyration; limitations of Euler's theory; Rankine's formula; numerical problems. Use of computational tools for computing compound stress and studying the elastic stability of columns

Introduce AI-assisted tools for stress prediction, materials property estimation, and predictive failure analysis

Text Books

Ferdinand P. Beer, E. Russell Johnston Jr., et al. Mechanics of Materials. McGraw-Hill Education, 7th Edition, 2015.

R. C. Hibbeler. Mechanics of Materials (SI Edition). Pearson Education, 11th Edition, 2024.

James M. Gere and Barry J. Goodno. Mechanics of Materials. Cengage Learning, 9th Edition, 2018.

References

William D. Callister Jr. and David Rethwisch. Materials Science and Engineering: An Introduction. Wiley, 10th Edition, 2018.

Egor P. Popov. Engineering Mechanics of Solids. Pearson India, 2nd Edition, 1998.

R. K. Bansal. Mechanics of Solids. Pearson India, 2nd Edition, 2012.

26ARE202	ROBOT KINEMATICS	L-T-P-C: 3-0-2-4

Course Objectives

- Introduce the mathematical foundations of spatial transformations and coordinate representations in robotic systems.
- To develop the ability to analyse and solve forward and inverse kinematics problems of various robot configurations using Denavit–Hartenberg representation.
- To provide understanding of velocity, static force analysis, Jacobian computation, and singularity issues in robotic manipulators.

Course Outcomes

At the end of the course, the student will be able to

CO1: Represent rigid body positions and orientations in 3D space using homogeneous transformation matrices, rotation matrices, Euler and RPY angles.

CO2: Formulate and solve forward and inverse kinematics problems for different types of robotic manipulators using DH parameters.

CO3: Perform velocity analysis of robotic systems, compute Jacobians analytically and geometrically, and identify singularities.

CO4: Apply the concepts of Jacobians in force and velocity domains for analysing static forces and motion transmission in manipulators.

CO5: Perform multi-body system modeling and analysis using software.

CO-PO Mappings

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1						1	3		
CO2	3	3	2	1	1						1	3		
CO3	3	3	2	1	1						1	3		
CO4	3	3	2	1	1						1	3		
CO5	3	3	2	1	1						1	3		

Syllabus

Unit 1

Spatial transformation- representation of a point in space – types of coordinate systems. Representation of a rigid body in space – position and orientation. Homogeneous transformation matrix – its properties. Rotation matrices. Rotation about an arbitrary axis. Inverse of transformation matrices. Forward and Inverse kinematics – position and orientation – Cartesian, cylindrical and spherical robot systems - RPY and Euler angles. Forward and inverse kinematics of Cartesian – RPY, Cartesian – Euler combinations.

Unit 2

Denavit- Hartenberg representation – DH parameters – DH table - derivation of the generalized DH matrix. Forward and Inverse kinematics based on DH representation. Examples – 2 link manipulator, SCARA robot, PUMA robot, Stanford robot, Rhino robot and other suitable examples.

Unit 3

Velocity analysis – Angular velocity matrix and its properties. Velocity propagation from link to link. Jacobians-Analytical and geometrical calculation of Jacobian. Singularity in robots – Static force in manipulators – Jacobian in force domain. Cartesian transformation of velocities and static forces.

Lab Exercises

Planar Kinematics

1. Modeling and analysis of a slider crank mechanism.
2. Modeling and analysis of a 4-bar linkage.
3. Modeling and analysis of a quick-return mechanism.
4. Modeling and analysis of a five-link mechanism.
5. Study of different gear trains and cams.

Robot Kinematics

1. Homogeneous transformation and orientation representation (RoboAnalyzer)
2. Forward kinematics of a 2-link manipulator (RoboAnalyzer)
3. Inverse kinematics of SCARA and PUMA robots (RoboAnalyzer)
4. Velocity and Jacobian analysis (ADAMS/ MATLAB)
5. Singularity and Force analysis (ADAMS/ RoboAnalyzer)

AI tools integration for trajectory generation, motion planning & motion analysis

Text Books

Craig, J.J., Introduction to Robotics: Mechanics and Control, 2nd Edition, Addison-Wesley, Reading, MA, 1989.
Niku, Saeed B. Introduction to robotics: analysis, control, applications. John Wiley & Sons, 2020.
Uicker, John Joseph, John J. Uicker Jr, Gordon R. Pennock, and Joseph E. Shigley. Theory of machines and mechanisms. Cambridge University Press, 2023.

References

Schilling, Robert J. Fundamentals of robotics: analysis and control. Simon & Schuster Trade, 1996.
Saha, Subir Kumar. Introduction to robotics. Tata McGraw-Hill Education, 2014.

26ARE203	DATA ANALYTICS	L-T-P-C: 2-0-2-3

Course Objectives

- To understand the concept of data processing and data plotting methods.
- To understand various statistical measures for data science
- To gain practical experience in programming tools for data sciences
- To carry out various case studies with data sets from robotics and to draw practical inferences

Course Outcomes

At the end of the course the student will be able to

CO1: Understand data classification and types of analytics.
CO2: Apply probability theory, hypothesis testing to analyze and interpret data effectively.
CO3: Perform data pre-processing, exploratory analysis, and visualization to evaluate models.
CO4: Apply database management to conduct end to end analysis.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2			1						1		2	
CO2	3	3		2	2						1		2	
CO3	3	3	2	2	3				2		2	1	3	2
CO4	3	2	3	2	3				2	2	2	2	3	2

Syllabus

Unit 1

Introduction to statistics, collection, classification, and tabulation of data. Types of data: primary and secondary. Presentation of data using histogram, frequency curve, frequency polygon, ogive curves, and stem-and-leaf chart. Types of analytics: descriptive, diagnostic, predictive, prescriptive. Applications in industries and data analytics process

Unit 2

Measures of central tendency and dispersion including mean, median, mode, geometric mean, harmonic mean, and weighted mean. Bivariate normal distribution, types, importance, methods of measuring correlation such as scatter diagram. Probability theory and distributions. Hypothesis testing, ANOVA, and chi-square tests.

Unit 3

Data cleaning, reduction, transformation, and discretization. Visualization and graphing including visualizing categorical and numerical distributions, overlaid graphs, plots, randomness, and probability. Exploratory data analysis, data analytics lifecycle, hypothesis testing, assessing models, decisions, uncertainty, and comparing samples.

Unit 4

Data scraping, wrangling, web scraping, data parsing, and data ingestion. Cloud database, SQL, and RDBMS. Aggregation and subqueries. Case studies using real datasets. Dashboards and storytelling with data. Introduction to machine learning and end-to-end analysis on a real-world dataset.

Lab Content: Introduction to Python / equivalent software programming tool - Control Structures, Data Structures, Python packages – NumPy, SciPy , Matplotlib, Power Bi, Tableau, Sci-kit learn, Pandas, Tensorflow, Streamlite.

Lab Exercise

1. Introduction to Python / equivalent Programming language
2. data types, statements, functions, File handling, Arrays, plots
3. Introduction -Data processing
4. Data cleaning, manipulation, grouping and visualization.
5. Dashboard creation using Excel / Power bi /Tableau
6. Time and frequency domain analysis.
7. Data Analysis with SQL
8. Anomaly detection using AI tools and introduction to predictive analytics using ML tools

Text Books / References

John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data ", 3rd Edition, MIT Press, 2021.

McKinney, W. (2022). Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter (3rd ed.). O'Reilly Media.

Nelli, F., 2015. Python data analytics: Data analysis and science using PANDAs, Matplotlib and the Python Programming Language. Apress.

Govers, F. X. (2018). Artificial intelligence for robotics. Packt Publishing.

Igual, L., & Seguí, S. (2016). Introduction to data science: A Python approach to concepts, techniques and applications. Springer.

26ARE204	FLUID POWER AUTOMATION	L-T-P-C: 3-0-0-3

Course Objectives

- Building the fundamentals of fluid power system
- Impart knowledge of circuit design for industrial application
- Provides theoretical and practical aspects of implementing automation in the industry

Course Outcomes

At the end of the course, the student will be able to

CO1: Identify fluid power components and their symbols as used in industry and select suitable fluid power components for different industrial applications.

CO2: Analyse the performance of the pump and actuators

CO3: Design the hydraulic and electro-hydraulic circuit for the given application.

CO4: Familiarize with fluid conditioning elements and control valves

CO5: Design a pneumatic and electro-pneumatic circuit with single and multi-cylinders for the given application

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3									2		
CO2	3	2	3									2		
CO3	3	2	3		2						2	2		
CO4	3	2	3									2		
CO5	3	2	3		2						2	2		

Syllabus

Unit 1

Basics of fluid power system – Advantages and applications of Fluid power systems – Fluid properties – Pascal's Law and its application – Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Pump performance, Characteristics and Selection - Sizing of pumps (Numerical problems in Pumps). Direction control valves: Two-way, Three-way, four way valve, check valve and shuttle valve – Actuation mechanisms in DCV- Pressure control valves: Pressure relief, Pressure Reducing, Counterbalance, Sequencing and Unloading Valves – Flow control valves and its types. Proportional valves, Servo valves: Mechanical type and Electrohydraulic servo valves.

Unit 2

Compressors: piston, screw and vane compressor – Fluid conditioning elements: Filter Regulator and Lubricator unit, Pneumatic silencers, After coolers, Air dryers – Air control valves – Fluid power actuators: Linear and Rotary actuators – types – Cushioning mechanism in cylinders – Sizing of actuators (Numerical problems in Actuators). Basic pneumatic circuits – Pneumatic vacuum systems – Cascade Circuit design method (two / three-cylinder circuits), Step-counter method, KV Map method. Electrical components and electrical controls for Fluid power circuits- PLC applications in Fluid power circuit. Electro-Pneumatic circuit design.

Unit 3

Accumulator – Types and application circuits – Pressure intensifier circuits. Electro-hydraulic circuit design. Industrial circuits: Speed control circuits – Regenerative cylinder circuits – Pump unloading circuit – Double pump circuit – Counterbalance valve circuit – Hydraulic cylinder sequencing circuit – Automatic cylinder reciprocating circuit – Cylinder synchronizing circuits – Fail safe circuits. Fluidics, MPL devices. Circuits using Fluid logic devices and applications. Sealing devices: Types and materials – Installation, Maintenance and troubleshooting of Fluid Power systems.

Text Books

Antony Esposito, "Fluid Power with Applications", Pearson, Seventh Edition., 2014.

W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" - Prentice-Hall - Fifth Edition 2013.

References Books

Sullivan James A., "Fluid Power - Theory and Applications", Fourth Edition, Prentice-Hall International, New Jersey, 1998.

Watton, John. Fundamentals of fluid power control. Vol. 10. Cambridge University Press, 2009.

26ARE282	DESIGN THINKING - A	L-T-P-C: 0-0-2-1

Course Objectives

- Introduce to the students, the concept of design thinking
- Make the students as a good designer by imparting creativity and problem solving ability
- Conceive, conceptualize, design and demonstrate innovative ideas using prototypes.

Course Outcomes

At the end of the course, the student will be able to

CO1: Familiarize with design thinking concepts and principles to solve critical problems.
CO2: Establish a workable design thinking framework to solve critical problems using empathy.
CO3: Interact with users to identify customer needs.
CO4: Generate and develop functional design through ideation.
CO5: Conceive, organize, lead, and implement projects in interdisciplinary domains.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	3						2	1		3	1
CO2	2	2	1	1				2		2	1		3	1
CO3	2	2	1	1		1		1	3	2	1		3	1
CO4	2	2	1	1	1	1				2	1		3	1
CO5	2	2	1	1	2	3		3	2	3	1		3	1

Syllabus

Design process: Traditional design, Design thinking, Existing sample design projects, Study on designs around us, Compositions/structure of a design,
Innovative design: Breaking of patterns, Reframe existing design problems, Principles of creativity
Empathy: Customer Needs, Insight-leaving from the lives of others/standing on the shoes of others, Observation
Conceptualization: Visual thinking, Concept Generation Methodologies, Concept Selection, Concept Testing, Prototyping
Introduction to AI-assisted product design & development
Introduction to Generative AI for ideation & design
Design projects for teams.

Text Book / Reference Books

Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins Publishers Ltd.
Idris Mootee, Design Thinking for Strategic Innovation,2013, John Wiley & Sons Inc
Brenda Laurel Design Research methods and perspectives MIT press 2003
Terwiesch, C. & Ulrich, K.T., 2009. Innovation Tournaments: creating and identifying Exceptional Opportunities, Harvard business press.
Ulrich & Eppinger, Product Design and Development, 3rd Edition, McGraw Hill, 2004
Stuart Pugh, Total Design: Integrated Methods for Successful Product Engineering,
Bjarki Hallgrimsson, Prototyping and model making for product design, 2012, Laurence King Publishing Ltd
Kevin Henry, Drawing for Product designers, 2012, Laurence King Publishing Ltd

26ARE281	FLUID POWER AUTOMATION LAB	L-T-P-C: 0-0-2-1

Course Objectives

- The course will enable the students to
- Developing design skills in hydraulic and pneumatic circuit design

Course Outcomes

At the end of the course, the student will be able to
CO1: Design a hydraulic and electro-hydraulic circuit
CO2: Design and testing of pneumatic circuit
CO3: Design and testing of electro-pneumatic circuit

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2				1		1	2		
CO2	3	2	2	1	2				1		1	2		
CO3	3	2	2	1	2				1		1	2		

List of exercises:

1. Design and simulate the hydraulic circuit with control elements.
2. Design and simulate an electro-hydraulic circuit for industrial application.
3. Design and simulate the pneumatic circuit with control elements.
4. Design and testing of speed control circuits and synchronizing circuits.
5. Design and testing of Pneumatic circuits with logic control valves.
6. Design, simulate and test a pneumatic circuit for multi-cylinder sequences.
7. Design, simulate and test a sequential circuit using the cascade method.
8. Design, simulate and test a sequential circuit using the cascade method.
9. Design and simulate multiple cylinder sequential circuits using the step counter method.
10. Design, simulate and test an electro-pneumatic circuit.
11. AI-based fault diagnosis in hydraulic & pneumatic systems
12. Demonstrate the application of digital twins for fluid systems

Reference Books

Laboratory Manuals
Antony Esposito, "Fluid Power with Applications", Pearson, Seventh Edition. 2013.

22ADM211	LEADERSHIP LESSONS FROM RAMAYANA	L-T-P-C: 1-0-0-1

Course Objectives

- Through a study of the Rāmāyaṇa, the student should gain a deeper understanding of the ethical grandeur of Indian culture, and be inspired to follow the ideals of the characters depicted therein.

Course Outcomes

At the end of the course the student will be able to

CO1: Appreciate the significance of *Rāmāyaṇa* as an *itihāsa,* and important aspects of *Bālakāṇḍa*.

CO2: Understand the family values and ideal human relationships portrayed in the *Ayodhyakāṇḍa* and *Aranyakāṇḍa* of *Rāmāyaṇa*.

CO3: Understand *dharma* and its nuances, emphasizing its applicability in an individual's life through *Kishkindhakāṇḍa* and *Sundarakāṇḍa* of Ramayana.

CO4: Appreciate the triumph of *dharma* over *adharma* through *Yuddhakāṇḍa* of *Rāmāyaṇa*

CO5: Appreciate the spiritual values from *Rāmāyaṇa* in resolving personal and social conflicts through varied effective presentations of important episodes of the *Rāmāyaṇa.*

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1						2	2	3	3	3	3			
CO2						3	3	3	3	2	3			
CO3						3	2	3	3	3	3			
CO4						3		3	3	3	3			
CO5						3		3	3	2	3			

Syllabus

Unit 1

An overview of Valmiki's epic. Introdcution to the content and structure of the epic text and it's principal characters.
Bala-Kāṇḍa: Preparing for the renowned mission.

Unit 2

Ayodhya-Kāṇḍa: Harbinger of an Entire Tradition of Nobleness.
Araṇya-Kāṇḍa: Tale of the forest life.

Unit 3

Kishkindha-Kāṇḍa: The Empire of Holy Monkeys.
Sundara-Kāṇḍa: Heart of the Ramayana

Unit 4

Yuddha-Kāṇḍa:The most popular part of the Ramayana
Uttara-Kāṇḍa: An attempt to explain the untold stories.

Unit 5

Ramayana and Modern-day learning
Ecological Awareness in the Ramayana
Different Ramayana: Epic that connects the world.

Text Books / References

Leadership Lessons from the Ramayana, ASCSS
Rajagopalachari. C, The Ramayana
Valmiki, The Ramayana, Gita Press

23LSE201	Life Skills for Engineers I	L-T-P-C: 1-0-2-P/F

Pre-requisite: An open mind and the urge for self-development, basic English language skills, knowledge of high school level mathematics.

Course Objectives

- Assist students in inculcating Soft Skills and developing a strong personality
- Help them improve their presentation skills
- Support them in developing their problem solving and reasoning skills
- Facilitate the enhancement of their communication skills

Course Outcomes

CO1 - Soft Skills: To develop greater morale and positive attitude to face, analyse, and manage emotions in real life situations, like placement process.
CO2 - Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.
CO3 - Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.
CO4 - Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.
CO5 - Verbal: To infer the meaning of words and use them in the right context. To have a better understanding of the basics of English grammar and apply them effectively.
CO6 - Verbal: To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	3	3		3
CO2									2	3		3
CO3		3		2								
CO4		3		2								
CO5										3		3
CO6									3	3		3

Syllabus

Soft Skills

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback, Need for change in mindset and up-skilling to keep oneself competent in the professional world.
Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

Aptitude

Problem Solving I

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.
Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.
Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.
Averages: Basics, and Weighted Average.
Data Interpretation: Tables, Bar Diagrams, Venn Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, Network Diagrams and other forms of data representation.

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English.
Grammar (**Basic**): Help students learn the usage of structural words and facilitate students to identify errors and correct them.
Reasoning: Stress the importance of understanding the relationship between words through analogy questions.
Speaking Skills: Make students conscious of the relevance of effective communication in today's world through various individual speaking activities.

References:

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
9. Cracking the New GRE 2012
10. Kaplan's – GRE Comprehensive Programme
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50
Pass / Fail		

*CA - Can be **presentations, speaking activities and tests.**