Programme Name/s : **Automation and Robotics/ Instrumentation & Control/ Instrumentation**

Programme Code : **AO/ IC/ IS**

Semester : **Third**

Course Title : **3D MODELLING & SIMULATION**

Course Code : **313014**

I. RATIONALE

3D simulation is the process of creating a three-dimensional virtual model of a product and testing it in a simulated environment before the final development for identifying potential problems in product design. This course will enable the diploma students to develop skills for comprehensive 3D simulation in-line with the industry demands for addressing real-world design challenges.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain the following industry/ employer expected outcome through various teaching learning experiences:
Graduates of 3D simulation course are expected to Integrate 3D simulation using CAD for creating real world projects.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use fundamental commands for basic 3D modeling in open source CAD software
- CO2 - Create simple 3D models for a given application
- CO3 - Create assembly of complex 3D structure for a given application
- CO4 - Apply rendering and visually appealing features for a 3D model
- CO5 - Create real-world projects by applying advanced simulation techniques

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	
313014	3D MODELLING & SIMULATION	SIM	SEC	-	-	4	-	4	2	-	-	-	-	-	25	10	25@	10	-	-	50

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.

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 Navigate the CAD software interface and locate basic tools. TLO 1.2 Develop a conceptual understanding of 3D simulation. TLO 1.3 Acquire the ability to use fundamental commands in CAD software for sketching, extrusion, and basic 3D modeling.	**Unit - I Introduction to 3D simulation** 1.1 Introduction to CAD software and its applications 1.2 Overview of the CAD software user interface 1.3 Basic sketching and drawing commands 1.4 Extrusion and basic 3D modeling 1.5 Introduction to simulation concepts	Model Demonstration Video Demonstrations Presentations Hands-on
2	TLO 2.1 Apply parametric design principles to create 3D models with adjustable parameters. TLO 2.2 Use assemblies in CAD software, allowing them to design simple automated components. TLO 2.3 Create a hands-on project involving simple 3D designs for a given application.	**Unit - II Creating Simple 3D Models** 2.1 Advanced sketching and parametric design 2.2 Constraints and relationships in CAD software 2.3 Creating simple assemblies for automation 2.4 Introduction to mechanical joints 2.5 Hands-on Project: Designing a basic automated component	Video Demonstrations Presentations Hands-on Model Demonstration Collaborative learning
3	TLO 3.1 Apply commands in CAD software. TLO 3.2 Explore techniques for incorporating electronic components into 3D designs. TLO 3.3 Develop in creating complex assemblies in CAD software, considering interconnections and joints in automation.	**Unit - III Assembly of complex 3D structures** 3.1 Advanced 3D modeling Techniques 3.2 Incorporating electronics into 3D Designs 3.3 Advanced assembly techniques in CAD software 3.4 Interconnecting components	Model Demonstration Video Demonstrations Presentations Hands-on Collaborative learning

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.
		3.5 Complex structures and mechanisms	
4	TLO 4.1 Apply the basics of rendering and visualization in CAD software. TLO 4.2 Apply materials to 3D models and understanding their impact on rendering .	**Unit - IV Rendering and Visualization** 4.1 Introduction to Rendering and Visualization 4.2 Applying materials to 3D models 4.3 Enhancing aesthetics in 3D model 4.4 Rendering realistic 3D model visualizations	Model Demonstration Video Demonstrations Presentations Hands-on Collaborative learning
5	TLO 5.1 Apply dynamic simulation techniques in CAD. TLO 5.2 Simulate structural integrity of components for various stress conditions. TLO 5.3 Apply their skills to a real-world simulation project.	**Unit - V Advanced Simulation Techniques** 5.1 Dynamic simulation principles 5.2 Simulating designed 3D model in CAD software 5.3 Stress analysis and structural Integrity 5.4 Real-world simulation project 5.5 Integration of Design, Rendering, and Dynamic Simulation	Model Demonstration Video Demonstrations Presentations Hands-on 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 Installing properly the open source CAD software.	1	*Installation of open source CAD software (Fusion 360/ any other).	2	CO1
LLO 2.1 Explore User Interface. LLO 2.2 Explore key features of the software.	2	*Explore the user interface, key tools and features of CAD software.	2	CO1
LLO 3.1 Creating 2D shape according to the given dimensions.	3	*Creation of a given 2D shape using basic sketching tools.	2	CO1
LLO 4.1 Create, save, and export project files in CAD software.	4	*Creation of a basic 3D object from the given 2D object using extrude function.	2	CO1
LLO 5.1 Creating a new project. LLO 5.2 Upload and export project files in CAD software.	5	Design a new project, upload and export the same.	2	CO1
LLO 6.1 Creating technical layout as per design specifications. LLO 6.2 Creating a document of the layout.	6	*Creation of a technical layout and document for a given 3D model.	2	CO1
LLO 7.1 Developing proficiency in exploring the utilization of CAD cloud-based collaboration features. LLO 7.2 Enabling effective team collaboration on cloud.	7	CAD cloud-based collaboration features.	2	CO1
LLO 8.1 Importing the given image. LLO 8.2 Creating a parametric design.	8	*Creation of a parametric design of a given image.	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Designing an assembly of a 3D object. LLO 9.2 -Applying constraints for movement for a given 3D object.	9	Design an assembly with appropriate constraints for movement of a given 3D object.	2	CO2
LLO 10.1 Designing simple automated components. LLO 10.2 Applying parametric principles to the component.	10	Design a simple automated component using parametric principles.	2	CO2
LLO 11.1 Applying CAD animation tools. LLO 11.2 Creating simple animation.	11	*Creation of a simple animation of an given object using CAD animation tools.	2	CO2
LLO 12.1 Collaborate with a peer on an assembly project using cloud-based features.	12	*Collaboration using cloud-based features.	2	CO2
LLO 13.1 Explore shortcut and commands for 2D sketch. LLO 13.2 Apply the shortcut and commands to create a 2D sketch.	13	Creation of 2D sketch using shortcut and commands.	2	CO2
LLO 14.1 Explore shortcut and commands for 3D model. LLO 14.2 Apply the shortcut and commands to create a 3D model.	14	*Creation of 3D models using shortcut and commands.	2	CO2
LLO 15.1 Explore the difference between components and bodies. LLO 15.2 Create components for a given assembly.	15	Creation of components for a given assembly.	2	CO3
LLO 16.1 Demonstrate the ability to create assemblies with multiple components and joints.	16	*Demonstration of assembling of joints and components for a given 3D object.	2	CO3
LLO 17.1 Explore the features of CAD simulation function. LLO 17.2 Create a basic circuit.	17	Creation of a basic electronic circuits using CAD simulation function (Amplifier/ any other).	2	CO3
LLO 18.1 Apply design principles. LLO 18.2 Optimize mechanical parts for manufacturing.	18	*Application of design principles for optimizing a simple mechanical part.	2	CO3
LLO 19.1 Integrate various mechanical components.	19	Integrating mechanical components by using CAD software.	2	CO3
LLO 20.1 Explore the features of mesh. LLO 20.2 Create a mesh body using 3D body.	20	Conversion of a given 3D body to a mesh body.	2	CO3
LLO 21.1 Create a given mesh body to 3D body.	21	Conversion of a given mesh body to a 3D body.	2	CO3
LLO 22.1 Develop a motion study of a assembly. LLO 22.2 Simulating its movement under different conditions.	22	*Conduction of a motion study for the given assembly.	2	CO3
LLO 23.1 Explore basic rendering concepts. LLO 23.2 Apply rendering function.	23	*Application of render function to a given simple 3D model.	2	CO4
LLO 24.1 Explore advanced rendering concepts. LLO 24.2 Apply advanced rendering function.	24	Application of render function to a complex 3D model.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 25.1 Analyze different types of materials. LLO 25.2 Apply appropriate materials to enhance the aesthetics.	25	*Enhancement of aesthetics of a given model using various materials.	2	CO4
LLO 26.1 Explore different lighting effects. LLO 26.2 Apply appropriate lighting effects to enhance the visualizations.	26	Enhancement of visualizations of a given model by incorporating different lighting effects.	2	CO4
LLO 27.1 Perform stress analysis on components, ensuring structural integrity. LLO 27.2 Observe stress analysis.	27	*Stress analysis on a given object in 3D model.	2	CO5
LLO 28.1 Perform electronic cooling on components in 3D model. LLO 28.2 Observe electronic cooling.	28	*Electronic cooling on electronic devices in 3D model.	4	CO5
LLO 29.1 Apply simulation tools to a real-world project.	29	Develop real-world projects by applying simulation tools.	2	CO1 CO2 CO3 CO4 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

- Not Applicable

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	Appropriate software suitable for process automation drawings like AutoDesk Inventor, FreeCAD, SolidWorks, AutoDesk Fusion 360 etc.	All
2	Personal Computer : 8GB RAM, 500 GB HDD, I3 or higher processor	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 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	2	1	1	2	1	1	2			
CO2	2	2	2	2	1	1	2			
CO3	2	2	2	2	1	1	2			
CO4	2	2	2	2	1	1	2			
CO5	2	3	3	3	1	1	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	Cameron Coward	A Beginner's Guide to 3D Modeling: A Guide to Autodesk Fusion 360	No Starch Press- 2019 (ISBN: 978-1593279264)
2	Randy H. Shih	Parametric Modeling with Autodesk Fusion 360	SDC Publications- 2023 (ISBN: 978-1-63057-610-3)
3	Paul J. Schilling, Randy H. Shih	Parametric Modeling with SOLIDWORKS	SDC Publications- 2024 (ISBN: 978-1-63057-626-4)
4	Daniel T. Banach, Shawna Lockhart, Sheila Markazi	Autodesk Inventor 2024 Essentials Plus	SDC Publications- 2024 (ISBN: 978-1-63057-589-2)
5	Kelly L. Murdock	Autodesk 3ds Max 2024 Basics Guide	SDC Publications- 2024 (ISBN: 978-1-63057-614-1)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://help.autodesk.com/view/fusion360/ENU/courses/	Self-paced learning for Fusion
2	https://www.youtube.com/@adskFusion/featured	Autodesk Fusion 360
3	https://www.youtube.com/playlist?list=PLrOFa8sDv6jcp8E3ayUFZ	SolidWorks Tutorials for Beginners

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Sr.No	Link / Portal	Description
	4iNI8uuPjXHe	
4	https://www.youtube.com/@FreeCADAcademy	Study FreeCAD software
5	https://www.youtube.com/playlist?list=PLkMYhICFMsGYkVrkVbX4xngskLzxTBStJ	AutoDesk Inventor Complete Learning Tutorials. Starting from Beginners level
6	https://www.youtube.com/playlist?list=PLrZ2zKOtC_-DR2ZkMaK3YthYLErPxCnT-	Learn Autodesk Fusion 360 in 30 Days for Complete Beginners

Note :

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