Department of Mechanical Engineering
B.Tech Automation and Robotics – Revision of curriculum for 2025 admission
Semester I and II

Semester I

Sl.No.	Course Code	Name of the course	L-T-P-C	Credit
1	23MAT133	Multivariable Calculus	2-1-0	3
2	25ARE101	Introduction to Data Structures with C	2-0-3	3
3	25PHY104	Engineering Physics C	3-0-0	3
4	25ARE102	Introduction to Automation and Robotics	2-0-0	2
5	25ARE103	Electrical and Electronics Engineering	2-0-3	3
6	23MEE102	Engineering Graphics and 3D modeling	2-0-3	3
7	23ENG101	Technical Communication	2-0-3	3
8	22ADM101	Foundation of Indian Heritage	2-0-1	2
		Total Credits		**22**

Semester II

Sl.No.	Course Code	Name of the course	Credits L-T-P-C	Credit
1	23MAT128	Linear Algebra	2-1-0	3
2	25ARE111	Engineering Dynamics	3-0-0	3
3	25CHY116	Engineering Chemistry C	3-0-0	3
4	25ARE112	Programming in C++	2-0-3	3
5	25ARE113	Actuators and Drives	3-0-0	3
6	25ARE181	Manufacturing Practice Lab	0-0-3	1
7	25ARE182	Embedded Robotics Lab	0-0-3	1
8	22ADM111	Glimpses of Glorious India	2-0-1	2
9	22AVP103	Mastery over mind	1-0-2	2
		Total Credits		**21**

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 with 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 its geometrical interpretations.
CO2: Understand the concept of scalar and vector fields.
CO3: Understand and apply the concepts extreme values and Lagrange multipliers for simple optimization problems.
CO4: Understand and apply the concepts line and double integrals to various problems including Green's theorem for 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	PO12	PSO1	PSO2	PSO3
CO1	1	3	1									1			
CO2	1	2	2									1			
CO3	3	2	2									1			
CO4	2	2	2									1			
CO5	2	2	1									1			

Syllabus

Unit 1
Limits and continuity of Functions of Severable 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.

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: 2-0-3-3

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	PO12	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 Book

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 its few 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 mathematically the wave equation, and apply in real life problems in sciences and engineering.
CO3: Introduced to basics of Optics, phenomenon of interference and 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 property.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	PO12	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	

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: Few case studies in Industrial automation and Robotics, pick and place robot, human robot interaction. Cyber-physical systems, IoT in automation. Ethical and societal aspects or 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: 2-0-3-3

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	PO12	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 Swich. 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: 2-0-3-3

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	PO12	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 Book
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
1. *Jain, Maheshwari, Gautam (2021), Engineering Graphics & Design, Khanna Book Publishing.*
2. Autodesk Fusion 360 For Beginners: Part Modeling, Assemblies, and Drawings – Tutorial Book
3. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing.
4. John K.C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009
5. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson.

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

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	PO12	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 – 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 – proof reading - Organising and formatting
Mechanics of Writing: Modifiers, phrasal verbs, tone and style, 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	PO12	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	PO12	PSO1	PSO2	PSO3
CO1	3	2	1									1	1		
CO2	3	3	2									1	1		
CO3	3	3	2									1	1		
CO4	3	2	1									1	1		
CO5	3	1	2									1	1		

Syllabus

Review: Matrices and System 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.

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	PO12	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	PO12	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										

UNIT 1: Solid state (8 Hrs)
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 (9 Hrs)
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 (10 Hrs)
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: 2-0-3-3**

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	PO12	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 experiment :

- 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	PO12	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 **S2**

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: 0-0-3-1

Course Objectives

The course will enable the students to
- 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:

S.No.	Course Outcomes	Knowledge level [Bloom's Taxonomy]
CO01	Follow and implement safety procedures in a laboratory environment.	Understand
CO02	Design and fabricate simple models using Additive Manufacturing.	Apply
CO03	Disassemble, measure, sketch, and reassemble product assemblies.	Apply
CO04	Perform basic sheet metal operations to fabricate simple geometries.	Apply
CO05	Carry out basic metal joining operations such as welding and soldering.	Apply

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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: 0-0-3-1**

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	PO12	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

1. Bräunl, T, "Embedded Robotics: From Mobile Robots to Autonomous Vehicles with Raspberry Pi and Arduino" (2nd ed.). Springer, 2022.
2. Cheich, M, "Arduino Book for Beginners". Open Hardware Design Group LLC, 2021.
3. Blum, J. "Exploring Arduino: Tools and Techniques for Engineering Wizardry" (2nd ed.). Wiley,2019.
4. Wild, J, "Arduino Step by Step: The Ultimate Beginner's Guide with Basics on Hardware, Software,Programming & DIY Projects". 3Dtech,2022.
5. https://www.tinkercad.com/
6. 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	PO12	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	PO12	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