Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	: Diploma In Automation and Robotics
Programme Code	: AO
Duration Of Programme	: 6 Semester
Semester	: Fourth

With Effect From Academic Year : 2023-24

Duration : 16 WEEKS

NCrF Entry Level : 3.5   **Scheme** : K

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Actual Contact Hrs./Week CL	TL	LL	Self Learning (Activity/ Assignment / Micro Project)	Notional Learning Hrs /Week	Credits	Paper Duration (hrs.)	Theory FA-TH Max	SA-TH Max	Total Max	Min	Based on LL & TL Practical FA-PR Max	Min	SA-PR Max	Min	Based on Self Learning SLA Max	Min	Total Marks
(All Compulsory)																							
1	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	314301	2	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	MICROCONTROLLER & APPLICATIONS	MAA	DSE	314328	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
3	AI IN ROBOTICS	AIR	DSC	314333	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
4	PRINCIPLES OF ROBOTICS	POR	DSC	314334	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
5	AUTOMATION TOOLS & SYSTEMS	AAS	DSC	314335	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
6	BASICS OF ROBOTIC PROCESS AUTOMATION	RPA	DSC	314011	-	-	-	4	-	4	2	-	-	-	-	-	25	10	50@	20	-	-	75
	Total				2	17		16	7		20		150	350	500		125		150		125		900

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.

2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.

3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.

4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks

5. 1 credit is equivalent to 30 Notional hrs.

6. * Self learning hours shall not be reflected in the Time Table.

7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY — Course Code : 314301

Programme Name/s	: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures/
Programme Code	: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE/ TR/ TX
Semester	: Fourth
Course Title	: ENVIRONMENTAL EDUCATION AND SUSTAINABILITY
Course Code	: 314301

I. RATIONALE

The survival of human beings is solely depending upon the nature. Thus, threats to the environment directly impact on existence and health of humans as well as other species. Depletion of natural resources and degradation of ecosystems is accelerated due to the growth in industrial development, population growth, and overall growth in production demand. To address these environmental issues, awareness and participation of individuals as well as society is necessary. Environmental education and sustainability provide an integrated, and interdisciplinary approach to study the environmental systems and sustainability approach to the diploma engineers.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Resolve the relevant environmental issue through sustainable solutions

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the relevant Environmental issues in specified locality.
- CO2 - Provide the green solution to the relevant environmental problems.
- CO3 - Conduct SWOT analysis of biodiversity hotspot
- CO4 - Apply the relevant measures to mitigate the environmental pollution.
- CO5 - Implement the environmental policies under the relevant legal framework.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course	Course Title	Abbr	Course	Learning Scheme	Credits	Assessment Scheme

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY   Course Code : 314301

Code		Category/s	Actual Contact Hrs./Week			SLH	NLH	Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
													Practical						
			CL	TL	LL				FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
									Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314301	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES VEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 2 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the need of studying environment and its components. TLO 1.2 Investigate the impact of population growth and industrialization on the relevant environmental issues and suggest remedial solutions TLO 1.3 Explain the Concept of 5 R w.r.t. the given situation TLO 1.4 Elaborate the relevance of Sustainable Development Goals in managing the climate change TLO 1.5 Explain the concept of zero carbon-footprint with carbon credit	**Unit - I Environment and climate change** 1.1 Environment and its components, Types of Environments, Need of environmental studies 1.2 Environmental Issues- Climate change, Global warming, Acid rain, Ozone layer depletion, nuclear accidents. Effect of population growth and industrialization 1.3 Concept of 5R, Individuals' participation in i) 5R policy, ii) segregation of waste, and iii) creating manure from domestic waste 1.4 Impact of Climate change, Factors contributing to climate change, Concept of Sustainable development, Sustainable development Goals (SDGs), Action Plan on Climate Change in Indian perspectives 1.5 Zero Carbon footprint for sustainable development, (IKS-Enviornment conservation in vedic and pre-vedic India)	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Justify the importance of natural resources in sustainable development TLO 2.2 Explain the need of optimum use of natural resources to maintain the sustainability	**Unit - II Sustainability and Renewable Resources** 2.1 Natural Resources: Types, importance, Causes and effects of depletion. (Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources), (IKS-	Lecture Using Chalk-Board Presentations

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY **Course Code : 314301**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
	TLO 2.3 Differentiate between renewable and non-renewable sources of energy TLO 2.4 Suggest the relevant type of energy source as a green solution to environmental issues	Concepts of Panchmahabhuta) 2.2 Impact of overexploitation of natural resources on the environment, optimum use of natural resources 2.3 Energy forms (Renewable and non-renewable) such as Thermal energy, nuclear energy, Solar energy, Wind energy, Geothermal energy, Biomass energy, Hydropower energy, biofuel 2.4 Green Solutions in the form of New Energy Sources such as Hydrogen energy, Ocean energy & Tidal energy	
3	TLO 3.1 Explain the characteristics and functions of ecosystem TLO 3.2 Relate the importance of biodiversity and its loss in the environmental sustainability TLO 3.3 Describe biodiversity assessment initiatives in India TLO 3.4 Conduct the SWOT analysis of the biodiversity hot spot in India TLO 3.5 Explain the need of conservation of biodiversity in the given situation	**Unit - III Ecosystem and Biodiversity** 3.1 Ecosystem - Definition, Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem 3.2 Biodiversity - Definitions, Levels, Value, and loss of biodiversity 3.3 Biodiversity Assessment Initiatives in India 3.4 SWOT analysis of biodiversity hot spot in India 3.5 Conservations of biodiversity - objects, and laws for conservation of biodiversity	Lecture Using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Classify the pollution based on the given criteria TLO 4.2 Justify the need of preserving soil as a resource along with the preservation techniques TLO 4.3 Maintain the quality of water in the given location using relevant preventive measures TLO 4.4 State the significance of controlling the air pollution to maintain its ambient quality norms TLO 4.5 Compare the noise level from different zones of city with justification TLO 4.6 Describe the roles and responsibilities of central and state pollution control board	**Unit - IV Environmental Pollution** 4.1 Definition of pollution, types- Natural & Artificial (Man- made) 4.2 Soil / Land Pollution – Need of preservation of soil resource, Causes and effects on environment and lives, preventive measures, Soil conservation 4.3 Water Pollution - sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards for domestic potable water, water conservation 4.4 Air pollution - Causes, effects, prevention, CPCB norms of ambient air quality in residential area 4.5 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city 4.6 Pollution Control Boards at Central and State Government level: Norms, Roles and Responsibilities	Lecture Using Chalk-Board Presentations
5	TLO 5.1 Explain Constitutional provisions related to environmental protection TLO 5.2 Explain importance of public participation (PPP) in enacting the relevant laws TLO 5.3 Use the relevant green technologies to provide sustainable solutions of an environmental	**Unit - V Enviornmental legislation and sustainable practices** 5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts 5.2 Public awareness about environment. Need of public awareness and individuals' participation. Role of NGOs 5.3 Green technologies like solar desalination,	Lecture Using Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
	problem TLO 5.4 Explain the role of information technology in environment protection	green architecture, vertical farming and hydroponics, electric vehicles, plant-based packaging 5.4 Role of information technology in environment protection and human health	

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

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Suggest the steps to implement (or improve the implementation) of the 5R policy in your home/institute stating your contribution
Draft an article on India's Strategies to progress across the Sustainable Development Goals
Make a chart of Renewable and non-renewable energy sources mentioning the advantages and disadvantages of each source
Conduct the SWOT analysis of biodiversity hotspot in India
Prepare a mind-mapping for the zero carbon footprint process of your field
Prepare a chart showing sources of pollution (air/water/ soil), its effect on human beings, and remedial actions
Any other assignment on relevant topic related to the course suggested by the facilitator

UNICEF Certification(s)

• Students may complete the self-paced course launched by Youth Leadership for climate Exchange under UNICEF program on portal www.mahayouthnet.in . The course encompasses five Modules in the form of Units as given below: -
Unit 1: Living with climate change
Unit 2 : Water Management and Climate Action
Unit 3: Energy Management and Climate Action
Unit 4 : Waste Management and Climate Action
Unit 5 : Bio-cultural Diversity and Climate Action
If students complete all the five Units they are not required to undertake any other assignment /Microproject/activities specified in the course. These units will suffice to their evaluations under SLA component

Micro project

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Technical analysis of nearby commercial RO plant.
Comparative study of different filters used in Household water filtration unit
Evaluate any nearby biogas plant / vermicomposting plant or any such composting unit on the basis of sustainabilityand cost-benefit
IKS-Study and prepare a note on Vedic and Pre-Vedic techniques of environmental conversion
Visit a local polluted water source and make a report mentioning causes of pollution
Any other activity / relevant topic related to the course suggested by the facilitator

Activities

•

Prepare a report on the working and functions of the PUC Center machines and its relavance in pollution control.
Prepare and analyse a case study on any polluted city of India
Prepare a note based on the field visit to the solid waste management department of the municipal corporation / local

authority

Record the biodiversity of your institute/garden in your city mentioning types of vegetation and their numbers

Visit any functional hall/cultural hall /community hall to study the disposal techniques of kitchen waste and prepare a report suggesting sustainable waste management tool

Watch a video related to air pollution in India and present the summary

Any other assignment on relevant topic related to the course suggested by the facilitator

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Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Nil	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Environment and climate change	CO1	8	4	4	4	12
2	II	Sustainability and Renewable Resources	CO2	10	4	4	8	16
3	III	Ecosystem and Biodiversity	CO3	8	4	4	4	12
4	IV	Environmental Pollution	CO4	12	4	8	6	18
5	V	Enviornmental legislation and sustainable practices	CO5	7	4	4	4	12
		Grand Total		**45**	**20**	**24**	**26**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

• Two-unit tests (MCQs) of 30 marks will be conducted and average of two-unit tests considered. Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as UNICEF Certification(s)/Microproject/assignment/activities. (60 % weightage to process and 40 % to product)

Summative Assessment (Assessment of Learning)

• Online MCQ type Exam

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes	Programme Outcomes (POs)	Programme Specific

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY   **Course Code : 314301**

(COs)	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	-	1	-	-	3	2	3			
CO2	-	2	2	-	3	2	3			
CO3	-	-	-	-	3	1	2			
CO4	1	-	-	-	3	2	2			
CO5	1	-	2	-	3	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Y. K. Singh	Environmental Science	New Age International Publishers, 2006, ISBN: 81-224-2330-2
2	Erach Bharucha	Environmental Studies	University Grants Commission, New Delhi
3	Rajagopalan R.	Environmental Studies: From Crisis to Cure.	Oxford University Press, USA, ISBN: 9780199459759, 0199459754
4	Shashi Chawla	A text book of Environmental Science	Tata Mc Graw-Hill New Delhi
5	Arvind Kumar	A Text Book of Enviornmental science	APH Publishing New Delhi (ISBN 978-8176485906)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://sdgs.un.org/goals	United Nation's website mentioning Sustainability goals
2	http://www.greenbeltmovement.org/news-and-events/blog	Green Belt Movement Blogs on various climatic changes and other issues
3	http://www.greenbeltmovement.org/what-we-do/tree-planting-for-watersheds	Green Belt Movement's work on tree plantation, soil conservation and watershed management techniques
4	https://www.youtube.com/@ierekcompany/videos	International Experts For Research Enrichment and Knowledge Exchange –IEREK's platform to exchange the knowledge in fields such as architecture, urban planning, sustainability
5	www.mahayouthnet.in	UNICEF Intiative for youth leadership for climate action
6	https://eepmoefcc.nic.in/index1.aspx?lsid=297&lev=2&lid=1180&langid=1	GOI Website for public awareness on enviornmetal issues
7	https://egyankosh.ac.in/handle/123456789/61136	IGNOU's Intiative for online study material on Enviornmental studies
8	https://egyankosh.ac.in/handle/123456789/50898	IGNOU's Intiative for online study material on sustainability
9	https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf	Final list of proposed Sustainable Development Goal indicators

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Sr.No	Link / Portal	Description
10	https://sustainabledevelopment.un.org/ memberstates/india	India's Strategies to progress across the SDGs.
11	https://www.un.org/en/development/desa/ financial-crisis/sust ainable-development.html	Challenges to Sustainable Development
12	https://nptel.ac.in/courses/109105190	NPTEL course on sustainable development
13	https://onlinecourses.swayam2.ac.in/ cec19_bt03/preview	Swayam Course on Enviornmetal studies (Natural Resources, Biodiversity and other topics)
14	https://onlinecourses.nptel.ac.in/ noc23_hs155/preview	NPTEL course on enviornmental studies which encomopasses SDGs, Pollution, Cliamate issues, Energy, Policies and legal framework
15	https://www.cbd.int/development/ meetings/egmbped/SWOT-analys is-en.pdf	SWOT analysis of Biodiversity
16	https://www.sanskrit.nic.in/SVimarsha/ V2/c17.pdf	Central sanskrkit university publication on Vedic and pre vedic enviornmetal conservation

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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MSBTE Approval Dt. 21/11/2024   **Semester - 4, K Scheme**

MICROCONTROLLER & APPLICATIONS	Course Code : 314328

Programme Name/s	: **Automation and Robotics/ Digital Electronics/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/ Instrumentation & Control/ Industrial Electronics/ Instrumentation/ Electronics & Computer Engg.**
Programme Code	: **AO/ DE/ EJ/ EK/ ET/ EX/ IC/ IE/ IS/ TE**
Semester	: **Fourth**
Course Title	: **MICROCONTROLLER & APPLICATIONS**
Course Code	: **314328**

I. RATIONALE

Microcontrollers plays a very important role in the design, development of embedded systems. Automation is used in every field of engineering and microcontroller is inbuilt component of these systems. Diploma engineers have to deal with various microcontroller based systems and maintain them. This course will enable the students to develop the skills to use and maintain microcontroller based applications.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
• Maintain microcontroller based systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret architecture of 8-bit microcontrollers.
- CO2 - Develop program in 8051 in assembly language for the given operation.
- CO3 - Develop program using timers and interrupts.
- CO4 - Interface the memory and I/O peripherals to 8051 microcontroller.
- CO5 - Maintain microcontroller based applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./ Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314328	MICROCONTROLLER & APPLICATIONS	MAA	DSE	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.

MICROCONTROLLER & APPLICATIONS | **Course Code : 314328**

6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 List the features of 8051 Microcontroller. TLO 1.2 Explain the significance of selection factors while selecting Microcontroller for application. TLO 1.3 Describe the 8051 block diagram. TLO 1.4 Differentiate Microcontroller and Microprocessor for the given parameters. TLO 1.5 Compare Harvard architecture and Von-Neumann architecture. TLO 1.6 Explain functions of each block of 8051 Microcontroller. TLO 1.7 Compare the given derivatives of 8051 Microcontroller.	**Unit - I Microcontroller Overview and 8051 Architecture** 1.1 Features and selection factors for Microcontroller 1.2 Block diagram of 8051 Microcontroller: CPU, input device, output device, memory and buses 1.3 Comparison of Microcontroller and Microprocessor on basis of: Memory, Complexity, Type of Architecture, Cost, Applications, Typical examples of Microcontrollers and Microprocessors 1.4 Architectures of Microcontroller: Harvard , Von Neumann. Concept of pipelining 1.5 8051 Microcontroller: Architecture, Pin Configuration, Memory Organisation, Power saving options 1.6 Derivatives of 8051 (8951, 8031, 8751). Comparison between derivatives	Learning using Chalk-Board Blended Classroom Presentations
2	TLO 2.1 Explain the function of the given software development tools. TLO 2.2 Classify addressing modes of 8051 with examples. TLO 2.3 Describe the function of the given instruction with suitable example. TLO 2.4 Explain the use of the given assembler directives with examples. TLO 2.5 Develop simple programs to perform the following operations: Data manipulation, Masking, Stack operation, Branching execution.	**Unit - II 8051 Programming** 2.1 Software Development Cycle: Editor, Assembler, Compiler, Cross-Compiler, Linker, Locator 2.2 Addressing Modes : Immediate, Register, Direct, Indirect, Indexed 2.3 Instruction set :Data Transfer, Arithmetic, Logical, Branching, Machine control and Boolean 2.4 Assembler Directives: ORG, DB, EQU, END, CODE, DATA 2.5 Assembly Language Programming (ALP): Data manipulation, Masking , Stack operation, Branch related programming	Lecture using Chalk-Board Presentations Blended Learning
3	TLO 3.1 Describe the functions of Timer/ Counters, their applications, and modes of Timers. TLO 3.2 Generate the waveforms by using the given mode of Timer. TLO 3.3 Explain the interrupt mechanism with the help of suitable example. TLO 3.4 Explain the operation of given mode for Serial communication. TLO 3.5 Explain I/O Port Programming.	**Unit - III 8051 Timers, Interrupts, Serial and Parallel Communication** 3.1 Configuration and Programming of Timer/ Counter using Special Function Registers [SFRs]: TMOD, TCON, THx, TLx, Simple programs to generate the time delays 3.2 Configuration and Programming of interrupts using SFRs: IE, IP 3.3 Serial Communication SFRs: SCON, SBUF, PCON, Modes of serial communication, Simple Programs on serial communication. Serial Communication using MAX 232 3.4 Configuration and Programming of I/O Port : P0, P1, P2, P3	Lecture using Chalk-Board Hands-on Blended Learning
4	TLO 4.1 Interface Input/Output Devices with 8051 microcontroller. TLO 4.2 Interface ADC with 8051	**Unit - IV 8051 Interfacing** 4.1 I/O Interfacing: Keyboard, Relays, LED, LCD, Seven Segment display	Lecture using Chalk-Board Hands-on

MICROCONTROLLER & APPLICATIONS **Course Code : 314328**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
	microcontroller. TLO 4.3 Interface DAC with 8051 microcontroller. TLO 4.4 Describe with neat sketch the interfacing of the given external memory. TLO 4.5 Describe the procedure to troubleshoot the given I/O device.	4.2 Interfacing ADC 0808/09 with 8051. Simple programs for ADC interfacing 4.3 Interfacing DAC 0808/09 with 8051. Simple programs for DAC interfacing 4.4 Memory Interfacing: Program and Data Memory	Blended Learning Presentations
5	TLO 5.1 Generate the given waveform using 8051 and DAC. TLO 5.2 Interface Analog Input devices with 8051 microcontroller. TLO 5.3 Program 8051 for the given application. TLO 5.4 Interface Stepper motor to 8051. TLO 5.5 Describe the procedure to troubleshoot the given microcontroller based application.	**Unit - V 8051 Applications** 5.1 Square and Triangular waveform generation using DAC 5.2 Temperature sensor (LM35) interfacing using ADC to 8051 5.3 Water Level controller design using 8051 5.4 Stepper Motor Interfacing to 8051 to rotate in clockwise and anticlockwise direction	Lecture using Chalk-Board Hands-on Blended Learning Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the functions of various blocks of 8051 microcontroller development board.	1	* Identification of various blocks of 8051 microcontroller development board	2	CO1
LLO 2.1 Develop an Assembly Language Program (ALP) for addition of two numbers using various addressing modes and assembler directives.	2	Assembly Language Program using various addressing modes	2	CO2
LLO 3.1 Develop an ALP to perform arithmetic operations: addition, subtraction, multiplication and division on 8-bit data.	3	* ALP to perform arithmetic operations on 8-bit data	2	CO2
LLO 4.1 Develop an ALP to perform arithmetic operations: addition, subtraction on 16-bit data.	4	* ALP to perform arithmetic operations on 16- bit data	2	CO2
LLO 5.1 Develop an ALP to perform addition of BCD data stored at external memory and store result in internal memory.	5	* ALP to perform addition of BCD data	2	CO2
LLO 6.1 Develop an ALP for sum of series of numbers stored in RAM locations 40-49H. Find the sum of the values at the end of the program, store the lower byte in 30H and the higher byte in 31H.	6	* ALP for series addition	2	CO2
LLO 7.1 Develop an ALP to transfer data from source to destination locations of internal/ external data memory.	7	* Array data transfer from source locations to destination locations	2	CO2
LLO 8.1 Develop an ALP to exchange block of data from source to destination location of internal/ external data memory.	8	* Block exchange of data from source locations to destination location	2	CO2
LLO 9.1 Develop an ALP for identifying smallest number from the given data bytes stored in internal/ external data memory.	9	* Finding the smallest number from the given data bytes	2	CO2
LLO 10.1 Develop an ALP for identifying largest number from the given data bytes stored in internal/ external data memory.	10	Finding the largest number from the given data bytes	2	CO2

MICROCONTROLLER & APPLICATIONS   **Course Code : 314328**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Develop an ALP for arranging numbers in ascending order stored in internal/ external data memory.	11	* Arranging the numbers in ascending order	2	CO2
LLO 12.1 Develop an ALP for arranging numbers in descending order stored in internal/ external data memory.	12	Arranging numbers in descending order	2	CO2
LLO 13.1 Write an ALP to generate delay using timer register.	13	* Generate delay using timer register	2	CO3
LLO 14.1 Develop an ALP to transfer 8 bit data serially on serial port.	14	* Serial 8 bit data transfer on serial port	2	CO3
LLO 15.1 Interface LED with microcontroller and turn it 'ON' with microcontroller interrupt.	15	LED interfacing to 8051	2	CO4
LLO 16.1 Develop an ALP to generate pulse and square wave by using timer delay.	16	Generating Pulse and Square wave using timer delay	2	CO4
LLO 17.1 Interface 4 X 4 LED matrix with 8051 to display various pattern.	17	LED matrix Interfacing to 8051	2	CO4
LLO 18.1 Interface 7-segment display to display the decimal number from 0 to 9.	18	* Seven Segment Display interface for displaying decimal numbers	2	CO4
LLO 19.1 Interface relay with microcontroller and turn it 'ON' and 'OFF'.	19	* Relay interfacing to Microcontroller	2	CO4
LLO 20.1 Interface LCD with 8051 microcontroller to display the characters and decimal numbers.	20	* LCD interfacing to 8051 to display characters and decimal numbers	2	CO4
LLO 21.1 Interface the given keyboard with 8051 and display the key pressed.	21	Keyboard interfacing to 8051	2	CO4
LLO 22.1 Interface ADC with 8051 microcontroller and verify input/output.	22	* ADC interfacing to 8051	2	CO4
LLO 23.1 Interface DAC with 8051 microcontroller to generate square wave.	23	* DAC Interfacing to generate the square waveform	2	CO5
LLO 24.1 Interface DAC with 8051 microcontroller to generate triangular wave, saw-tooth wave.	24	DAC interfacing to generate the triangular waveforms	2	CO5
LLO 25.1 Interface stepper motor to microcontroller and rotate in clockwise direction at the given angles.	25	* Stepper Motor interfacing to 8051	2	CO5
LLO 26.1 Interface stepper motor to microcontroller and rotate in anti-clockwise direction at the given angles.	26	Stepper Motor interfacing to 8051 for rotating anti-clockwise	2	CO5
LLO 27.1 Design water level controller using any suitable open source simulation software to detect and control the water level in a tank.	27	Water Level Controller using 8051	4	CO5
LLO 28.1 Interface temperature sensor LM35 to 8051 to read temperature, convert it to decimal and send the value to Port 0 with some delay.	28	Temperature Sensor interfacing to detect and measure temperature	4	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Build a class period bell using microcontroller 8051.
- Build a circuit using 8051 microcontroller to blink LED.
- Build a circuit to display number 0 to 9 with a given delay.
- Build digital clock with 8051 microcontroller.
- Develop Fire Detection System using smoke and temperature sensor.

Student Activity

- Prepare power point presentation on applications of microcontroller.
- Undertake a market survey of different microcontrollers.

Assignment

- Prepare a chart of various features using data sheets of 8051 microcontroller and its derivatives.
- Prepare chart of stepper motor to display its features and steps for its operations using data sheets.
- Prepare a chart of various types of ADC and DAC to display its features and pin functions using data sheets.
- Prepare a chart of various types of LCDs to display its features , pin functions and steps of operations using data sheets.
- Prepare a power point presentation on 8051 interfacing/applications.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII.   LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	DSO with Bandwidth : 50-100 MHz TFT colour LCD Dual channel real time sampling1GSa/s equivalent sampling 25 GSa/s Memory 1Mbpts 10 waveforms and 10 Set up scan be stored.	13,16,23,24
2	4X4 LED matrix suitable to interface with 8051 trainer kit	17
3	7-segment LED Display	18
4	Relay trainer board suitable to interface with 8051 trainer kit	19
5	LCD trainer board	20
6	Keyboard: 4 x 4 trainer board	21
7	ADC(0808) trainer board	22
8	DAC (0808) trainer board	23,24
9	Stepper Motor: 50/100 rpm	25,26
10	Water level controller kit	27
11	Temperature Controller trainer board	28
12	Temperature Sensor LM35: 5V operating voltage, Operating temperature range (°C) -55 to 150, analog output	28
13	8051 Microcontroller kit: On-chip 64 KB ISP+IAP flash, 1KB SRAM, 5V operating voltage, 0 to 40 MHz 64 kB of on-chip Flash program memory	All
14	Desktop PC with microcontroller simulation software.	All

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IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Microcontroller Overview and 8051 Architecture	CO1	11	2	6	6	14
2	II	8051 Programming	CO2	8	4	4	4	12
3	III	8051 Timers, Interrupts, Serial and Parallel Communication	CO3	10	4	4	6	14
4	IV	8051 Interfacing	CO4	10	4	6	8	18
5	V	8051 Applications	CO5	6	2	4	6	12
		Grand Total		**45**	**16**	**24**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	1	1	-	1			
CO2	2	2	2	2	1	-	2			
CO3	2	2	2	1	1	1	2			
CO4	2	2	2	2	1	-	2			
CO5	2	3	2	2	1	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Mazidi Muhammad Ali, Mazidi Janice Gillispe, Mckinlay Rolin D	The 8051 Microcontroller and Embedded Systems: Using Assembly and C	Pearson Publication, 2017 ISBN: 9788131710265

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Sr.No	Author	Title	Publisher with ISBN Number
2	Ayala Kenneth J	The 8051 Microcontroller	Thomson Delmar Learning, 2004 ISBN: 9781401861582
3	Deshmukh Ajay V	Microcontroller: Theory and Application	McGraw Hill,2011 ISBN: 9780070585959
4	Pal Ajit	Microcontrollers: Principle and Application	PHI Learning, 2014 ISBN: 978812034394
5	Chattopadhyay Santanu	Microcontroller and Applications	All India Council for Technical Education, 2023 ISBN: 9788196057602

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://vlabs.iitkgp.ac.in/rtes/#	Keyboard-MCU interfacing take a input from keypad and display on LCD
2	https://studytronics.weebly.com/8051microcontroller.html	8051 Microcontroller Architecture, Internal Memory , Instruction Set, Timers and Counters, Interrupts
3	https://archive.nptel.ac.in/courses/108/105/108105102/	S. Chattopadhyay, SWAYAM/NPTEL course on "Microprocessors and Microcontrollers"
4	https://www.keil.com/download/product/	Introduction to KEIL tool for 8051 programming
5	https://www.dnatechindia.com/Interfacing-LCD-to-8051.html	Interfacing LCD to 8051
6	https://web.mit.edu/6.115/www/document/8051.pdf	MCS@51 Microcontroller family user's manual
7	https://econtent.msbte.edu.in/econtent/marathi_econtent.php	Microcontroller and Applications Learning Material In Marathi-English

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

AI IN ROBOTICS   **Course Code : 314333**

Programme Name/s	: **Automation and Robotics**
Programme Code	: **AO**
Semester	: **Fourth**
Course Title	: **AI IN ROBOTICS**
Course Code	: **314333**

I. RATIONALE
Artificial Intelligence (AI) gives robots a computer vision that enables them to navigate, detect and determine their reactions accordingly. The goals of human-robot interaction are to make daily lives easier, more efficient, and more enjoyable. This course enable students to comprehend principles of AI and apply them in the field of robotics.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME
The aim of this course is to help students to attain the following Industry/Employer expected outcome through various teaching learning experiences :
- Simulate automated robotic systems through artificial intelligence concepts.

III. COURSE LEVEL LEARNING OUTCOMES (COS)
Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Determine initial state and goal state for a given problem.
- CO2 - Use relevant AI search strategies for problem solving.
- CO3 - Interpret different types of knowledge and reasoning techniques used in AI.
- CO4 - Apply the learning methods adopted in AI.
- CO5 - Apply the principles of AI in robotics.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme													
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks		
															Practical								
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA				
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min			
314333	AI IN ROBOTICS	AIR	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175		

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

AI IN ROBOTICS   **Course Code : 314333**

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the different terminologies of Artificial Intelligence (AI). TLO 1.2 Describe different types of agents. TLO 1.3 Describe initial state and goal state for a given problem. TLO 1.4 Explain the ethics as applicable to AI.	**Unit - I Basics of Artificial Intelligence** 1.1 AI: Definition and characteristics, history, scope, need for AI in Robotics 1.2 Agent and environment: Definition, characteristics and classification of agents, rational agent and intelligent agent, environment and its properties 1.3 State space search: Goal directed agent, State space search notations-Initial state, action or an operator, plan, path cost 1.4 AI Ethics: Transparency, fairness, accountability, privacy, security	Lecture using chalk and board Presentation
2	TLO 2.1 State characteristics of given problem. TLO 2.2 Describe the properties of the search algorithm. TLO 2.3 Explain different uninformed search techniques. TLO 2.4 Explain different informed (heuristic) search techniques. TLO 2.5 Explain local search algorithm.	**Unit - II AI Search Algorithms** 2.1 Search problem: Representation of search problem, illustration of search process 2.2 Search algorithm: Definition, types, properties of search algorithm- completeness, optimality, time complexity and space complexity 2.3 Uninformed search strategies: breadth first search, uniform cost search, depth first search 2.4 Informed (heuristic) search strategies: Greedy best-first search, A* search 2.5 Local search: Local search algorithms and optimization problems; travelling salesman problem, hill climbing search	Lecture using chalk and board Presentation Demonstration
3	TLO 3.1 Describe different types of knowledge. TLO 3.2 Map between facts and knowledge representation. TLO 3.3 Explain the architecture of knowledge-based agent in Artificial Intelligence (AI). TLO 3.4 Describe forward and backward reasoning. TLO 3.5 Explain different approaches to planning.	**Unit - III Knowledge, Reasoning and Planning** 3.1 Knowledge: Definition and types of knowledge 3.2 Knowledge representation techniques, AI knowledge life cycle 3.3 Knowledge based agent in AI: Introduction, architecture, rules of inference, first order logic, forward chaining and backward chaining 3.4 Reasoning: Definition and its types, forward reasoning and backward reasoning, probabilistic reasoning: need, cause of uncertainty, bayesian reasoning 3.5 Planning: Definition, types of planning, planning graph	Lecture using chalk and board Presentation Demonstration
4	TLO 4.1 Describe different forms of learning. TLO 4.2 Explain the machine learning workflow. TLO 4.3 Predict the potential occurrence of future outcomes. TLO 4.4 Explain probabilistic language processing.	**Unit - IV Learning adopted in AI** 4.1 Forms of learning, knowledge in learning, statistical learning methods, Importance of AI in learning 4.2 Machine learning: Definition, techniques in machine learning – supervised learning, unsupervised learning, reinforcement learning, semi-supervised learning 4.3 Introduction to predictive modeling: definition, stages of predictive modeling – problem definition, hypothesis generation, data extraction/collection, data exploration and transformation, splitting dataset into training set and test set, types of predictive models, algorithms of predictive modelling 4.4 Communication, perceiving and acting, probabilistic	Lecture using chalk and board Presentation Demonstration Flipped Classroom

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
		language processing and perception	
5	TLO 5.1 Describe the concept of robotic perception. TLO 5.2 Illustrate the relationship between robotic perception, localization, and mapping. TLO 5.3 Explain the significance of planning uncertain movements in robotics. TLO 5.4 Explain the ethics and risks of artificial intelligence in robotics. TLO 5.5 State the applications of AI in robotics field.	**Unit - V Applications of AI in Robotics** 5.1 AI technology used in robotics, robotic perception, localization, mapping- configuring space 5.2 Planning uncertain movements, dynamics, and control of movement 5.3 Ethics and risks of artificial intelligence in robotics 5.4 Application of AI in automation and robotics-computer vision, AI enabled manipulation and grasping, AI enhanced navigation and motion control, real world perception and natural language processing, future of AI in robotics	Lecture using chalk and board Presentation Demonstration Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Idenitfy the initial state and goal state for 3-pegs problem. LLO 1.2 Write the steps to solve 3-pegs problem as a state space problem.	1	* Identification of initial state and goal state for a given 3-pegs problem	2	CO1
LLO 2.1 Identify the initial state and goal state for the state space problem: Problem is to place 8 queens on a chessboard so that no two queens are in the same row, column or diagonal. LLO 2.2 Develop the flowchart for finding initial state and goal state for the state space problem to place 8 queens on a chessboard so that no two queens are in the same row, column or diagonal.	2	Identification of initial state and goal state for a given problem on chessboard	2	CO1
LLO 3.1 Write a program to implement breadth first search algorithm (Uninformed) using python.	3	* Implementation of breadth first search algorithm	2	CO2
LLO 4.1 Write a program to implement depth first search algorithm (Uninformed) using python.	4	Implementation of depth first search algorithm	2	CO2
LLO 5.1 Write a program to implement A* search algorihm for solving the given problem using python.	5	* Implementation of forward chaining algorithm	2	CO2
LLO 6.1 Write a program to implement travelling salesman problem for solving the given problem using python.	6	Implementation of travelling salesman problem	2	CO2
LLO 7.1 Using first order logic write a program to implement forward chaining algorithm using python.	7	* Implementation of forward chaining algorithm	2	CO3
LLO 8.1 Using first order logic write a program to implement backward chaining algorithm using python.	8	Implementation of backward chaining algorithm	2	CO3
LLO 9.1 Write a program to implement forward reasoning using python.	9	Implementation of forward reasoning	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Write a program to implement backward reasoning using python.	10	* Implementation of backward reasoning	2	CO3
LLO 11.1 Write a program to implement Bayesian reasoning using python.	11	Implementation of Bayesian reasoning	2	CO3
LLO 12.1 Write a program to read the data from a given dataset into python.	12	Implementation of data extraction	2	CO4
LLO 13.1 Write a program to split available dataset into training and test set using python.	13	* Develop a program to split dataset	2	CO4
LLO 14.1 Simulate different types of motion commands for robot.	14	* Implementation of motion commands for robot using simulator	2	CO5
LLO 15.1 Simulate different end effector command for given Robot.	15	Implementation of end effector command for a given robot	2	CO5
LLO 16.1 Simulate robot operation using machine vision system.	16	Execution of robotic operations by bridging robot-vision systems	2	CO5
LLO 17.1 Write a program for specific path movement of robot.	17	* Implementation of specific path movement of robot	2	CO5
LLO 18.1 Write a program for painting operation with AI based Robot.	18	Implementation of painting operation with AI based robot	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Case study on various future applications of robotic systems.
- Case study on future AI based technology.
- Case study on robotics system used in the automobile / manufacturing industry.

Student Activity

- Prepare a power point presentation on the topic Future of AI in robotics.
- Prepare a chart on various types of search algorithms.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.

- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 7 or above)	All
2	Python Interpreter / IDE	All
3	Python 3.9 or latest version	All
4	Robotics simulation software : RT Toolbox3 / Roboanalyzer or any other simulation software	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Artificial Intelligence	CO1	12	2	4	4	10
2	II	AI Search Algorithms	CO2	16	6	8	8	22
3	III	Knowledge, Reasoning and Planning	CO3	12	2	6	6	14
4	IV	Learning adopted in AI	CO4	14	4	4	6	14
5	V	Applications of AI in Robotics	CO5	6	2	4	4	10
		Grand Total		**60**	**16**	**26**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3

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CO1	2	2	-	-	-	-	-		
CO2	3	3	2	2	1	1	1		
CO3	3	2	3	2	1	1	1		
CO4	2	-	3	2	-	-	1		
CO5	3	-	1	3	1	1	1		

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Russell, S.; Norvig, P.	Artificial Intelligence: A Modern Approach	Publicher: Pearson ISBN : 978-0134610993
2	Poole, David L.; Mackworth, Alan K.	Artificial Intelligence: Foundations of Computational Agents	Publisher: Cambridge University Press ISBN : 978-1107195394
3	Nilsson, Nils J.	The Quest for Artificial Intelligence	Publisher: Cambridge University Press ISBN : 978-0521116398
4	Knight, Kevin; Rich, Elaine; Nair, Shivashankar B.	Artificial Intelligence	Publisher: McGraw Hill Education ISBN : 978-0070087705
5	Jones, M. Tim	Artificial Intelligence: A Systems Approach	Publisher: Jones and Bartlett Learning ISBN : 978-0763773373
6	Govers, Francis X.	Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques	Publisher: Packt Publishing Limited ISBN : 978-1788835442
7	Deb, S. R.; Deb, Sankha	Robotics Technology and Flexible Automation	Publisher: McGraw Hill Education ISBN : 978-0070077911
8	Chowdhary, K.	Fundamentals of artificial Intelligence	Publisher: Springer India Private Ltd. ISBN : 978-8132239703
9	Murphy, Robin R.	Introduction to AI Robotics	Publisher: The MIT Press ISBN : 978-0262038485
10	Jefferis, David	Artificial Intelligence: Robotics and Machine Evolution	Publisher: Crabtree Publishing Company ISBN : 978-0778700463

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.javatpoint.com/artificial-intelligence-ai	Artificial Intelligence
2	https://www.simplilearn.com/tutorials/artificial-intelligenc e-tutorial	Artificial Intelligence
3	https://www.tutorialspoint.com/artificial_intelligence/index .htm	Artificial Intelligence
4	https://techvidvan.com/tutorials/robotics-and-artificial-int elligence/	Robotics and AI

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Sr.No	Link / Portal	Description
5	https://www.bertelkamp.com/media/documents/training/RT_Toolb ox3_Details.pdf? _cchid=39fca59addcd41d2401d433a3c68eaf8	Simulation S/W RT Toolbox3
6	https://www.allied-automation.com/rt-toolbox3-robot-simulati on/	Simulation S/W RT Toolbox3
7	https://nptel.ac.in/courses/106/105/106105078/	NPTEL Web Content- Artificial Intelligence, Prof. P. Mitra, Prof. S. Sarkar, IIT Kharagpur
8	https://onlinecourses.nptel.ac.in/noc23_ge40/preview	SWAYAM course- Fundamental of AI) By Prof. Shyamanta M. Hazarika , IIT Guwahati
9	https://www.javatpoint.com/search-algorithms-in-ai	Artificial Intelligence
10	http://www.roboanalyzer.com/uploads/2/5/8/8/2588919/roboanal yzerusermanual.pdf	Roboanalyzer user manual
11	https://cse22-iiith.vlabs.ac.in/exp/self-organizing-maps/	Virtual lab

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

PRINCIPLES OF ROBOTICS   **Course Code : 314334**

Programme Name/s	**: Automation and Robotics**
Programme Code	**: AO**
Semester	**: Fourth**
Course Title	**: PRINCIPLES OF ROBOTICS**
Course Code	**: 314334**

I.   RATIONALE

Robotics is the engineering discipline dealing with the design, construction, and operation of robots. The "Principles of Robotics" course will facilitate diploma students to acquire an understanding of the fundamental concepts, theories, and principles that govern the design, operation, and application of robotic systems. This course will also enable the students to get acquaints the basic concepts of engineering mechanics that is used in robotic system.

II.   INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain the following industry/ employer expected outcome through various teaching learning experiences:
Apply the principles of Robotics to automate various industries.

III.   COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the basic anatomy of a robotic system.
- CO2 - Apply the concepts of engineering mechanics in robotic system.
- CO3 - Interpret the transformations used in robotics.
- CO4 - Analyse the kinematics of the robotic arm.
- CO5 - Interpret the dynamics and motion planning of the robotic arm.

IV.   TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Assessment Scheme												Total Marks
				Actual Contact Hrs./Week			SLH	NLH	Credits	Paper Duration	Theory				Based on LL & TL				Based on SL			
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
314334	PRINCIPLES OF ROBOTICS	POR	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10		175

PRINCIPLES OF ROBOTICS | **Course Code : 314334**

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :
1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the robot anatomy by specifying the functions of various basic elements of robot systems. TLO 1.2 Classify the robot arm configurations. TLO 1.3 Describe the robot joints. TLO 1.4 Describe the specifications related to robotics. TLO 1.5 Select appropriate gripper for the given application. TLO 1.6 Identify the safety measures to be adopted for given robotic application.	**Unit - I Fundamentals of Robotics** 1.1 Definition, brief history, Asimov's laws of robot, robot anatomy: Base, manipulator arm, end effectors, sensors, control system, actuators 1.2 Robot arm configurations: Cartesian coordinate, polar, cylindrical, jointed arm, SCARA (Selective Compliance Assembly Robot Arm) 1.3 Types of mechanical joints in robotics system: Linear, orthogonal, rotational, twisting, revolving 1.4 Robot specification: Degree of freedom, work envelope, payload, resolution, accuracy, repeatability 1.5 End effectors of robot: Types of end effectors, mechanical grippers, pneumatic gripper, magnetic grippers, vacuum grippers, adhesive grippers 1.6 Bureau of Indian Standards (BIS) for safety in robotics: Design, safegaurds, awareness means, provisions for emergency movements of robot	Lecture using Chalk-Board Video Demonstrations Collaborative learning Flipped Classroom
2	TLO 2.1 Describe the characteristics of forces. TLO 2.2 Describe the moment of forces in the given force system. TLO 2.3 Determine the equilibrium of forces of the given system. TLO 2.4 Describe centroids and centre of gravity of the given system.	**Unit - II Basics of Engineering Mechanics for Robotics** 2.1 Introduction of mechanics: Engineering mechanics, statics, concept of rigid body, force: Definition, unit, Bow's notation, characteristics, types of force system 2.2 Moment of force: Definition, unit, sign conventions 2.3 Equilibrium of forces: Definition, conditions, simple numerical on equilibrium 2.4 Centroids and centre of gravity: Concept, definition	Lecture using Chalk-Board Video Demonstrations Collaborative learning
3	TLO 3.1 State the significance of kinematics. TLO 3.2 Calculate rotation matrices about various axes.	**Unit - III Transformations used in Robotics** 3.1 Kinematics: Definition and significance, coordinate system and frames in robotics, reference and body frames, pose of a rigid body	Lecture using Chalk-Board Video Demonstrations

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PRINCIPLES OF ROBOTICS   **Course Code : 314334**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
	TLO 3.3 Calculate the coordinate transformation matrix and HTM of a given frame of robot manipulator. TLO 3.4 Calculate the DH parameters of a given frame of robot manipulator. TLO 3.5 Calculate the transformation between the given DH frames of robot manipulator.	3.2 Rotation matrix: Representation of orientation, concept of roll, pitch, yaw motion, elementary rotation matrix about Z axis (derivation), elementary rotation matrix about X axis and Y axis (only formula) 3.3 Coordinate transformation matrix: Description, equation, homogeneous transformation matrix (HTM)-equation, description, numerical 3.4 DH (Denavit–Hartenberg) parameters, DH rules, DH table for the given manipulator such as 2R, 2P,3P, 3R, SCARA 3.5 Transformation between DH frames and the corresponding HTM	Collaborative learning
4	TLO 4.1 Differentiate between forward and inverse kinematics. TLO 4.2 Perform forward position analysis of the given manipulator. TLO 4.3 Describe Jacobian matrix. TLO 4.4 Perform Jacobian computations for a given manipulator.	**Unit - IV Kinematics of the Robotic Arm** 4.1 Position analysis: Concept of forward position analysis / kinematics and inverse position analysis / kinematics 4.2 Forward position analysis for 2P and 2R planar arm 4.3 Definition of linear and angular displacement, linear and angular velocity, linear and angular acceleration 4.4 Differential motion and velocities of robot: Jacobian equation in robotics, Jacobian matrix in robotics 4.5 Simple Numerical on Jacobian matrix based on the end-effector's coordinates and joint parameters	Lecture using Chalk-Board Video Demonstrations Collaborative learning
5	TLO 5.1 Differentiate between kinematics and dynamics. TLO 5.2 Describe dynamic equations of motion. TLO 5.3 Compare joint space planning and cartesian space planning. TLO 5.4 Describe point to point motion and continuous path motion.	**Unit - V Overview of Dynamics of the Robotic Arm and Motion Planning** 5.1 Dynamics: Definition, concept of forward and inverse dynamics 5.2 Dynamic equations of motion for joints of robot manipulators: Lagrange-Euler and Newton-Euler equations (no derivation, only simple numerical based on equations) 5.3 Motion planning: Concept, joint space planning, cartesian space planning 5.4 Cartesian trajectories: Concept, point to point and continuous path motion	Lecture using Chalk-Board Video Demonstrations Collaborative learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Install 3D model based open source software (Ex. RoboAnalyzer). LLO 1.2 Observe the movement of a robot manipulator using virtual robot module with the help of 3D model based open source software.	1	*Analysis of robot manipulator movement using 3D model based open source software (OSS)	2	CO1
LLO 2.1 Observe the movement of joints in robots using 3D model based open source software.	2	*Working of different type of joints used in robots using 3D model based OSS	2	CO1

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PRINCIPLES OF ROBOTICS — **Course Code : 314334**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Operate a 2-finger pneumatic parallel gripper of a robot. LLO 3.2 Operate a 2-finger vacuum parallel gripper of a robot.	3	Operatation of a 2-finger pneumatic and vacuum parallel gripper of a robot	2	CO1
LLO 4.1 Verify law of moment of forces using law of moment apparatus for given forces.	4	*Verification of law of moment of forces using law of moment apparatus	2	CO2
LLO 5.1 Verify centroid of given plane.	5	Verification of centroid of given plane	2	CO2
LLO 6.1 Determine rotation matrix along X axis using open source software for the given manipulator. LLO 6.2 Determine rotation matrix along Y axis using open source software for the given manipulator. LLO 6.3 Determine rotation matrix along Z axis using open source software for the given manipulator.	6	Determination of the rotation matrix of the given manipulator along any given axis using OSS	2	CO3
LLO 7.1 Determine Homogeneous Transformation Matrix (HTM) for pure translation using 3D model based open source software. LLO 7.2 Determine HTM for pure rotation using 3D model based open source software. LLO 7.3 Determine HTM for rotation and translation using 3D model based open source software.	7	* Determination of the HTM for rotation and translation for the given robot manipulator using 3D model based OSS	2	CO3
LLO 8.1 Verify DH table for different values of DH parameters of a given robot manipulator using 3D model based open source software.	8	Analysis of DH table for different values of DH parameters of a given robot manipulator using 3D model based OSS	2	CO3
LLO 9.1 Determine HTM for different values of DH parameters of a given robot manipulator for various links using 3D model based open source software.	9	*Determine the HTM for different values of DH parameters of a given robot manipulator for various links using 3D model based OSS	2	CO3
LLO 10.1 Analyse forward kinematics of PUMA 560 robot using virtual lab (http://vlabs.iitkgp.ac.in/mr/exp1/index.html#). LLO 10.2 Determine the position and orientation of end effector of a 4 axis/6 axis robot using forward kinematics.	10	*Determination of the position and orientation of end effector of a 4 axis/6 axis robot using forward kinematics	2	CO4
LLO 11.1 Analyse inverse dynamics of PUMA 560 robot for various inputs of the manipulator position using virtual labs (http://vlabs.iitkgp.ac.in/mr/exp3/index.html#). LLO 11.2 Determine the joint angle for the given position of the end effector of a 4 axis/6 axis robot using inverse kinematics.	11	*Determination of the joint angle for the given position of the end effector of a 4 axis/6 axis robot using inverse kinematics	2	CO4
LLO 12.1 Analyse Jacobian matrix using open source software for the given manipulator.	12	Derivation of Jacobian matrix using OSS for the given manipulator	2	CO4
LLO 13.1 Analyse forward dynamics of the given robot manipulator using 3D model based open source software.	13	*Determination of the position and orientation of the end effector for the given force at the joint of a 4 axis/6 axis	2	CO5

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.2 Determine the position and orientation of the end effector for the given force at the joint of a 4 axis/6 axis robot using forward dynamics.		robot using forward dynamics		
LLO 14.1 Analyse forward dynamics of the given robot manipulator using 3D model based open source software. LLO 14.2 Determine the forces required at the joint from the position and orientation of the end effector of a 4 axis/6 axis robot using inverse dynamics.	14	Determination of the forces required at the joint from the position and orientation of the end effector of a 4 axis/6 axis robot using inverse dynamics	2	CO5
LLO 15.1 Identify the workspace of the given robot manipulator. LLO 15.2 Interpolate the cartesian trajectories of the given robot manipulator.	15	Interpolation of Cartesian space trajectories of the given 4axis/6axis robot manipulator	2	CO5
LLO 16.1 Interpolate joint space trajectories of the given 4 axis/6 axis robot manipulator.	16	Interpolation of the joint space trajectories of the given 4 axis/6 axis robot manipulator	2	CO5
Note : Out of above suggestive LLOs - '*' Marked Practicals (LLOs) Are mandatory. - Minimum 80% of above list of lab experiment are to be performed. - Judicial mix of LLOs are to be performed to achieve desired outcomes.				

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Solve numerical on calculation of equilibrium of simple/composite solid bodies from given problem statement.
- Determine the homogeneous transformation matrix (HTM) of the given manipulator.
- Explain DH (Denavit–Hartenberg) parameters, DH rules, DH table for the given manipulator such as 2R, 2P, 3P, 3R, SCARA.
- Explain Cartesian trajectories concept, point to point and continuous path motion.
- Solve the examples on calculation of dynamic equations of motion for joints of robot manipulators.
- Determine Jacobian matrix of the given manipulator based on the end-effector's coordinates and joint parameters.

Micro project

- Build junkbots from recycled materials.
- Prepare a prototype of basic robots.
- Build jumping robot which will jump like a frog using materials such as motors, springs etc.
- Build a robotic arm with two degrees of freedom.
- Prepare a prototype of line follower robot.
- Prepare a prototype of robot manipulator with pneumatic actuator.
- Prepare a prototype of robot manipulator with hydraulic actuator.
- Build a dancing robot which can dance, flip, and tumble around the floor using motors and suitable material for balancing.

Activity

- Prepare charts of safety measures in robots.
- Perform a survey and write a report on robots used in the packaging industry.
- Prepare charts showing comparison of end effectors of robot.

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- Perform a survey and write a report on robots used in the automobile industry.
- Prepare charts or flex of Asimov's laws of robot.
- Prepare photographic charts showing real life applications robots in various sectors.
- Prepare charts showing various elements of robot, configurations, grippers etc.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Any open source software like Scilab to find out the rotation matrix and Jacobian matrix (https://www.scilab.org)	1,2,12
2	4 axis robotic arm manipulator and programming software Payload - Minimum 500g Maximum reach - 320mm	14,13,10,11,15,16
3	Silent pneumatic compressor Voltage 220 V, Frequency 50 Hz	14,13,10,11,15,16
4	Any 3D model based open source software like RoboAnalyzer to find out HTM, DH parameters, forward and inverse kinematics and dynamics etc. (http://www.roboanalyzer.com/virtual- experiments.html.)	14,13,7,8,9,6
5	Parallel link gripper kit containing pneumatic and vacuum gripper	3
6	Law of moment's apparatus consisting of a stainless steel graduated beam 12.5 mm square in section, 1m long, pivoted at centre.	4
7	Models of geometrical figures such as square, rectangle, triangle, circle, semicircle,quarter circle	5

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Robotics	CO1	10	4	4	4	12
2	II	Basics of Engineering Mechanics for Robotics	CO2	8	2	4	4	10
3	III	Transformations used in Robotics	CO3	16	4	6	8	18
4	IV	Kinematics of the Robotic Arm	CO4	16	4	6	8	18
5	V	Overview of Dynamics of the Robotic Arm and Motion Planning	CO5	10	4	4	4	12
		Grand Total		**60**	**18**	**24**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

PRINCIPLES OF ROBOTICS   **Course Code : 314334**

- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning End semester assessment is of 70 marks.

XI.   SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	2	2	1	1	3			
CO2	3	2	2	2	-	1	2			
CO3	3	3	3	3	-	1	2			
CO4	3	3	3	3	-	1	2			
CO5	3	3	3	2	-	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII.   SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Saha, S.K.	Introduction to Robotics	McGraw Hill Education Pvt. Ltd. 2008 978-0070140011
2	Craig, J.J.	Introduction to Robotics (Mechanics and Control)	Pearson Education Ltd. 2017 978-0133489798
3	Ghosal, A.	Robotics- Fundamental Concepts and Analysis	Oxford University Press 2009 978-0195673913
4	Khurmi, R.S.; Khurmi, N.	Engineering Mechanics	S.Chand & Co. New Delhi 2018 978-9352833962
5	Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M.	Robot Modeling and Control	Wiley 2020 978-1119523994

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.roboanalyzer.com/virtual-experiments.html	A 3D model based open source software to teach robotics subjects
2	http://vlabs.iitkgp.ac.in/mr/	Virtual lab for Robotics developed by IIT Kharagpur
3	https://archive.nptel.ac.in/ courses/112/104/112104298/	NPTEL study material for chapter 1,3,4,5
4	https://www.scilab.org/	Free ware open source software to find out Jacobian matrix

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Sr.No	Link / Portal	Description
5	https://www.coursera.org/specializations/ modernrobotics	Modern Robotics: Mechanics, Planning, and Control Specialization
6	https://archive.org/details/gov.in.is.14530.1998/page/ n3/mod e/2up	BIS for safety in robotics

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 21/11/2024   **Semester - 4, K Scheme**

AUTOMATION TOOLS & SYSTEMS   **Course Code : 314335**

Programme Name/s	**: Automation and Robotics**
Programme Code	**: AO**
Semester	**: Fourth**
Course Title	**: AUTOMATION TOOLS & SYSTEMS**
Course Code	**: 314335**

I. RATIONALE

In the present global manufacturing scenario, industries are moving more and more toward automated operations. Knowledge and skill related with Advanced Automation Systems like Programable Logic Controllers (PLCs), Supervisory Control and Data Acquisition (SCADA), Human Machine Interface (HMI) play a pivotal role in optimizing industrial processes by providing control, data acquisition capabilities and real-time monitoring. Understanding these systems is essential for Automation & Robotics engineering students, as it empowers them to design, implement, and secure interconnected systems that drive modern industries, fostering innovation, productivity, and safety.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attend the following industry/ employer expected outcome through various teaching learning experiences:
Maintain industrial automation systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Describe the working of PLC with its structure.
- CO2 - Execute different PLC ladder programming instructions.
- CO3 - Maintain PLC for specific application.
- CO4 - Use SCADA and HMI with relevant network communication protocols.
- CO5 - Develop simple SCADA and HMI based applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme											Total Marks
				Actual Contact Hrs./ Week			SLH	NLH			Theory				Based on LL & TL				Based on SL			
																	Practical					
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
314335	AUTOMATION TOOLS & SYSTEMS	AAS	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10		175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks

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5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the need of PLC over the hardwired relay logic. TLO 1.2 Compare PLC with other dedicated controllers. TLO 1.3 Explain the function of different elements of PLC with the help of block diagram. TLO 1.4 Describe types of PLC and selection criteria for the given application. TLO 1.5 Explain concept of redundancy in PLC with suitable diagram.	**Unit - I Fundamentals of PLC** 1.1 PLC in industrial automation: Benefits & limitations, comparison of PLC with Personal Computer (PC) and dedicated controllers like Microcontrollers and PID controllers 1.2 Block diagram of PLC, building blocks of PLC: Power supply, CPU, memory organization, input-output modules (Discrete and analog), special I/O Modules 1.3 Commonly used I/O devices used for PLC 1.4 Types of PLC: Fixed, Modular 1.5 Selection criteria of PLC based on different applications 1.6 Concept of sinking and sourcing in PLC, Concept of redundancy in PLC	Lecture using Chalk-Board, Presentations, Video Demonstrations, Flipped Classroom
2	TLO 2.1 Describe different programming languages used to program PLC. TLO 2.2 Specify appropriate I/O addressing format for the given PLC. TLO 2.3 Explain use of different PLC programming instructions used to write a simple program for performing a given operation. TLO 2.4 Describe the PLC installation procedure.	**Unit - II PLC Programming** 2.1 PLC programming languages: Functional Block Diagram (FBD), Instruction List, Structured text, Sequential Function Chart (SFC), Ladder Programming (Introduction only) 2.2 Basics of ladder programming, PLC processor scan cycle, PLC I/O addressing in ladder logic 2.3 PLC arithmetic functions (Add, subtract, multiply, divide instructions, increment and decrement instructions), PLC logical functions (NOT, AND, OR, XOR), PLC compare and data handling instruction 2.4 Programming Timer: Addressing a timer block, status bits, ON delay, OFF delay and reset, retentive timer 2.5 Programming Counter: Addressing a counter block, status bits, UP and DOWN counter, up-down counter 2.6 PLC-PC interface, do's and don'ts in PLC installation	Lecture using Chalk-Board, Presentations, Video Demonstrations
3	TLO 3.1 Explain basics of Ladder programming for a given Boolean expression. TLO 3.2 Develop Ladder program for simple applications. TLO 3.3 Prepare Ladder program for a given industrial application. TLO 3.4 Describe regular PLC maintenance practices. TLO 3.5 Enlist steps to troubleshoot PLC for a specific	**Unit - III PLC Applications and Maintenance** 3.1 Ladder programming for Seal in circuit, Boolean expression and logic gates 3.2 Simple programming using ladder logic based on relay, timer, counter, logical, arithmetic, comparison, and data handling instructions 3.3 PLC based applications: Motor sequence control, traffic light control, bottle filling plant, car parking, tank level control, conveyor system, stepper motor control 3.4 Regular PLC maintenance practices	Lecture using Chalk-Board, Presentations, Video Demonstrations, Hands-on

AUTOMATION TOOLS & SYSTEMS | **Course Code : 314335**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
	application.	3.5 Standard steps for PLC troubleshooting	
4	TLO 4.1 Explain various benefits and applications of SCADA. TLO 4.2 Describe architecture of SCADA. TLO 4.3 Explain the need of HMI. TLO 4.4 Explain the major features of the given communication protocol used for SCADA.	**Unit - IV Basics of SCADA and HMI** 4.1 Supervisory Control and Data Acquisition (SCADA): Introduction, need, benefits and typical applications 4.2 SCADA architecture: Master Terminal Unit (MTU), Remote Terminal Unit (RTU), communication protocols, various editors of SCADA 4.3 Human Machine Interface (HMI): Introduction, need, benefits and typical applications 4.4 Industrial Networking: Network topologies, modes of network communication- Master slave, bus arbitration, token passing, random bus access (CSMA/CD), CS (Client-server) 4.5 RS232, RS422, RS485 standards for data communication 4.6 Industrial ethernet, concept of Fieldbus, MODBUS protocol, Highway Addressable Remote Transducer (HART) Protocol	Lecture using Chalk-Board, Presentations, Collaborative learning, Hands-on
5	TLO 5.1 Identify the steps in Interfacing of PLC and SCADA system. TLO 5.2 Describe the need and architecture of OPC. TLO 5.3 Describe the steps in creating simple SCADA screen for a given application. TLO 5.4 Identify the steps in integrating given HMI panel with given PLC. TLO 5.5 Enlist the steps to develop HMI screen for the given simple application.	**Unit - V SCADA Application Development and HMI** 5.1 Interfacing SCADA system with PLC: Typical connection diagram 5.2 Object linking and embedding for process control (OPC) - need, architecture 5.3 Developing SCADA screen for simple applications - conveyor system, car washing system, bottle filling and product Sorting 5.4 Steps for integrating PLC with HMI panel 5.5 Developing HMI screen for blinking, movement, filling and visibility of object	Lecture using Chalk-Board, Presentations, Video Demonstrations, Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Inspect different controls available on front panel of PLC. LLO 1.2 Identify the function of each part of PLC.	1	*Identification of different parts of PLC front panel available in your laboratory	2	CO1
LLO 2.1 Segregate available devices into analog and discrete I/O devices. LLO 2.2 Segregate available devices into analog and discrete I/O devices.	2	Classification of various components available in laboratory into discrete I/O and analog I/O devices	2	CO1
LLO 3.1 Interface available discrete input devices to PLC. LLO 3.2 Interface available discrete output devices to PLC. LLO 3.3 Interface available discrete input	3	*Interfacing of discrete input and output devices to the PLC	2	CO1

AUTOMATION TOOLS & SYSTEMS | **Course Code : 314335**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
devices to PLC. LLO 3.4 Interface available discrete output devices to PLC.				
LLO 4.1 Interface available analog input devices to PLC. LLO 4.2 Interface available analog output devices to PLC. LLO 4.3 Interface available analog input devices to PLC. LLO 4.4 Interface available analog output devices to PLC.	4	Interfacing of analog input and output devices to the PLC	2	CO1
LLO 5.1 Develop ladder program using relay instructions. LLO 5.2 Develop ladder program using relay instructions.	5	Development of ladder diagrams to design basic logic gates	2	CO2
LLO 6.1 Execute the use of timer instruction in PLC ladder programming. LLO 6.2 Execute the use of timer instruction in PLC ladder programming.	6	*Verification of ladder program for blinking of LEDs	2	CO2
LLO 7.1 Execute the use of counter instruction in PLC ladder programming. LLO 7.2 Execute the use of counter instruction in PLC ladder programming.	7	*Demonstration of ladder logic for pulse counting using push button/ limit switch/ proximity sensor	2	CO2
LLO 8.1 Demonstrate steps to install any PLC ladder programming software. LLO 8.2 Understand the features of ladder programming software.	8	Identification of different features of PLC software or Ladder programming simulation software	2	CO3
LLO 9.1 Develop ladder program using arithmetic instructions. LLO 9.2 Develop ladder program using comparison instructions. LLO 9.3 Develop ladder program using data handling instructions.	9	*Implementation of ladder program for the temperature measurement system of given liquid using RTD or Thermocouple	4	CO1 CO3
LLO 10.1 Develop ladder program for seal in circuit. LLO 10.2 Develop ladder program for motor sequence control.	10	Simulation of ladder diagram for motor sequence control	2	CO3
LLO 11.1 Develop ladder program for Traffic light control.	11	*Demonstration of traffic light control system using ladder diagram	2	CO3
LLO 12.1 Develop ladder program for bottle filling plant.	12	*Demonstration of a bottle filling plant using proximity sensor, solenoid valve, conveyer belt mechanism using PLC	2	CO1 CO3
LLO 13.1 Develop ladder program for Car parking system.	13	Simulation of a mall Entry-Exit car parking system using ladder diagram	2	CO3
LLO 14.1 Develop ladder program for water level indicator system.	14	Demonstration of a basement and overhead water tank level indication system using PLC	2	CO3
LLO 15.1 Develop ladder program for Stepper motor control.	15	*Execution of stepper motor rotation in clockwise and anti-clockwise direction using PLC	2	CO3
LLO 16.1 Configure and perform hands-on practice to identify various features of any available SCADA software in the laboratory.	16	*Identification of various features of given SCADA software	2	CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 17.1 Identify Different objects configuration (buttons, lamps, motors, conveyor) and dynamic properties(blinking, filling, movement) in SCADA software. LLO 17.2 Configure and perform hands-on practice to identify various features of any available SCADA software in the laboratory.	17	*Identification of various features of given SCADA software	2	CO4
LLO 18.1 Identify different network cables (Fiber optics, coaxial, twisted) and their accessories used in SCADA communication.	18	Identification of various available network cables used in SCADA	2	CO4
LLO 19.1 Identify different network communication buses (Modbus, Profibus) used in SCADA.	19	Identification of different network communication buses used in SCADA	2	CO4
LLO 20.1 Configure available HMI panel with software and integrate it with a given PLC.	20	*Identification of various features of OPC DA server software	2	CO5
LLO 21.1 Configure available HMI panel with software and integrate it with a given PLC.	21	*Identification of various features of OPC DA server software	2	CO5
LLO 22.1 Develop SCADA graphic screen and integrate it with PLC to perform seal in logic.	22	*Development of the interconnection between PLC and SCADA software using OPC	4	CO5
LLO 23.1 Develop SCADA graphic screen and integrate it with PLC to perform conveyor control.	23	*Development of SCADA graphic screen and interfacing it with PLC to perform seal-in-logic	2	CO5
LLO 24.1 Develop SCADA graphic screen and integrate it with PLC to perform car washing systems. LLO 24.2 Develop SCADA graphic screen and integrate it with PLC to perform conveyor control.	24	*Development of SCADA graphic screen and interfacing it with PLC to perform Conveyor control operation	2	CO5
LLO 25.1 Develop SCADA graphic screen and integrate it with PLC to perform product sorting.	25	Development of SCADA graphic screen and interfacing it with PLC to perform car washing system	2	CO5
LLO 26.1 Develop SCADA graphic screen and integrate it with PLC to perform bottle filling operation. LLO 26.2 Develop SCADA graphic screen and integrate it with PLC to perform bottle filling operation.	26	Development of SCADA graphic screen and interfacing it with PLC to perform bottle filling operation	2	CO5
LLO 27.1 Configure available HMI Panel with software and integrate it with a given PLC. LLO 27.2 Develop SCADA graphic screen and integrate it with PLC to perform object sorting operation.	27	Development of SCADA graphic screen and interfacing it with PLC to perform object sorting operation	2	CO5
LLO 28.1 Develop HMI graphic screen for blinking, movement and visibility of an object. LLO 28.2 Develop HMI graphic screen for blinking, movement and visibility of an object.	28	*Development of HMI graphic screens for different properties of given objects	2	CO5

AUTOMATION TOOLS & SYSTEMS   **Course Code : 314335**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Automatic mixing system: Implement Automatic product mixing control system using PLC.
- Traffic light control: Prepare PLC based simple traffic light control system.
- Elevator control: Prepare a 4 floor elevator control system using PLC.
- Automatic Street light controller: Prepare a SCADA based system to control the street lights as per the intensity of natural light.
- Coffee vending machine: Develop Plc based coffee vending machine.
- Level control system: Prepare water tank discrete level control system using PLC.
- Home automation: Implement a versatile automation system for home that can automate any three home appliances using SCADA.
- Railway gate automation: Prepare a SCADA based system to control the railway gate automatically.
- Automatic agricultural irrigation system: Prepare a SCADA based to control drip irrigation.
- Sequential control of Motors: Develop a HMI control system for operating different motors sequentially.
- Product counting on conveyor: Make a HMI application to count product passing on conveyor in a specific time.
- Color sensing and sorting of objects: Develop a HMI screen for sorting of different products based on color.

Student activity

- Make a Report on general maintenance and troubleshooting methods of PLC.
- Make a report on market survey of different types of PLC software.
- Make a report on market survey of different types of HMI panels and software.
- Make a report on market survey of different types of SCADA software.
- Visit any virtual lab to perform an activity and prepare a report on it.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Trainer setup for PLC - stepper motor interface, Conveyer belt assembly	10,12,15

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	IEC Standard compatible latest version of SCADA software from any reputed manufacturer like - Ellipse/ Citect/ wonderware - intouch/ Json/ Wincc/ Cimplicity etc.	16,17,21,22,23,24,25,26
3	Trainer set up for Coaxial cable, UTP and STP cables, Fiber optics cable with associated connection accessories	18
4	Trainer setup for Network communication Buses such as Modbus / Profibus etc.	19
5	Input and output devices for PLC: lamps, DC motors, Proximity sensors, Temperature Sensors, Limit switches, Push buttons, RTD/ Thermocouple	2,3,4,7,9,11,12
6	Open Source OPC DA server softwares like - Kepserver OPC / MXOPC / Matrikon OPC	20,21,26
7	Min 7' inch HMI Panel with required software -Siemens, Delta, Weintek, Schneider etc.	27,28
8	IEC 1131-3 compatible PLC with programming Software and interfacing Hardware - (Micro and Modular PLC with analog and digital I/Os) along with user manual	8,9,10,11,12,13,14,15,1,2,3,4,5,6,7
9	Computer System: OS with windows 10 or higher, minimum of 8 GB RAM, Minimum of Intel core i3 or equivalent	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of PLC	CO1	8	4	4	2	10
2	II	PLC Programming	CO2	10	6	6	6	18
3	III	PLC Applications and Maintenance	CO3	10	2	4	8	14
4	IV	Basics of SCADA and HMI	CO4	9	4	6	8	18
5	V	SCADA Application Development and HMI	CO5	8	2	4	4	10
		Grand Total		45	18	24	28	70

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

• Two offline unit tests are of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

• End semester assessment is of 70 marks. End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline	PO-2 Problem Analysis	PO-3 Design/ Development	PO-4 Engineering Tools	PO-5 Engineering Practices for	PO-6 Project Management	PO-7 Life Long	PSO-1	PSO-2	PSO-3

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	Specific Knowledge		of Solutions		Society, Sustainability and Environment		Learning			
CO1	3	2	-	2	-	-	2			
CO2	3	3	2	3	-	-	2			
CO3	3	3	3	3	2	1	2			
CO4	3	2	1	2	-	-	2			
CO5	3	3	3	3	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dunning, Garry	Introduction to Programmable Logic Controller	Thomson/Delmar Learning, 2005 ISBN: 978-1401884260
2	Petruzella, F.D.	Programmable Logic Controller (Fourth Edition)	Tata-McGraw Hill India, 2010 ISBN: 978-0071067386
3	Hackworth, John; Hackworth, Federic	Programmable Logic Controller	Prentice Hall, 2003 ISBN: 978-0130607188
4	Boyar, S. A.	Supervisory Control and Data Acquisition	ISA publication (4th edition), ISBN: 978-1936007097
5	Bailey, David; Wright, Edwin	Practical SCADA for Industry	Newnes (an imprint of elsevier), 2003 ISBN: 0750658053
6	Manoj, K.S.	Industrial Automation with SCADA Concept, Communication and Security	Notion Press, eISBN: 9781684668298

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=MS3qJq2jvu0	This NPTEL lecture discuss about basics of program logic controllers. Various programming techniques and terms used in PLC are discussed in detail.
2	https://instrumentationtools.com/free-allen-bradley-plc-ladd er-logic-training-course/	Allen Bradley PLC Ladder Logic Training Course.
3	https://www.youtube.com/watch?v=E2WNPXJf-Kw	PLC Introduction. PLC Basics, Components of PLC, Modular PLC Modules, Input Output.
4	https://www.matrikonopc.com/opc-server/opc-data-access-versi ons.aspx	OPC Data Access (OPC DA) Versions & Compatibility.
5	https://github.com/riclolsen/json-scada/releases/download/V0 .31-alpha/json-scada_setup_v.0.31.exe	An open source SCADA software.
6	https://www.ptc.com/en/products/kepware/kepserverex/demo-dow nload	Kepserver OPC free Demo software.
7	https://citectscada.software.informer.com/download/#download ing	Student version of Citect SCADA software.

Sr.No	Link / Portal	Description
8	https://www.weintek.com/globalw/Software/EasyBuilderPro.aspx	An open source HMI software/ Simulator.
9	https://ial-coep.vlabs.ac.in/	Virtual Laboratory on automation.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

BASICS OF ROBOTIC PROCESS AUTOMATION	Course Code : 314011

Programme Name/s	: Automation and Robotics
Programme Code	: AO
Semester	: Fourth
Course Title	: BASICS OF ROBOTIC PROCESS AUTOMATION
Course Code	: 314011

I. RATIONALE

Robotic Process Automation (RPA) is one of the fastest-growing domains in the world that responds to the demands of various sectors to meet current workforce needs especially in IT with ease of work and quality. RPA, also known as Software Robotic, eliminates the need of human intervention in performing repetitive less complex task just by dragging and dropping techniques. This course aims to develop in students, the basic skills related to RPA.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry/employer expected outcomes through various teaching learning experiences:
Develop a basic Robotic Process Automation (RPA) workflow.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Design Graphical User Interface (GUI) using simple VB.
- CO2 - Identify the commands and tags of HTML, JavaScript to automize the robotic process.
- CO3 - Use appropriate tools and platforms of Robotic Process Automation (RPA).
- CO4 - Identify image, text by using data types and user events in RPA.
- CO5 - Describe the techniques used for office tool automation like Excel and PDF using UiPath .

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314011	BASICS OF ROBOTIC PROCESS AUTOMATION	RPA	DSC	-	-	4	-	4	2	-	-	-	-	-	25	10	50@	20	-	-	75

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.

BASICS OF ROBOTIC PROCESS AUTOMATION | **Course Code : 314011**

6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explore the basics of RPA. TLO 1.2 Develop simple program using menus and dialogs box. TLO 1.3 Apply relevant control flow and loop statements for a given problem. TLO 1.4 Design GUI using special functions.	**Unit - I Fundamentals of VB.net used in RPA** 1.1 Robotic Process Automation(RPA) - Concepts, Differentiating RPA from automation, Languages used for RPA, Basics of VB used in RPA 1.2 Menus-menu editor and popup menu 1.3 Control flow statement if- else, do-while Select Case statement 1.4 Special functions and tools -inputbox(), message box(), format(), date and time functions	Video Demonstrations Hands-on Collaborative learning
2	TLO 2.1 Use syntax of HTML in development of UiPath application. TLO 2.2 Use query language as a tool to create and modify table. TLO 2.3 Apply relevant HTML tools and functions of Cascading Style Sheets (CSS) and JavaScript in the given application.	**Unit - II Concept of HTML in RPA** 2.1 Use of HTML in User Interfaces designed in UiPath - concept 2.2 Basics of query language and relational algebra in creating and altering table contents 2.3 Programming using basic tags in HTML	Video Demonstrations Hands-on Collaborative learning
3	TLO 3.1 Describe the methodology and tools used for robotic process automation. TLO 3.2 Describe the procedure to install robotic automation tools. TLO 3.3 Design user interface using robotic automation tools.	**Unit - III RPA Platform** 3.1 Emergence of RPA - evolution, future of RPA, benefits of RPA 3.2 Working of RPA - methodology and key consideration 3.3 List the steps required to install the design user interface	Video Demonstrations Hands-on Collaborative learning
4	TLO 4.1 Select the relevant data types, variables for managing activities. TLO 4.2 Use Element triggers, Image trigger as user events to automizer activities. TLO 4.3 Design activities based on control flow techniques if-else, do-while, for loop.	**Unit - IV Designing the RPA using Events and Data Elements** 4.1 Data types-scalar, variables-managing variables for automizing process flow 4.2 Usage of user events -Element triggers, Image trigger 4.3 Simplified activities based on control flows statements using if-else, do-while, for loop	Video Demonstrations Hands-on Collaborative learning
5	TLO 5.1 Describe the scope of Excel automation in UiPath. TLO 5.2 Design robotic program for PDF automation in UiPath.	**Unit - V Applications of UiPath in Office Automation** 5.1 Excel automation- Concept in RPA tool, key benefits, Data Table Activities, new excel file generation. 5.2 PDF automation- Concept in RPA tool, key objectives, Extracting data from PDF, Optical Character Recognition (OCR), PDF generation from OCR	Video Demonstrations Hands-on Collaborative learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

BASICS OF ROBOTIC PROCESS AUTOMATION   **Course Code : 314011**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Install the RPA tool. LLO 1.2 Explore the features of the given RPA tool.	1	* Identification of features for the given RPA Tool (UiPath/ Blue Prism/ Automation Anywhere) with 'Welcome' message display.	2	CO1 CO3
LLO 2.1 Install visual studio. LLO 2.2 Use variable constant and the arithmetic operators for developing given program. LLO 2.3 Use 'Textbox' control and 'Button' control to design the given application.	2	* GUI design for arithmetic operation using VB.net	2	CO1
LLO 3.1 Use date, time and string function to develop the given application. LLO 3.2 Use 'DateTimePicker' control to design current time and date display.	3	Date and Time indicator using VB.net	2	CO1
LLO 4.1 Use the 'PictureBox' control and 'Listbox' control to design the problem statement. LLO 4.2 Use 'Timer' function in the given application. LLO 4.3 Execute the syntax for 'Switch' function statement to solve the given problem.	4	Rotation of 'PictureBox' on windows form using VB.net	2	CO1
LLO 5.1 Use 'Common Dialog' control to design various office tools. LLO 5.2 Use different special controls - 'FileListbox', 'Directory' and 'Drive' control.	5	* Explorer design using a directory, drive, FileListbox, and Common Dialog control	2	CO1
LLO 6.1 Use Multiple Document Interface (MDI) form concept to design given text editors.	6	* Notepad design with cut, copy, paste, file new, open, save functions using MDI form in VB.net	2	CO1
LLO 7.1 Use 'Data' control to add, delete, update the data through GUI. LLO 7.2 Write syntax of if-else statements.	7	* Generation of student score-card to manage the database using data tool in VB.net	2	CO1
LLO 8.1 Identify the logical steps for given document flow in HTML. LLO 8.2 Use CSS syntax for formatting the document. LLO 8.3 Use different tags to design the document.	8	* Pictorial document design a using HTML	2	CO2
LLO 9.1 Use different HTML List Tags	9	Selection of the various courses from the courses list given in the document using HTML	2	CO2
LLO 10.1 Use CSS syntax to represent the data. LLO 10.2 Design tabular format by using 'Table tag'.	10	* Student admission record in the form of table	2	CO2
LLO 11.1 Use radio button, checkbox tags to design survey form.	11	* Survey form designing using HTML	2	CO2

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BASICS OF ROBOTIC PROCESS AUTOMATION   **Course Code : 314011**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.2 Use form tag in HTML.				
LLO 12.1 Use frame Tag to link website.	12	* Development of a webpage to display various food corners available using frame tag in HTML/ JAVA scripting	4	CO2
LLO 13.1 Explore the features of dialog box in the given RPA tool (UiPath Studio).	13	* Activity to display the entered number using UiPath	2	CO3
LLO 14.1 Identify common data variables used in UiPath.	14	Analysis of basic mathematical functions using arguments and data variable in UiPath	2	CO4
LLO 15.1 Identify the types of variables and workflow in the RPA tools.	15	* Determination the number of files from the given folder path using different types of variables in UiPath	2	CO4
LLO 16.1 Assign data variables and activities for designing given application.	16	* Creation a Fibonacci series using data variables	2	CO4
LLO 17.1 Use data variable, arguments and different workflows.	17	Create a sequence that asks the user for first and last name, and gives choices to order from favourite snacks, and then displays the answers in UiPath	2	CO4
LLO 18.1 Use data variable, arguments and different workflow for given application.	18	Development of the current age calculation program using workflow technique in UiPath	2	CO4
LLO 19.1 Use control flow techniques to develop the activity.	19	Print 1 to 10 numbers using while control flow activity in UiPath	2	CO4
LLO 20.1 Use the basic control flow techniques to design the application. LLO 20.2 Design the given application using inputbox (), message box().	20	Odd and Even number identification using control flow techniques in UiPath	2	CO4
LLO 21.1 Use variables and control flow techniques for office tool automation.	21	* Data table creation in RPA using office tool automation in UiPath	2	CO5
LLO 22.1 Use variables and control flow techniques for Excel automation.	22	* Edit, Add, Delete the rows and columns in the data table in Excel file in UiPath	2	CO5
LLO 23.1 Use variables and control flow techniques to generate data table.	23	Conversion of Excel data from the file into the data table using UiPath	2	CO5
LLO 24.1 Use variables and control flow techniques to generate result sheet in Excel automation.	24	* Preparation of result sheet of an examination conducted for a student using UiPath	4	CO5
LLO 25.1 Use parameters of automation for PDF file.	25	Procedure of PDF text identification using PDF automation in UiPath	2	CO5
LLO 26.1 Use 'Select Extraction' type syntax for PDF file.	26	Extraction of PDF content and display it in textbox in UiPath	2	CO5
LLO 27.1 Use 'Read PDF Text' activity for PDF file.	27	* Read a PDF file using the Read PDF with OCR activity in UiPath	2	CO5
LLO 28.1 Use 'Read Range' and 'Write Range' functions to merge excel files in Excel Automation	28	Merge two Excel sheets and write to a new sheet in UiPath	2	CO5

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
using UiPath.				

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- NA

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Personal Computers 8GB RAM,500GB HDD, i3 or higher processor	All
2	Software required: Visual Studio, Web browser, UiPath	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester summative assessment is of 50 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)		Programme Specific Outcomes* (PSOs)

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	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	2	2	-	-	1			
CO2	2	2	2	2	-	-	1			
CO3	2	2	2	2	-	-	2			
CO4	2	2	2	2	-	-	2			
CO5	2	2	2	2	-	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Tripathi, Alok Mani	Learning Robotic Process Automation	Packt Publishing Ltd, 2018 ISBN: 978-1788470940
2	Taulli, Tom	The Robotic Process Automation Handbook	Apress,1st Edition, 2020 ISBN: 978-1484257296
3	Mullakara, Nandan; Asokan, Arun Kumar	Robotics Process Automation Projects	Packt Publishing Ltd, 2020 ISBN: 978-1839217357
4	Ying, Lim Mei	Robotic Process Automation with Blue Prism Quick Start Guide	Packt Publishing Ltd, 2018 ISBN: 978-1789610444
5	Javed, Adeel	Robotic Process Automation Using Uipath Studiox	Springer India, 2022 ISBN: 978-1484278765

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=8hH7B2CZwUc	About RPA Tool-BluePrism
2	https://www.youtube.com/watch?v=rVd66AFAeHs	About RPA WorkFusion
3	https://www.youtube.com/watch?v=f4bRC3_8to	About KOFAX
4	https://www.uipath.com/learning/video-tutorials	RPA tutorials
5	www.w3schools.com	HTML tutorials

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students