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MANUFACTURING SYSTEMS ENGINEERING **Course Code : 316360**

Programme Name/s : Production Engineering
Programme Code : PG
Semester : Sixth
Course Title : MANUFACTURING SYSTEMS ENGINEERING
Course Code : 316360

I. RATIONALE

The course on Manufacturing Systems Engineering equips students with the knowledge and skills related to Group Technology, Flexible Manufacturing Systems, Computer Integrated Manufacturing, and Lean Manufacturing for optimizing and modernizing manufacturing operations. The opportunities will be provided to students to explore evolution of manufacturing, implementing efficient layouts and material handling, leveraging automation and data-driven approaches, and focusing on waste reduction and sustainability.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Implement various manufacturing systems in a manufacturing industry for smooth production related activities.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Suggest changes in given manufacturing industries/workshop considering technological advancement, product life cycle and technology life cycle.
- CO2 - Suggest Group Technology (GT) for a given manufacturing situation.
- CO3 - Prepare Flexible Manufacturing System (FMS) layout and flexible fixturing design for a given situation.
- CO4 - Prepare plan for Computer Integrated Manufacturing (CIM) using open source software. (Kladana software)
- CO5 - Apply the different tools of lean manufacturing for productivity improvement.

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	
316360	MANUFACTURING SYSTEMS ENGINEERING	MSE	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

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 Compare the features of Industry 1.0, 2.0, 3.0 and 4.0 TLO 1.2 Explain the role of computers in manufacturing industries. TLO 1.3 Identify the stage of given product on product life cycle. TLO 1.4 Identify the stage of specified technology on technology life cycle.	**Unit - I Introduction to Manufacturing System** 1.1 Evolution of transformation in manufacturing systems up to Industry 4.0. 1.2 System approach in manufacturing industries. 1.3 Role of computers and information technology in manufacturing and manufacturing systems. 1.4 Product life cycle & its importance. 1.5 Technology life cycle for new product development.	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit
2	TLO 2.1 Identify the type of production layouts for given situation. TLO 2.2 Select suitable GT layout for a given situation. TLO 2.3 Develop part families based upon their features.	**Unit - II Group Technology (GT)** 2.1 Group Technology - concept, definition, need, scope, & benefits. 2.2 Production layout-types, features and applications. 2.3 Group Technology Layout- concept, need, benefits, comparison with conventional layout with examples. 2.4 Group Technology- codification systems: OPTIZ coding system and its applications. 2.5 Part attributes- Design and manufacturing attributes. 2.6 Part family- concept, method to form and approach to form cell using part families.	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit Flipped Classroom
3	TLO 3.1 Describe the function of FMS. TLO 3.2 Sketch different types of layout for FMS implementation. TLO 3.3 Select the proper automated material handling system. TLO 3.4 Describe the role of AGV’s in material handling system.	**Unit - III Flexible Manufacturing System (FMS)** 3.1 Introduction & elements of FMS, Needs of FMS, General FMS consideration, Functions of different elements. 3.2 Types of flexibilities and FMS, FMS layout and its advantages. 3.3 Automated material handling system, Types and its applications, Automated storage and retrieval System. 3.4 Automated Guided Vehicles (AGV’s) and its types, Tool Management, Tool supply system, Tool Monitoring System, Flexible Fixturing, and Flexible Assembly Systems.	Lecture Using Chalk-Board Video Demonstrations Presentations Site/Industry Visit
4	TLO 4.1 Explain the need of CIM. TLO 4.2 List the different software used in CIM. TLO 4.3 Describe the characteristics of concurrent engineering. TLO 4.4 Explain the elements of CIM.	**Unit - IV Computer Integrated Manufacturing (CIM) System** 4.1 Basic Concepts of CIM- CIM Definition, Elements of CIM, CIM wheel, concept or technology, Evolution of CIM, Advantages of CIM. 4.2 Needs of CIM- Hardware and software. 4.3 Concurrent Engineering- Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering. 4.4 Elements of CIM: Computer Aided Design (CAD), Computer Aided Process Planning (CAPP), Computer Aided Manufacturing Control (CAMC) and Computer Aided Business Function (CABF).	Lecture Using Chalk-Board Video Demonstrations Presentations Case Study 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.
5	TLO 5.1 Explain the need of lean manufacturing. TLO 5.2 Identify the material flow management system. TLO 5.3 Apply the concept of green production system.	**Unit - V Lean Manufacturing System** 5.1 Introduction of Lean Manufacturing, Elements of Lean Manufacturing, Workplace organization, Total Predictive Maintenance (TPM) and its pillars. 5.2 Material flow management system, Kanban card system, 7 types of waste, Value stream mapping. 5.3 Concept of Manufacturing excellence, approaches to manufacturing excellence, Green supply chain management.	Lecture Using Chalk-Board Video Demonstrations Presentations Case Study

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 Collect the given job from your institute workshop. LLO 1.2 Sketch the product life cycle. LLO 1.3 Suggest the changes in existing production cycle.	1	*Product Life Cycle of a Manufactured Component.	2	CO1
LLO 2.1 Collect the given job from your institute workshop or any lab. LLO 2.2 Sketch technology life cycle of the product. LLO 2.3 Suggest the changes in existing technology life cycle.	2	Technology Life Cycle of a Manufactured Component.	2	CO1
LLO 3.1 Collect the given job from your institute workshop. LLO 3.2 Prepare its step-by-step production flow. LLO 3.3 Draw its production layout w.r.t. production flow.	3	*Production layout of a component manufactured in a workshop.	2	CO2
LLO 4.1 Prepare a GT layout by considering its smooth flow of operation.	4	Group Technology layout of above manufactured component.	2	CO2
LLO 5.1 Identify the mechanical assembly/ component from any lab. LLO 5.2 Prepare a manual OPTIZ code for the component.	5	Manual OPTIZ GT code for any mechanical assembly or component available in the lab	2	CO2
LLO 6.1 Identify the mechanical assembly/ component from any lab. LLO 6.2 Prepare list of design and manufacturing attributes of the component.	6	*Part family code by considering the design and manufacturing attribute.	2	CO2
LLO 7.1 Identify the manufacturing process of a component prepared in the Institute workshop. LLO 7.2 Draw a sequence of flow of operation for manufacturing a component by considering automated material handling equipment.	7	*Sequence of flow of production process by using automated material handling system concept.	2	CO3
LLO 8.1 Collect the given job from your institute workshop. LLO 8.2 Prepare its step-by-step production flow. LLO 8.3 Draw its FMS layout w.r.t. production flow.	8	FMS layout of a manufactured component.	2	CO3

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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 Select any mechanical assembly/ component from the lab. LLO 9.2 Prepare a flexible fixturing area w.r.t. design of a component.	9	Flexible fixturing tree for any manufactured component or assembly.	2	CO3
LLO 10.1 Identify the mechanical assembly and draw its CIM wheel w.r.t. all manufacturing processes and systems of it.	10	CIM Wheel for manufacturing a mechanical product (eg. Washing machine, Car door assembly, IC engine, etc.)	2	CO4
LLO 11.1 Select any mechanical assembly/ component from the lab. LLO 11.2 Prepare step-by-step process plan.	11	*Process planning of a manufactured assembly/component.	2	CO4
LLO 12.1 Identify the place of machines and raw material in the workshop. LLO 12.2 Choose a machine where to organize workplace area.	12	*Workplace area of workshop by considering lean manufacturing concept.	2	CO5
LLO 13.1 Identify any machine from the workshop. LLO 13.2 Prepare a checklist of maintenance parameters of machine.	13	*Checklist of preventive maintenance of any machine in the workshop.	2	CO5
LLO 14.1 Identify the different raw materials used in the workshop. LLO 14.2 Draw a material flow chart for the component.	14	*Material flow chart for material management in the workshop.	2	CO5
LLO 15.1 Draw the steps in supply chain of manufacturing a component in the workshop.	15	Supply chain chart for any manufacturing activity in the workshop.	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	CNC Milling Machine: Spindle speed- Up to 6000 rpm, X-axis: 500 mm to 1,500 mm, Y-axis: 300 mm to 1,000 mm, Z-axis: 300 mm to 1,000 mm, Spindle power- Up to 11 KW	1,2,3,4,12,13,14
2	Lathe Machine: Chuck size- 200 to 250 mm, Spindle speed- Up to 4000 rpm, Max turning length-195 mm, Feed rate-Up to 4-6 m/min	1,2,3,4,12,13,14
3	Milling Machine: Longitudinal travel (X)- 800 mm, Cross travel (Y)- 300 mm, Vertical travel (Z)- 250 mm, Spindle speed- Up to 5000 rpm, Power- 3 HP	1,2,3,4,12,13,14
4	CNC Turning Machine: Chuck size- 200 to 250 mm, Spindle speed- Up to 6000 rpm, Max turning length- 500 mm, Spindle power- Up to 11 KW	1,2,3,4,12,13,14
5	Process Planning Software for facilities as production planning, assembly line planning, material requirement planning, etc.	5,6,7,11

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

Sr.No	Unit	Unit Title	Aligned	Learning	R-	U-	A-	Total

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			COs	Hours	Level	Level	Level	Marks
1	I	Introduction to Manufacturing System	CO1	10	4	4	6	14
2	II	Group Technology (GT)	CO2	14	2	6	4	12
3	III	Flexible Manufacturing System (FMS)	CO3	12	4	6	10	20
4	IV	Computer Integrated Manufacturing (CIM) System	CO4	14	2	4	8	14
5	V	Lean Manufacturing System	CO5	10	2	4	4	10
Grand Total				**60**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning 25 Marks.
- Two-unit tests of 30 marks and average of two-unit tests.

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning.
- End semester assessment 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	-	-	1	1	1	1			
CO2	3	-	-	2	1	1	1			
CO3	3	2	-	1	1	1	1			
CO4	3	3	-	1	1	1	1			
CO5	3	-	-	1	1	2	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	Stanley B. Gershwin	Manufacturing Systems Engineering	First Edition, PTR Printice Hall, New Jersey (ISBN No. 978-0135606087)
2	Mikell P. Groover	Fundamentals of Modern Manufacturing	Fourth Edition, Wiley, USA (ISBN No. 978-0470467008)
3	Vajpayee S. K.	Principles of Computer-Integrated Manufacturing	First Edition, Prentice Hall India Learning Private Limited (ISBN No. 978-8120314764)
4	H. K. Shivanand	Flexible Manufacturing Cells and System	First Edition, New Age International Publishers (ISBN No. 978-8122472677)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.leanproduction.com/tpm/	Total Productive

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Sr.No	Link / Portal	Description
		Maintenance
2	https://www.ascm.org/topics/lean-manufacturing/	Lean Manufacturing
3	https://www.unleashedsoftware.com/blog/flexible-manufacturing-in-2021-flexible-manufacturing-systems-explained/	Flexible Manufacturing System
4	https://onlinecourses.nptel.ac.in/noc23_me86/preview	NPTEL Course on Manufacturing Systems Technology I & II
5	https://onlinecourses.nptel.ac.in/noc20_me44/preview#:~:text=In%20this%20course%2C%20Computer%20Integrated%20Manufacturing%20%28CIM%29%20approaches,is%20also%20the%20need%20of%20contemporary%20manufacturing%20systems.	NPTEL Course on Computer Integrated Manufacturing
6	https://egyankosh.ac.in/bitstream/123456789/27217/1/Unit-1.pdf	Process Planning
7	https://www.swipeguide.com/insights/waste-lean-manufacturing	Seven Types of waste in Lean Manufacturing

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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