HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

DEPARTMNET OF MECAHANICAL ENGINEERING
CURRICULUM AND SYLLABUS
UNDER CBCS

for

M.Tech. Degree Programme
In

Robotics & Mechatronics
(Applicable for Students admitted from Academic Year 2018-19)

Centre for Automation and Robotics
School of Mechanical Sciences
Hindustan Institute of Technology and Science

VISION STATEMENT OF THE INSTITUTE

TO MAKE EVERY MAN A SUCCESS AND NO MAN A FAILURE

MISSION STATEMENT OF THE INSTITUTE

To provide every individual with a conducive environment suitable to achieve his/her career goals, with a strong emphasis on personality development, and to offer the academically inclined the resources to gain quality education in all spheres of Engineering, Applied Sciences and Management, without compromising on the quality and code of ethics

SCHOOL OF MECHANICAL SCIENCES
CENTRE FOR AUTOMATION & ROBOTICS

VISION

A research team with synergetic strengths emphasizes on robotics and automation related research, product development, teaching, training and consultancy with a goal to innovate and disseminate new knowledge to meet the needs of industries and society

MISSION

To engage in multidisciplinary research in the fields of robotics and automation, condition monitoring, vision system and artificial intelligence. Centre strives to provide solutions which will support industrial automation systems. It also focuses on providing the students with a varied academic and research experience on industrial automation and robotics, and helps the University in educating the future work force in meeting the oncoming technical challenges and advancements in the field of automation and robotics.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO):

The Program Educational Objectives (PEOs) describe the professional accomplishments of our graduates about three-five years after having completed the under-graduate program in Electronics and communication Engineering.

1. Be able to attain knowledge in multi-disciplinary engineering domain and be able to evaluate, interpret and apply this knowledge.
2. Be able to solve complex problems independently by improving abilities on analysis, synthesis and criticism.
3. Be able to define, analyse and develop solution methods for robotics, control and automation problems belonging to various disciplines.
4. Be able to develop novel and original ideas and methods; be able to develop innovative solutions in system, process and algorithm designs.
5. Be able to design and implement analytical, model-based and experimental research; be able to analyse and interpret complex situations encountered in the process.
6. Be able to convey the processes and results of the studies in both national and international written or oral media.
7. Be able to combine the information from different areas and develop solution methods for different areas by taking part in multi-disciplinary teams.
8. Having proficiency in preserving social, scientific and ethical values in all academic and professional activities.
9. Having awareness of new and emerging applications about the profession; be able to examine and learn them in case of necessity.
10. Having comprehensive knowledge on the modern techniques, methods and their boundaries in engineering.
11. Be able to construct scientific problems with novel and original ideas and methods, and be able to solve these problems using conventional methods or developing innovative methods.
12. Be able to have continuous self-improvement by tracking scientific developments.

IMPORTANT ABBREVIATIONS

AY	Academic Year
AAT	Alternate Assessment Tools
CGPA	Cumulative Grade Point Average
CIE	Continuous Internal Evaluation
CO	Course Outcome
PC	Professional Core Course
PE	Professional Elective
CF	Core Foundation
EE	Engineering Elective
OE	Open Elective
LTPS	Lecture-Tutorial-Practical-Self-Study
CC	Core Course
PEO	Program Educational Objective
PO	Program Outcome
ESE	End Semester Examination
SGPA	Semester Grade Point Average
RM	Robotics & Mechatronics

STRUCTURE OF THE CURRICULUM

Sl. No.	Type of Course	L	T	P	TCH	CREDITS
1	Theory without tutorials	2	0	0	2	2
2	Theory with tutorial	2	1	0	3	3
3	Theory with Practical	2	0	2	4	3
4	Lab	0	0	4	4	2

CREDITS SPLIT UP

SEMESTER	CREDITS
1	21
2	19
3	13
4	12
TOTAL	**65**

SEMESTER I

Sl. No	Course Code	Course	L	T	P	C	TCH
THEORY							
1	MEE3701	Sensors & Data Acquisition	2	0	2	3	4
2	MEE3702	Computer Programming for Microcontroller	2	0	2	3	4
3	MEE3703	Virtual Instrumentation	2	0	2	3	4
4	MEE37XX	Departmental Elective I	2	0	2	3	4
5	MEE37XX	Departmental Elective II	2	0	2	3	4
6	ZZZ3715	Research Methodology & IPR	2	0	0	2	2
PRACTICAL							
7	MEE3751	Mechatronics Lab	0	0	4	2	4
8	MEE3796	Seminar				2	
					TOTAL	**21**	**26**

- Research Methodology & IPR is a compulsory Course.

SEMESTER II

Sl. No	Course Code	Course	L	T	P	C	TCH
THEORY							
1	MEE3704	Industrial Robots	2	0	2	3	4
2	MEE3705	Artificial Intelligence	2	1	0	3	4
3	MEE3706	Kinematics & Dynamics of Robots	2	0	2	3	4
4	MEE37XX	Departmental Elective III	2	0	2	3	4
5		Open Elective	2	0	2	3	4
PRACTICAL							
6	MEE3752	Artificial Intelligence Lab	0	4	0	2	4
7	MEE3781	Mini-project				2	
					TOTAL	**19**	**24**

- One of the core course shall be a MOOC. (same course to all students)

SEMESTER III

Sl. No	Course Code	Course	L	T	P	C	TCH
THEORY							
1	MEE37XX	Departmental Elective IV	2	0	2	3	4
PRACTICAL							
2	MEE3897	Internship *				2	
3	MEE3898	Project Phase –I				8	
					TOTAL	**13**	**4**

*Internship to be undergone during vacation between 2nd and 3rd semesters

SEMESTER IV

Sl. No	Course Code	Course	L	T	P	C	TCH
PRACTICAL							
1	MEE3899	Project Phase –II				12	
					TOTAL	**12**	

LIST OF DEPARTMENTAL ELECTIVES

Sl. No	Course Code	Course	L	T	P	C	TCH
1	MEE3721	Concepts in Mechanisms and Machines	2	0	2	3	4
3	MEE3722	CNC Technology	2	0	2	3	4
4	MEE3723	Condition Monitoring	2	0	2	3	4
5	MEE3724	Building Automation	2	0	2	3	4
6	MEE3725	Machine Vision	2	0	2	3	4
8	MEE3726	Robotic Operating System	2	0	2	3	4
9	MEE3727	Field Robots	2	0	2	3	4
10	MEE3728	Industrial Automation	2	0	2	3	4
11	MEE3729	Actuators & Drives	2	0	2	3	4

LIST OF OPEN ELECTIVES

Sl. No	Course Code	Course	L	T	P	C	TCH
1	MEE3741	Product Development	2	0	2	3	4

Course Title	SENSORS AND DATA ACQUISITION				
Course Code	**MEE3701**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – CLASSIFICATION OF SENSORS

Classification of transducers, sensor characteristics, statistical approach to measurements.

Lab:

- Familiarization of various sensors

MODULE 2 – SENSORS FOR FORCE, PRESSURE & STRAIN APPLICATIONS

Types, characteristics and applications – Force, Pressure and Strain Sensors.

Lab:

- Measurement of force, pressure and strain

MODULE 3 – SENSORS FOR POSITION, VELOCITY & TEMPERATURE APPLICATIONS

Types, characteristics and applications – Position, Velocity & Temperature Sensors.

Lab:

- Measurement of position, velocity and temperature

MODULE 4 – DATAACQUISITION

Introduction to Data Acquisition Systems. Signal conditioning for real time applications.

Lab:

- Familiarization of virtual instrumentation for Data Acquisition

MODULE 5 – DATA ACQUISITION FOR MECHATRONIC APPLICATIONS

Case Study of real time mechatronic systems.

Lab:

- Measurement of position, velocity and temperature using virtual instrumentation
- Measurement of force, pressure and strain using virtual instrumentation
- Closed loop control system design for temperature control applications

REFERENCE

1.	H.K.P Neubert "Instrument Transducers Oxford Herman University Press Eighth Impression 2008.
2.	Ramon Pallas-Arenyand Johan G. Webster "Sensor And Signal Conditioning" John Wiley, New York 1991.
3.	Dan Sheingold-Editior "Transducer Interfacing Handbook", Analog Devices Inc 1980
4.	Harry L. Trietly , "Transducers In Mechanical And Electronic Design", Marcel Dekker Inc 1986.
5.	Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw-Hill, Edition, 1996
6.	Lisa.K.Wills, LabVIEW for Everyone Prentice Hall of India, 1996.
7.	Labview Basics I and II Manual, National Instruments, 2003
8.	Barry Paton, Sensor, Transducers and Lab VIEW, Prentice Hall, 2000

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Able to understand the specifications of sensors	1,2,7,12
Perform measurements of force, pressure and strain	1,2,3,7,8,9,10,11,12
Perform measurements of force, pressure and strain	1,2,3,7,8,9,10,11,12
Able to interface DAQ with sensors	1,2,3,7,8,9,10,11,12
Understand the programming of virtual instrumentation & to apply the skills for mechatronic systems	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	COMPUTER PROGRAMMING FOR MICROCONTROLLER				
Course Code	**MEE3702**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**	ESE		**50%**	

MODULE 1 –INTRODUCTION TO PROGRAMMING

Variables – Datatype – String handling – scope – Operators – Type manipulation – Conditions - Looping

Lab Exercises:

1. Variables and its scope
2. Type manipulation
3. Decision making
4. Iterative processing

MODULE 2 – ARRAYS & POINTERS

Arrays: Defining – Array handling – Multi-dimensional arrays – Introduction to Pointers – Using pointers effectively

Lab Exercises:

1. Single and multi-dimensional arrays
2. Pointers

MODULE 3 – MODULAR PROGRAMMING

Functions – Mathematical functions – Time measure – Storage class and scope

Lab Exercises:

1. Handling built-in functions
2. Writing functions
3. Storage class

MODULE 4 - STRUCTURES, UNIONS & DATA STORAGE

Declaring and Defining a Structure – Accessing structure members – Returning a structure from a functional call – Unions – Array of structures

Lab Exercises:

1. Structures
2. Unions

MODULE 5 - MICROCONTROLLER LIBRARIES

Using core libraries – Writing own library – library header file – library code file

Lab Exercises:

1. Accessing Core libraries
2. Creating library files

REFERENCE

1.	Julian Bayle, “C Programming for Arduino”, Packt Publishing, 2013
2.	Warwick A. Smith, “C Programming for Embedded Microcontrollers”, Elektor International Media, 2008
3.	Jack Purdum, “Beginning C for Arduino”, Second Edition, Apress, 2015
4.	Stephen G Kochan, “Programming in C”, Fourth Edition, Addison Wesley, 2014
5.	Day Kashi Nath, “C Programming Essentials”, Pearson, 2010

COURSE OUTCOMES	PO MAPPING
Ability to perform decision making and iterative programming	1,2,7,12
Understand and handle array data structure	1,2,3,7,8,9,10,11,12
Ability to create and access functions	1,2,3,7,8,9,10,11,12
Understand structure and union data structures	1,2,3,7,8,9,10,11,12
Ability to create and access libraries	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	VIRTUAL INSTRUMENTATION				
Course Code	**MEE3703**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – INTRODUCTION

History of instrumentation, Comparison of traditional instrumentation with virtual instrumentation, Architecture of virtual instrumentation, Hardware and software in virtual instrumentation.

Lab:

- Virtual instrumentation demonstration.

MODULE 2 – BASIC FUNCTIONS

LabVIEW – Controls and Indicators, 'G' programming, Data types, Graphical programming palettes and tools, Function and Libraries, FOR Loops, WHILE loops, Shift Registers, CASE structure, Formula nodes, Arrays and Clusters, Graphs and charts, File I/O.

Lab:

- Graphical programming using LabVIEW/MATLAB.

MODULE 3 – DATA ACQUISITION SYSTEMS

Basics of DAQ Hardware and Software, Concepts of Data Acquisition, Installing Hardware, Installing drivers, Hardware - Configuring & addressing, Digital and Analog I/O function, Buffered I/O, Real time Data Acquisition.

Lab:

- Data Acquisition demonstration.

MODULE 4 – SIGNAL PROCESSING

Signal generation – Normalised frequency, Wave & pattern VI's.
Signal Processing – DFT, FFT, Frequency Spacing, Power Spectrum.
Measurement - The Measurement VI's, Calculating the frequency spectrum of the signal.

Lab:

- Signal analysis of an analog sensor input using DAQ.

MODULE 5 – ADVANCED CONCEPTS & APPLICATIONS

LabVIEW communication terminologies, Automotive applications, Industrial applications.

Lab:

- Case studies using real time implementation in industries.

REFERENCE

1.	Jovitha Jerome, Virtual Instruments using LabVIEW, PHI Learning Private Ltd, 2010.
2.	Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw-Hill, Edition, 1996.
3.	Lisa.K.Wills, LabVIEW for Everyone Prentice Hall of India, 1996.
4.	Barry Paton, Sensor, Transducers and Lab VIEW, Prentice Hall, 2000.
5.	LabVIEW Basics I and II Manual, National Instruments, 2003.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Appreciate Virtual Instrumentation Concepts	1,2,7,12
Build graphical programming for measurements	1,2,3,7,8,9,10,11,12
Able to select data acquisition systems and parameters	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	-	
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	2	20%
6.	Tutorials	4	40%
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	1	10%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	RESEARCH METHODOLOGY AND IPR				
Course Code	ZZZ3715	Credits	2	L-T-P-S	2-0-0-0
CIE	50%			ESE	50%

MODULE 1

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

MODULE 2

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

MODULE 3 – DATA ANALYSIS AND INTERPRETATION

Classification of Data, Methods of Data Collection, Sampling, Sampling techniques procedure and methods, Ethical considerations in research Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS etc.), statistical inference, Interpretation of results

MODULE 4

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

MODULE 5 – PATENT RIGHTS

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications..

MODULE 6 - NEW DEVELOPMENTS IN IPR

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

REFERENCE

1.	Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’
2.	Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3.	Ranjit Kumar, 2 nd Edition, “Research Methodology: A Step by Step Guide for beginners”
4.	Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
5.	Mayall , “Industrial Design”, McGraw Hill, 1992.
6.	Niebel , “Product Design”, McGraw Hill, 1974.
7.	Asimov, “Introduction to Design”, Prentice Hall, 1962.
8.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
9.	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
10.	C. R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques , New Age

11.	International publishers, Third Edition. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition, SAGE, 2005
12.	Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition Creswell, John W. Research design: Qualitative, quantitative, and mixed methods, approaches. Sage publications, 2013

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
• Understand research problem formulation. • Analyze research related information • Follow research ethics • Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. • Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. • Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.	

Course Title	MECHATRONICS LAB				
Course Code	**MEE3791**	Credits	**2**	L-T-P-S	**0-0-4-0**
CIE	**50%**			ESE	**50%**

MODULE 1 – SENSORS

- Sensors characteristics, signal processing
- Virtual instrumentation.

MODULE 2 –ACTUATORS

- Various types of actuators – Electrical, Mechanical – Stepper, Servo actuators
- Characteristics and Selection

MODULE 3 – DATA ACQUISITION SYSTEMS

- Measurement of Temperature, Force, Vibration, Strain etc
- Data Acquisition

MODULE 4 – SIGNAL PROCESSING

Signal generation – Signal Processing – DFT, FFT, Frequency Spacing, Power Spectrum. Measurement - The Measurement VI's, Calculating the frequency spectrum of the signal. Signal analysis of an analog sensor input using DAQ.

MODULE 5 – ADVANCED CONCEPTS & APPLICATIONS

- Case studies using real time implementation in industrial applications.

REFERENCE

1.	Jovitha Jerome, Virtual Instruments using LabVIEW, PHI Learning Private Ltd, 2010.
2.	Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw-Hill, Edition, 1996.
3.	Lisa.K.Wills, LabVIEW for Everyone Prentice Hall of India, 1996.
4.	Barry Paton, Sensor, Transducers and Lab VIEW, Prentice Hall, 2000.
5.	LabVIEW Basics I and II Manual, National Instruments, 2003.
6.	LabVIEW Signal Processing Manual, National Instruments, 1997.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Appreciate Virtual Instrumentation Concepts	1,2,7,12
Build graphical programming for measurements	1,2,3,7,8,9,10,11,12
Able to select data acquisition systems and parameters	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	-	
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	2	20%
6.	Tutorials	4	10%
7.	Mini project	-	30%
8.	Field work	1	20%
9.	Seminar	1	
10.	Case study	1	10%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	INDUSTRIAL ROBOTS				
Course Code	**MEE3704**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – ROBOT ANATOMY

Classification and parts of robots, configuration, work volume.

Lab:

- Familiarization of industrial robot

MODULE 2 – ROBOT MANIPULATORS

Construction and classification of manipulators – gripper design.

Lab:

- Design of grippers for industrial robots

MODULE 3 – ROBOT SYSTEM PROGRAMMING

Types of robot programming and virtual robotics.

Lab:

- Familiarize virtual robotics and programming of industrial robots

MODULE 4 – ROBOT SAFETY

Robot safety, training, maintenance and quality improvement.

Lab:

- Industrial Visit

MODULE 5 – APPLICATIONS

Industrial applications – welding, deburring, assembling, palletizing.

Lab:

- Programming for various applications
- Industrial Visit

REFERENCE

1.	Mikell P. Groover, Roger N. Nagel, Industrial Robotics: Technology, Programming, and Applications" McGraw-Hill Companies, 2012.
2.	S.R. DEB, S. DEB, Robotics Technology and Flexible Automation, Mc-GrawHill, 2nd Edition, 2011.
3.	Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand robot anatomy	1,2,7,12
Develop kinematic models of robot configurations	1,2,3,7,8,9,10,11,12
Program industrial robot for handling and processing applications	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on robot virtual platform, safety and training	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on robot applications	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	-	
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	20%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	ARTIFICIAL INTELLIGENCE				
Course Code	MEE3705	CREDITS	3	L-T-P-S	2-1-0-1
CIE	50%	ESE	50%		

MODULE 1 – INTRODUCTION
Introduction to AI: Intelligent agents - Informed & Uninformed search strategies.

MODULE 2 - KNOWLEDGE AND REASONING
Heuristic search - A* algorithm - Adversarial search Constraint satisfaction problems.

MODULE 3 - MACHINE LEARNING
Basic concepts - Linear models - Perceptron - K nearest neighbors

MODULE 4 - SUPERVISED LEARNING
Advanced models of Machine learning - Neural networks - Support Vector Machines

MODULE 5 - AI IN ROBOTICS
Applications of Artificial intelligence in Robotics

REFERENCE	
1.	Stuart Russel, Peter Norvig, “Artificial Intelligence: A Modern Approach”, Global Edition, 2016
2.	PrateekJoshi,”Artificial Intelligence with Python”, Packt Publishing, 2017
3.	David L. Poole, Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2010
4.	Sebastian Raschka, “Python Machine Learning”, Packt Publishing, 2015
5.	Jerry Kaplan, “Artificial Intelligence”, Oxford University Press, 2016

COURSE OUTCOMES	PO MAPPING
Understand the concepts in AI and search techniques	1,2,7,12
Understand the different reasoning concepts	1,2,3,7,8,9,10,11,12
Design planning and learning environment for AI	1,2,3,7,8,9,10,11,12
Understand Supervised learning techniques	1,2,3,7,8,9,10,11,12
Apply AI techniques for real-world problems	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	KINEMATICS AND DYNAMICS OF ROBOTS				
Course Code	**MEE3706**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – ROBOT TRANSFORMATIONS

Robot transformations, position and orientation, combined transformations, Euler and RPY angles.

Lab:

- Perform basic transformations of robot

MODULE 2 – FORWARD KINEMATICS

Direct kinematics for various robots, DH representation, arm equation.

Lab:

- Forward kinematics for various robot configurations

MODULE 3 – INVERSE KINEMATICS

Inverse kinematics for various robots, general properties of solution.

Lab:

- Inverse kinematics programming

MODULE 4 – WORKSPACE ANLYSIS AND TRAJECTORY PLANNING

Workspace analysis, joint space and cartesian space techniques.

Lab:

- Motion analysis and path planning

MODULE 5 – MANIPULATOR DYNAMICS

Kinetic and potential energy – inertia, dynamic models of robot.

Lab:

- Dynamic analysis of robot manipulator

REFERENCE

1.	Mikell P. Groover, Roger N. Nagel, Industrial Robotics: Technology, Programming, and Applications" McGraw-Hill Companies, 2012.
2.	Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987
3.	Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.
4.	S.R. DEB, S. DEB, Robotics Technology and Flexible Automation, Mc-GrawHill, 2nd Edition, 2011.
5.	John J. Craig, Introduction to Robotics Mechanics and Control, Third Edition, Pearson, 2008.
6.	Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, MIT Press., 2003.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Perform robot transformations	1,2,7,12
Apply forward & inverse kinematics	1,2,3,7,8,9,10,11,12
Calculate work volume	1,2,3,7,8,9,10,11,12
Perform trajectory planning	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on robot dynamics	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title		ARTIFICIAL INTELLIGENCE LAB				
Course Code		MEE3752	CREDITS	2	L-T-P-S	0-0-4-0
CIE		50%	ESE	50%		

EXPERIMENTS

Search Strategies:

1. Depth/ Breadth first search
2. A* algorithm
3. Heuristic search
4. Adversarial search
5. CSP

Classification:

1. Linear classification
2. Perceptron learning
3. Clustering

Machine Learning:

1. Artifical Neural Network
2. Support Vector Machine

Case Studies

REFERENCE

1.	Stuart Russel, Peter Norvig, "Artificial Intelligence: A Modern Approach", Global Edition, 2016
2.	PrateekJoshi,"Artificial Intelligence with Python", Packt Publishing, 2017
3.	David L. Poole, Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010
4.	Sebastian Raschka, "Python Machine Learning", Packt Publishing, 2015
5.	Jerry Kaplan, "Artificial Intelligence", Oxford University Press, 2016

COURSE OUTCOMES	PO MAPPING
Understand the concepts in AI and search techniques	1,2,7,12
Understand the different reasoning concepts	1,2,3,7,8,9,10,11,12
Design planning and learning environment for AI	1,2,3,7,8,9,10,11,12
Understand Supervised learning techniques	1,2,3,7,8,9,10,11,12
Apply AI techniques for real-world problems	1,2,3,7,8,9,10,11,12

Course Title	CONCEPTS IN MECHANISMS AND MACHINES				
Course Code	**MEE3721**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – MECHANISMS

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinametic pairs – Constraint& motion - Degrees of freedom – Slider crank – Single and double – Crank rocker mechanisms – Inversions – applications. Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.

Lab:

- Familiarization of mechanisms
- Simple simulation exercises

MODULE 2 – FRICTION

Types of friction – friction in screw and nuts – pivot and collar – thrust bearings – collar bearing – plate and disc clutches – belt (flat &vee) and rope drives – creep in belts – Jockey pulley – open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tension – condition for maximum power transmission – basics of brakes, journal and rolling element bearings hydrostatic and aerostatic bearings – recirculating ball screw and nut assembly.

Lab:

- Determination of co-efficient of friction.

MODULE 3 – GEARING AND CAMS

Gear profile and geometry-nomenclature of spur and helical gears – law of gearing – interference requirement of minimum number of teeth in gears-gear trains-simple and compound gear trains determination of speed and torque in Epicyclic gear trains-Cam profile-different types of followers.

Lab:

- Measurement of gear profile

MODULE 4 – VIBRATION

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – torsional vibration of shafts – single and multirotor systems – geared shafts – critical speed of shafts.

Lab:

- Vibration measurement

MODULE 5 – MACHINE TOOLS

Machine tool construction-features – operations of lathe, milling machine, drilling machine – Drive system for machine tools – mechanical, hydraulic and electric stepped and variable speeds – spindle speeds and feed drives-linear and reciprocation motion generation.

Lab:

- Machining exercises.

REFERENCE	
1.	Bansal.R.K."Theory of Machines" Laxmi Publications (P) ltd., New Delhi. 2011.
2.	G.C.Sen . and A. Bhattacharya, "Principles of machine tools" , New Central book Agency, 1999
3.	Joseph Edward Shigley, Charles R.Mischke, "Mechanical Engineering Design" Mcgraw Hill International Edition, 2008
4.	R.S.Khurmi and Gupta . " Theory of Machines" Eurasia Publishing House Pvt Ltd. 2012

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand the mechanisms	1,2,7,12
Understand the concept of friction	1,2,3,7,8,9,10,11,12
Understand the design aspects of gears and cams	1,2,3,7,8,9,10,11,12
Understand the basics of vibration	1,2,3,7,8,9,10,11,12
Know about the manufacturing processes	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	CNC TECHNOLOGY				
Course Code	MEE3722	Credits	3	L-T-P-S	2-0-2-1
CIE	50%			ESE	50%

MODULE 1 – INTRODUCTON

CNC – types and applications.

MODULE 2 – CNC HARDWARE

CNC machines – mechanical structure, mechanisms, electrical motors.

MODULE 3 – CNC CONTROL

Control systems, feedback devices, drives, tooling.

Lab:

- Familiarization of CNC machines
- Assembly and disassembly

MODULE 4 – PROGRAMMING

CNC part programming and computer assisted part programming.

Lab:

- Exercises on CNC machining

MODULE 5 – ECONOMICS AND MAINTANANCE

Selection, operating cost, maintenance, troubleshooting.

Lab:

- Exercises on preventive maintenance

REFERENCE

1.	YoreurKoren, Computer Control of Manufacturing Systems, Pitman, London, 1987.
2.	Radhakrishnan P., Computer Numerical Control Machines, New Central Book Agency, 1992.
3.	Berry Leatham – Jones, Computer Numerical Control, Pitman, London, 1987.
4.	SteaveKrar and Arthur Gill, CNC Technology and Programming, McGraw–Hill Publishing Company, 1990.
5.	Hans B.Kief And T.Frederick Waters, Computer Numerical Control Macmillan/McGraw-Hill, 1992.
6.	G.E.Thyer, Computer Numerical Control of Machine Tools. Second Edition, B/H Newnes, 1993.
7.	Groover, M.P., Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall, 1998.
8.	Mike Mattson, CNC Programming Thomson Learning, 2003.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand product development	1,2,7,12
Understand and apply knowledge on basics of product development	1,2,3,7,8,9,10,11,12

Understand and apply knowledge on product designing	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on prototyping	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on testing and financial modelling	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	-	
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	2	20%
6.	Tutorials	-	
7.	Mini project	1	30%
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	2	20%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	CONDITION MONITORING				
Course Code	MEE3723	Credits	3	L-T-P-S	2-0-2-1
CIE	50%			ESE	50%

MODULE 1 – INTRODUCTON

Maintenance and condition monitoring.

MODULE 2 – CONDITION MONITORING OF ROTATIING ELEMENTS

Need for monitoring, failure modes of electrical machines, effects of monitoring, cause for failure.

MODULE 3 – TEMPERATURE MONITORING

Instrumentation for monitoring temperature, Local temperature measurement, Bulk measurement.

MODULE 4 – VIBRATION MONITORING

Instrumentation for vibration monitoring, level monitoring, frequency spectrum monitoring.

MODULE 5 – CASE STUDIES

Case studies – vibration, temperature monitoring.

Lab:

- Exercises on condition monitoring of rotary elements

REFERENCE

1.	Kulkarni S. V. and Khaparde S. A., " Transformer Engineering – Design, Technology and Diagnostics" Second Edition, CRC Press, New York
2.	T. S. Ramu and H N Nagamani, "Partial Discharge Based Condition Monitoring of High Voltage Equipment" New Age International, New Delhi
3.	W. H. Tang and Q. H. Wu, "Condition Monitoring and Assessment of Power Transformers Using computation Intelligence", Springer, London 2010
4.	Peter Tavner, Li Ran, Jim Penmanand Howard Sedding, "Condition Monitoring of Rotating Electrical Machines", Published by The Institution of Engineering and Technology, London, United Kingdom, 2008
5.	Hamid A Toliyat, Subhasis Nandi, Seungdeog Choi, HomayounMeshgin-Kelk, " Electric Machines: Modeling, Condition Monitoring and Fault Diagnostics, CRC Press
6.	Chakravorti Sivaji, DeyDebangshu, Chatterjee Biswendu, "Recent Trends in the Condition Monitoring of Transformers- Theory, Implementation and Analysis" Springer, 2013
7.	Greg C. Stone, Edward A. Boulter, Ian Culbert, Hussein Dhirani, "Electrical Insulation for Rotating Machines: Design, Evaluation, Aging,Testing, and Repair", IEEE Press Series on Power Engineering, A John Wiley & Sons, Inc., Publication, 2004
8.	R.E. James and Q. Su, "Condition Assessment of High Voltage Insulation in Power System Equipment", Published by The Institution of Engineering and Technology, London, United Kingdom, 2008

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand product development	1,2,7,12
Understand and apply knowledge on basics of product development	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on product designing	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on prototyping	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on testing and financial modelling	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	-	
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	2	20%
6.	Tutorials	-	
7.	Mini project	1	30%
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	2	20%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	BUILDING AUTOMATION				
Course Code	**MEE**3724	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – INTRODUCTON

Building Automation System-Features, characteristics, Systems in Building Automation.

MODULE 2 – BUILDING MANAGEMENT SYSTEM

Qualitative study, sensors and actuators, controllers.

MODULE 3 – ENERGY MANAGEMENT SYSTEM

Concept, Energy meters-types, analysis of power quality, energy consumption, energy saving.

MODULE 4 – SAFETY SYSTEMS

Introduction, fire safety, fire alarm systems-components, controllers, features.

Lab:
Industrial Visit

MODULE 5 – INTEGRATED SYSTEMS

Integration-Energy management system, building management system, challenges, future aspects.

Lab:

- Industrial Visit

REFERENCE

1.	Reinhold A. Carlson Robert A. Di Giandomenico, Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security Access Control, Lighting, Building, 1 st edition, R.S. Means Company Ltd), 1991.
2.	Geoff Levermore, Building Energy Management Systems: An Application to Heating, Natural Ventilation, Lighting and Occupant Satisfaction, Routledge,2nd Edition, 2000.
3.	Nancy G. Leveson, Engineering a Safer World: Systems Thinking Applied to Safety (Engineering Systems)1st Edition, The MIT Press, 2011.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand building automation	1,2,7,12
Understand and apply knowledge on building management system	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on energy management system	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on safety system	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on integrated systems	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	-	
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	2	20%
6.	Tutorials	-	
7.	Mini project	1	30%
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	2	20%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	MACHINE VISION				
Course Code	MEE3725	CREDITS	3	L-T-P-S	2-0-2-1
CIE	50%			ESE	50%

MODULE 1 – Introduction to Machine Vision

Introduction – Fundamentals of digital image processing – Image formation – Image physics – Binary image analysis – Thresholding

Lab Exercises:

1. Image Handling
2. Thresholding
3. Binary image analysis

MODULE 2 – Image Enhancement

Histogram processing – 2D Convolution – Filtering – Enhancing images – Illumination correction – Denoising

Lab Exercises:

1. Histogram based enhancement
2. Image filtering
3. Illumination Correction

MODULE 3 – Feature Extraction

Color – Edge - Texture descriptor – Shape detection – Morphological image processing – Content based image retrieval – Pattern recognition – Matching in 2D

Lab Exercises:

1. Connected component analysis
2. Morphology based detection
3. Texture based pattern recognition

MODULE 4 – Segmentation & Classification

Motion in 2D sequence – Image segmentation: Region based – Mean shift – Clustering – Supervised Classification - Unsupervised classification

Lab Exercises:

1. Image segmentation
2. Object classification

MODULE 5 – Depth Estimation and Multi-Camera views

Perceiving 3D from 2D images – Image geometry – Triangularization - 3D sensing and Object pose computation – Models in 3D – Integration of machine vision system

Lab Exercises:

1. Background subtraction
2. Object Tracking
3. Depth estimation from 2D images

REFERENCE

1.	Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer-Verlag London Limited 2011.
2.	D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education, 2003.
3.	Richard Hartley and Andrew Zisserman, “Multiple View Geometry in Computer Vision”, Second Edition, Cambridge University Press, March 2004.
4.	R.C. Gonzalez and R.E. Woods, “Digital Image Processing”, Addison- Wesley, 1992.

5.	E. R. Davies, "Computer and Machine Vision: Theory, Algorithms, Practicalities", Fourth Edition, Elsevier, 2012

COURSE OUTCOMES	PO MAPPING
Possess knowledge on representation of digital images, light and color	1,2,7,12
Apply fundamental concepts of image processing for machine vision applications	1,2,3,7,8,9,10,11,12
Write programs for analyzing images for various machine vision tasks	1,2,3,7,8,9,10,11,12
Ability to perform object classification from digital images	1,2,3,7,8,9,10,11,12
Ability to perform depth calculation from multi-camera views	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	ROBOT OPERATING SYSTEM				
Course Code	MEE3726	CREDITS	3	L-T-P-S	2-0-2-1
CIE	50%			ESE	50%

MODULE 1 – INTRODUCTION

Introduction to ROS - ROS file system level - ROS computation graph level - ROS community level

Lab Exercises:

1. ROS packages
2. ROS nodes
3. ROS messages

MODULE 2 - 3D ROBOT MODELING IN ROS

ROS packages for robot modeling - Creating ROS package for robot description - Visualizing robot in 3D model

Lab Exercises:

1. Creating URDF model
2. Using Rviz for visualizing 3D model
3. Robot description

MODULE 3 - SIMULATING ROBOTS

Understanding Gazebo - Robotic arm simulation - Simulating joints - Interfacing with ROS controllers

Lab Exercises:

1. Simulating robotic arm
2. Moving joints using Gazebo
3. Moving mobile robot

MODULE 4 - MOTION PLANNING

Configuration Space - Collision matrix - Motion planning methods - Motion planning using ROS - ROS Controllers

Lab Exercises:

1. MoveIt configuration package setup & motion planning

MODULE 5 - INTERFACING I/O BOARDS, SENSORS & ACTUATORS

ROS Serial package – ROS and Microcontroller - Interfacing Sensors & Actuators

Lab Exercises:

1. Integrated system

REFERENCE

1.	Lentin Joseph, “Mastering ROS for Robotic Programming”, Packt Publishing, 2015
2.	Morgan Quigley, Brian Gerkey, William D. Smart, “Programming Robots with ROS: A Practical Introduction to the Robot”, O'Reilly, 2015
3.	Aaron Martinez, Enrique Fernández, “Learning ROS for Robotics Programming”, Packt Publishing, 2013
4.	AnisKoubaa, “Robot Operating System (ROS): The Complete Reference – Volume 1”, Springer, 2016
5.	R. Patrick Goebel, “ROS by Example: A Do-It-Yourself Guide to the Robot Operating System”, Lulu, 2012

COURSE OUTCOMES	PO MAPPING

Understand ROS architecture	1,2,7,12
Ability to model a robot in ROS	1,2,3,7,8,9,10,11,12
Ability to Simulate a mobile robot	1,2,3,7,8,9,10,11,12
Ability to plan movement of a robot by avoiding collisions	1,2,3,7,8,9,10,11,12
Ability to interface sensors and actuators with ROS	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	FIELD ROBOTS				
Course Code	**MEE**3727	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – INTRODUCTION

History, need and specification of service and field robots.

Lab:

- Familiarization of filed robots

MODULE 2 – AERIAL ROBOTS AND HUMANOIDS

Collision avoidance, wheeled and legged humanoids. Application and design aspects.

Lab:

- Design and simulation.

MODULE 3 – SPACE AND DEFENCE ROBOTS

Classification, Application and Design aspects – space and defence robots.

Lab:

- Design and simulation

MODULE 4 – SYSTEM INTEGRATION

Programming and system interfacing for robot applications.

Lab:

- Sensors and actuators integration

MODULE 5 – DESIGN AND FABRICATION OF FIELD ROBOTS

Design, simulation and fabrication of field robots.

Lab:

- Design, simulation and fabrication

REFERENCE

1.	Ulrich Nehmzow,Mobile Robots - A practical introduction, Springer, 2003
2.	Mikell P. Groover, Roger N. Nagel, Industrial Robotics: Technology, Programming, and Applications" McGraw-Hill Companies, 2012.
3.	Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987
4.	Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.
5.	S.R. DEB, S. DEB, Robotics Technology and Flexible Automation, Mc-GrawHill, 2nd Edition, 2011.
6.	Edquist, Flexible Automation: The Global Diffusion of New Technology, Wiley-Blackwell,1988.

7.	John J. Craig, Introduction to Robotics Mechanics and Control, Third Edition, Pearson, 2008.
8.	Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, MIT Press., 2003.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand history of field robots	1,2,7,12
Understand and apply knowledge on aerial robot and humanoids	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on space and defence robots	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on system integration	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on fabrication of robots	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE :

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz		
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	1	50%
8.	Field work	1	10%
9.	Seminar		
10.	Case study	2	20%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	INDUSTRIAL AUTOMATION				
Course Code	**MEE3728**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – INTRODUCTION

Introduction to automation tools – PLC, SCADA, DCS, Hybrid DCS-PLC.

Lab:

- Familiarization of automation systems

MODULE 2 – PROGRAMMABLE LOGIC CONTROLLERS

Hardware, selection, I/O devices and programming

Lab:

- Programming of PLC

MODULE 3 – AUTOMATION SPECIFICATIONS)

Functional design specifications for automation tool, Development of user requirement specifications.

MODULE 4 – DISTRIBUTED CONTROL SYSTEM

Architecture, specifications, sensor interfacing.

Lab:

- DCS for automation applications

MODULE 5 – CASE STUDY

Case Study of automation systems.

Lab:

- Case study of industrial automation systems

REFERENCE

1.	Gary Dunning, Introduction to Programmable logic Controllers, Thomson / Delmar Learning, 2005
2.	Webb, Reis, Programmable logic Controllers: principles and applications, Prentice Hall of India, 2002
3.	Jose A. Romagnoli, Ahmet Palazoglu, Introduction to process Control, CRC Tylor and Francisgroup, 2005
4.	John. S. Oakland, Statistical Process Control, Butterworth – Heinemann, 2007
5.	B.G Liptak, Instrument Engineer's Handbook : Process Control and Optimization, Chilton Book Company, 2005
6.	Installation and user manuals of different DCS, PLC Vendors

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**

Understand the application of tools like PLC, DCS, and SCADA in automation.	1,2,7,12
Design the DCS for their application.	1,2,3,7,8,9,10,11,12
Configure of PLC and DCS.	1,2,3,7,8,9,10,11,12
Interface sensors, actuators and PLC systems.	1,2,3,7,8,9,10,11,12
Understand advanced design methodologies and design different controller for different types of processes.	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	ACTUATORS AND DRIVERS				
Course Code	**MEE**3729	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – CLASSIFICATION OF ACTUATORS

Classification of actuators – Hydraulic, Pneumatic & Electric.

Lab:

- Familiarization of various actuators

MODULE 2 – HYDRAULIC SYSTEMS

Types – Linear, Rotary, Flow control valve, Applications – Design aspects.

Lab:

- Design and simulation of hydraulic circuits

MODULE 3 – PNEUMATIC SYSTEMS

Types – Linear, Rotary, Flow control valve, Applications – Design aspects.

Lab:

- Design and simulation of pneumatic circuits

MODULE 4 – ELECTRIC SYSTEMS

Types – Linear, Rotary, Servo & Stepper motors, Applications – Design aspects.

Lab:

- Construct electric actuation for specific applications

MODULE 5 – DRIVES AND CONTROLS

Servos, Power transmission systems – Belt, chain and gear transmission systems.

Lab:

- Familiarization of power systems and its applications

REFERENCE

1.	Anthony Esposito, Fluid Power with Applications, Pearson Education 2000.
2.	MajumdarS.R., Oil Hydraulics,Tata McGraw-Hill, New Delhi 2009
3.	Majumdar S.R., Pneumatic systems – Principles and maintenance, Tata McGraw Hill, New Delhi 2005
4.	Anthony Lal, Oil hydraulics in the service of industry, Allied publishers, 1982
5.	M.P. Groover, Industrial Robotics – Technology, Programming and Applications, McGraw- Hill, USA, 1986

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand the classification and selection of actuators	1,2,7,12
Perform simulation of hydraulic circuits	1,2,3,7,8,9,10,11,12
Perform simulation of pneumatic circuits	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on electric systems	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on drives and controls	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	2	10%
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	1	10%
6.	Tutorials	-	
7.	Mini project	-	
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	5	50%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%

Course Title	PRODUCT DEVELOPMENT				
Course Code	**MEE3741**	Credits	**3**	L-T-P-S	**2-0-2-1**
CIE	**50%**			ESE	**50%**

MODULE 1 – INTRODUCTON

Product development – Characteristics, Duration, Cost, Challenges, IDEO Product development.

Lab:

- Industrial Case Studies, Organisational Realities, IDEO (Case Studies)

MODULE 2 – BASICS OF PRODUCT DEVELOPMENT

Development processes and organisation, Product planning, Identifying Customer needs, Product Specifications, Concept – Generation, selection & testing.

Lab:

- Proposal for a new product development (Based on field study).

MODULE 3 – PRODUCT DESIGN

Product architecture, Industrial design, Design for manufacturing, 3D CAD Modelling

Lab:

- 3D design of new product using design tools.
- Architecture layout of the new product.

MODULE 4 – PROTOTYPING

Understanding prototypes, Principles of prototyping, Planning of prototypes, Rapid prototyping technologies - SLA, SLS & FDM.

Lab:

- 3D Printing of the developed design.

MODULE 5 – BUSINESS ASPECTS OF PRODUCT DEVELOPMENT

Robust design, Product development economics, Patents and intellectual property.

Lab:

- Robust design analysis.
- Base-case financial model of the developed product.

REFERENCE

1.	Ulrich, Karl, and Steven Eppinger. Product Design and Development. 3rd Edition. McGraw-Hill, 2003.
2.	Thomke, Stefan H., and Ashok Nimgade. "IDEO Product Development." Harvard Business School Case 600-143, June 2000.
3.	Groover, CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education India, 1984.
4.	Chee Kai Chua, Kah Fai Leong, Chu Sing Lim. Rapid Prototyping: Principles and Applications, World Scientific 2003.

5.	A. K. Chitale, R. C. Gupta. Product Design And Manufacturing. PHI India Publications, 2013.

COURSE OUTCOMES (NEED NOT BE RESTRICTED TO 5 AND NEED NOT BE 1 CO FOR 1 UNIT.)	**PO**
Understand product development	1,2,7,12
Perform 3D modelling of engineering components	1,2,3,7,8,9,10,11,12
Perform 3D scanning of engineering components	1,2,3,7,8,9,10,11,12
Create 3D print of prototypes	1,2,3,7,8,9,10,11,12
Understand and apply knowledge on testing and business model	1,2,3,7,8,9,10,11,12

ASSESSMENT

CIE:

SL. NO.	METHODOLOGY	NO. OF ASSESSMENTS	WEIGHTAGE
1.	Written test	2	10%
2.	Quiz	-	
3.	Surprise test	-	
4.	Online test	-	
5.	Assignments	2	20%
6.	Tutorials	-	
7.	Mini project	2	30%
8.	Field work	1	10%
9.	Seminar	1	10%
10.	Case study	2	20%

Questions for CIE (50%) and ESE (50%) will be designed to evaluate the various educational components (Blooms taxonomy) such as:

BT LEVEL	WEIGHTAGE
Remembering and understanding the course contents	20%
Applying the knowledge acquired from the course	60%
Designing and analysing various engineering problems	10%
Understanding of various system models	10%