GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-V

Course Title: Advance Manufacturing System
(Course Code: 4351906)

Diploma program in which this course is offered	Semester in which offered
Mechanical & Mechatronics Engineering	5th Semester

1. RATIONALE

Manufacturing processes converts raw material to finished product for customer usage. Now a day's customer is the king in the market and needs and desires of customer has increased the varieties and features in products. This has increased the complexities at almost all the stages of manufacturing. In modern manufacturing system it is very important to listen voice of customer and deploy his needs in entire manufacturing system. In modern era of the liberalized economy, we are facing world class competition in our own country. Global industries in the form of advanced manufacturing systems, is compelling Indian industries to reorganize their manufacturing strategies for competing on the dimensions of cost, quality, flexibility and deliverability. Hence it is important for us to understand the various modern-manufacturing systems available today.

Recent advance manufacturing system /techniques / electronics devices provide precision machine control compare to conventional machines. With higher accuracy quality and productivity. Objective of leaning this subject is to make aware the students about the advance manufacturing practices/systems being implemented at leading industries across the globe, which ultimately leads to more customer satisfaction in terms of low cost and high quality.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

• Identify and use the proper manufacturing systems to manufacture products with available resource at internationally competitive price with innovation, creativity and better quality.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following Cos.

CO-1	Identify role of computers and information technology in manufacturing systems with concept of technological life cycle and product life cycles.
CO-2	Develop an FMS (Flexible Manufacturing System) layout for given simple part family, using group technology concepts to and make proper grouping as per

	their attributes.
CO-3	Recognize use of Automation and control technology in industries.
CO-4	Discuss use of robotics Industrial automation, programmable logic controllers in modern manufacturing system and Industry 4.0
CO-5	Describe application of recent trends in modern manufacturing system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Total Credits	Examination Scheme				
				Theory Marks		Practical Marks		Total
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T– Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'**are compulsory, as they are crucial for that particular CO at the 'Precision level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	**Presentation on "How it's made" with type of manufacturing process and system** Faculty will assign any one part from Annexure-I. (Each student will have different part in a batch). Student will download movies/content and will present with the concept "How it's made.	1	02
02	**Development of GT codes:** Faculty will ask each student to bring at least one component having mechanical features and having more than 5-6 machining operations. Each student will also prepare the drawing and process plan (As per attached Annexure-II). Then the data will be interchanged by batch students. Collection of parts and making drawing and	2	04

	process plans will be as home assignment. Faculty will assign this task in very first period of practice. Students would: a. Prepare drawing of part brought by the student. b. Prepare process plan as per Annexure-II for the part brought by student. c. Interchange part drawings and process plans. (No photo copies are allowed. Each student in a batch will have total drawings and process plans equal to number of students in a batch who have brought parts. This may be also given as home assignment). d. Prepare feature matrix. Select GT coding system and assign GT code to each.		
03	**Preparation of FMS layout: Students would:** a. Develop part family (May be 3-6 parts) from all parts. (Taken in Ex. No. 2 above.) This is to be carried out logically from feature matrix. b. Assume quantities of each part of part family developed in an above. c. Assume additional data for following: i. Number of shifts and working hours in each shift. ii. Average number of working days in a month. iii. Utilization factor of FMS unit. d. Prepare process time matrix. e. Determine type and number of work stations. Perform necessary calculations and prepare conceptual FMS layout.	3	04
04	Prepare report/Case study on Industrial Automation and process control system.	4	02
05	**Demonstration:** Students would: a. Demonstrate working of following: i. Robot-anyone. ii. Sensors-each one from force & torque type, velocity and acceleration type, proximity type, position type and vision type. iii. Programmable logic controller (PLC). b. Sketch following. i. Configuration sketch of robot demonstrated. ii. Working sketch of sensors demonstrated. iii. Block diagrams of PLC.	5 & 7	04
06	**Industry 4.0** Prepare report /Case study on Industry 4.0	6	02
07	Demonstration and simulation of computer integrated manufacturing system on various free access software.	8	02
08	Prepare report /Case study on lean manufacturing and	8	02

	green manufacturing.		
09	Prepare report/Case study on Computer aided process planning and concurrent engineering.	8	02
10	**Industrial visit and report :** Students would: Visit any one advanced manufacturing system/CAD-CAM/ Robotics/Additive manufacturing based industry/Centre of excellence/Exhibition and prepare brief report on it.	ALL	02
11	**Seminar presentation:** Students would: Prepare and present seminar topic individually. (Seminar topic has to be given by faculty).	ALL	02
Total (Hours)		**-**	**28**

Note:

I. More Practical Exercises can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list.

II. Care must be taken in assigning and assessing the study report as it is a Second-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data (which and why) before the group starts their market survey.

The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed Practical Exercises of this course, which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Demonstration type PrOs (PrOs Number: 5 & 6)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	25
4	Punctuality	15
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Experimentation/performance type PrOs (PrOs Number: 2,3,4,7 & 8)		
1	Knowledge	20
2	Procedure follows	30
3	Observation Skill	20
4	Conclusion/ Summary	10
5	Quality of Report	10
6	Punctuality	10
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
Presentation type PrOs (PrOs Number: 1,10)		
1	Presentation & Organization	25

2	Content (MATTER+PPT)	20
3	Subject Knowledge	20
4	Communication Skill (VERBAL+NONVERBAL)	25
5	Time Taken	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 5 & 6)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labeling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing
Participation	25%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Punctuality	15%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

Experimentation/performance type PrOs (PrOs Number: 2,3,4,7 & 8)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or more	Student give the correct answers between 70-89%	Student give the correct answers between 50-69%	Student give the correct answers less than 50%
Procedure follows	30%	Student follow all the	Student follow all the	Student follow all the	Student follow all the

		procedure with precaution in a logical order	procedure with some precaution in a logical order	procedure without precaution in a logical order	procedure without precaution in an illogical order
Observation Skill	20%	Excellent focused attention in the exercise	Moderately focused attention on exercise	Focused limited attention in the exercise	Participation is minimum
Conclusion/ Summary	10%	Student concept is mostly clear	Student concept is partly clear	Student concept is somewhat clear	Student concept is not clear
Quality of Report	10%	Neat Handwriting, figure, and table. Complete labeling of figure and table	Only formatting is not proper (Location of figures/tables, use of pencil and scale)	A few required elements (labelling/ notations) are missing	Several require elements (content in paragraph, labels, figures, tables) are missing
Punctuality	10%	Timely Submission	Submission late by one laboratory	Submission late by two laboratories	Submission late by more than two laboratories

Presentation type PrOs (PrOs Number: 1,10)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Presentation & Organization	25%	Student shows enthusiasm and presents information in logical, interesting sequence which engages the audience	Student presents information in logical sequence which audience can follow	Audience has difficulty following presentation because student jumps around	Delivery not smooth and audience attention lost because there is no sequence of information
Content (MATTER + PPT)	20%	Accurate and in depth information, sufficient amount of information, proper citing of resources	Accurate information, sufficient information, some resources not cited	Some information is inaccurate, sufficient information, some resources are not cited	Information is inaccurate, most sources are not cited
Subject	20%	Student	Student is at	Student is	Student does

Knowledge		demonstrates full knowledge (more than required) and answers all questions with explanations and elaboration	ease with information and gives expected answers to all questions, but fails to elaborate	uncomfortable with information and is able to answer only rudimentary questions	not have grasp of information; student cannot answer questions about subject
Communication Skill (VERBAL + NONVERBAL)	25%	Student mumbles, incorrectly pronounces terms, and speaks too quietly for students in the back of class to hear	Student's voice is low. Student incorrectly pronounces terms. Audience members have difficulty hearing presentation	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear presentation	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation
Time Taken	10%	The presentation was of the proper duration	Presentation speech is 10% short or over the allotted time	Presentation speech is 20% short or over the allotted time	Presentation speech is 30% or more short or over the allotted time

6. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrO is a guide to procure them by the administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1	Kits on robotics.	5
2	Set of sensor / transducer demonstration and operation trainer kit. (This should include sensors/transducers as per syllabus.)	5
3	Analog to digital and digital to analog trainer modules.	5
4	Digital logic trainer board.	5
5	PLC trainer or Demo software	5

7. AFFECTIVE DOMAIN OUTCOMES

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the COs mentioned above and PrOs. More could be added to fulfill the development of this course competency.

a. Work as a leader/team member.
b. Follow safety practices.
c. Follow ethical practices
d. Maintain tools and equipment.
e. Practice environment-friendly methods and processes (Environment related).

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's Affective Domain Taxonomy, should gradually increase as planned below:

I. Valuing Level in 1st year
II. Organization Level in 2nd year.
III. Characterization Level in 3rd year.

8. UNDERPINNING THEORY

Based on the higher level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes(UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Introduction.**	1a. Develop familiarity with manufacturing systems and its features. Components and types. 1b. Describe role of computers in manufacturing industries. 1c. Identify the stage of given product on product life cycle. 1d. Identify the stage of specified technology on technology life cycle. 1e. Explain the need to manufacture products at international competitive price with better quality & Innovation.	1.1 Manufacturing system definition & Features of Manufacturing system. 1.2 History of the industrial revolution and Manufacturing evolution. 1.3 Components and types of manufacturing system. 1.4 Role of computers and information technology in manufacturing and manufacturing systems. 1.5 Product life cycle its importance &Technology life cycle. 1.6 Scope, trends and challenges in Indian and global market.
Unit – II	2a. Select type of production layouts for given parts.	2.1 GT - concept, definition, need, scope, & benefits. 2.2 Production layout-types,

Group Technology (GT) & Cellular Layout.	2b. Select and develop GT codes for given parts. 2c. Identify features and develop part families of the given parts. 2d. Prepare cell layout of given part family.	features and applications. 2.3 GT Layout -concept, need, benefits, comparison with conventional layout with examples. 2.4 GT- codification systems- types, method of coding and examples. 2.5 Part features- concept, types and examples. 2.6 Part family- concept, method to form and approach to form cell using part families. 2.7 Types and comparison of cell: manual and automatic cell, assembly cell. 2.8 Cell layout.
Unit – III **Flexible Manufacturing Cell and System.**	3a. Identify role of major Elements of FMC/FMS. 3b. Explain Major Elements of FMC/FMS. 3c. Develop simple FMC/FMS layout for given data and family of components. 3d. Illustrate cases in which flexible manufacturing systems are effectively applied and suggest possible applications.	3.1 Flexible Manufacturing Cell (FMC) System (FMS) a – concept, definition and comparison with other manufacturing systems. 3.2 Major elements of F M C / FMS and their functioning: i. Tool handling system. ii. Material handling system. iii. Automated guided Vehicles (AGV). iv. Automated storage and retrieval system (AS/RS). v. Main frame computer. 3.3 FMS layout - concept, types and applications. 3.4 Data required developing an FMS layout. 3.5 Signal flow diagram and line balancing in FMS. 3.6 Alternatives Approaches to flexible manufacturing system.
Unit – IV **Automation and control technology**	4a. Identify basic elements of an automated system. 4b. Explain various level of Automation. 4c. Explain Industrial control	4.1 Introduction to Automation &Basic elements of Automated System. 4.2 Level of Automation. 4.3 Introduction to Industrial

	system. 4d. Identify difference between process industries and discrete manufacturing. 4e. Identify Control technology.	control system. 4.4 Process industries verses discrete manufacturing. 4.5 Continuous verses discrete control. 4.6 Sensors and Actuators used in Automation.
Unit – V **Robotics.**	5a. Identify the basic parts of a Robot. 5b. Differentiate between different robotic configurations and their functions. 5c. Identify different types of sensors used in Robotics. 5d. List the three general areas of industrial robot application. 5e. Evaluate the use of robots in manufacturing Industries.	5.1 Robots-concept, definition, benefits and various areas of application in Manufacturing systems. 5.2 Terminology used in Robotics. Robots-types, physical configuration, classification and selection criterion. 5.3 Axes nomenclature of Robots. Types and uses of Manipulators & Grippers. 5.4 Sensors- types, classifications, working principle and applications of position, force & torque, proximity, vision, velocity & acceleration sensors. 5.5 Overview of robot programming methods & languages.
Unit – VI **Discrete control Programmable Logic Controller (PLC)**	6a. Identify need of process control logic control and sequence control. 6b. Explain the various components of a 6c. Explain about need and types of PLC. .	6.1 Introduction to Discrete Process Control. 6.2 Logic Control. 6.3 Sequence Control. 6.4 Introduction and need of Programmable Logical Controller (PLC). 6.5 Components of PLC. .
Unit –VI **Industry 4.0**	7a. To impart basic idea in Industry 4.0. 7b. To provide students knowledge of need design principle of	7.1 Historical evolution, origin and key understandings of Industry 4.0 7.2 Need, Design principal

	Industrial 4.0 7c Identify and aware with various technologies of Industry 4.0	and current and future trends in Industry 4.0 7.3 .Industry 4.0 Technologies 7.4 Environmental Management and its technology in Industry 4.0
Unit – VIII **Recent Trends in manufacturing system.**	8a. Identify the applications of various advance techniques used in Manufacturing. 8b. Identify and aware with environmental friendly Manufacturing system.	8.1 Computer Aided Process Planning (CAPP) – concept, types, features, methods and importance and introduction to concurrent engineering. 8.2 Computer Integrated Manufacturing (CIM): need, block diagram, functional areas covered and their importance. Computer Aided Inspection (CAI) – concept, benefit, types, working and examples. Coordinate Measuring Machine (CMM) - its working and applications. Concept of reverse engineering. 8.3 Factory of future (FOF) and smart factory. 8.4 Artificial intelligence concept, definition and application areas. 8.5 Lean Manufacturing and waste reduction, Toyota Production System principles and Methodologies. 8.6 Just in Time (JIT) manufacturing – Pull and push types of manufacturing systems. 8.7 Green Manufacturing. 8.8 Additive manufacturing: concept and types

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching	Distribution of Theory Marks

		Hours	R Level	U Level	A Level	Total Marks
I	Introduction.	04	02	04	00	06
II	Group Technology (GT) & Cellular Layout.	06	03	03	06	12
III	Flexible Manufacturing System (FMS).	06	03	03	06	12
IV	Automation and control technology.	04	04	02	00	06
V	Robotics.	06	04	03	03	10
VI	Discrete control Programmable Logic Controller (PLC).	04	03	03	00	06
VII	Industry 4.0	04	03	03	00	06
VIIi	Recent Trends in Manufacturing system.	08	06	06	00	12
		42	**27**	**28**	**15**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student- related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course.

Sr. No.	Activity
1	Prepare a list of mechanical features based innovative product/products in the market that faces challenges related to quality or cost.
2	Prepare a list of mechanical features based creative ideas that can be converted into products.
3	Visit nearby industry or other technical institute (having more infrastructure and facilities) and present a case study covering the scope of this subject.
4	Visit or participate in the technical events, exhibition, conference, seminar (with Presentation).
5	Collect / download videos / presentations / case study on advances in Manufacturing systems.
6	Watch innovative technical shows or documentary on television or other social media.
7	Download and study at least two research paper related to advance manufacturing system and write review on it.
8	Participation in various technical events, project competition, quiz organized by various technical institute in state.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (If any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Sr. No.	Unit No.	Unit Title	Strategies
1	I	Introduction.	Presentation, Video.
2	II	Group Technology (GT) & Cellular Layout.	Presentation, Video, Assignment, Industrial Visit, demonstration of real parts with features identification.
3	III	Flexible Manufacturing System (FMS).	Presentation, Video, Simulated models.
4	IV	Automation and control technology.	Presentation, Video, Simulated models.
5	V	Robotics.	Demonstration, Video, Presentation, Industrial Visit, Mini Project.
6	VI	Industry 4.0	Demonstration, Video, Presentation, Industrial Visit, Mini Project
7	VII	Discrete control Programmable Logic Controller (PLC).	Demonstration, Video, Presentation, Simulated models.
8	VIII	Recent Trends in Manufacturing system.	Video, Case study, Industrial Visit, Seminars. Various softwares

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-projects are group-based (groups of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed here**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more Cos which are, in fact, an integration of PrOs, Uos, and ADOs. Each student must maintain a dated workdiaryconsistingofindividualcontributionstotheprojectworkandgiveaseminarpresentationbefore submission. The duration of the micro project should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit a micro-project by the end of these semesters to develop the industry-oriented Cos.

A representative list of micro-projects is given here. This has to match the competency and the Cos. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty could add similar micro-projects in any form (chart/presentation/report/model):

List of Sample Micro project (Indentify similar type of micro project by Faculty)

Sr. No.	Unit No.
1	Prepare detail report on history of manufacturing.
2	Prepare detail list of various industries with its main products.
3	Code the given part using GT coding system.
4	Prepare simple FMS layout based on given inputs.
5	Prepare simple ladder diagram for given conditions for PLC.
6	Select the suitable sensor for given conditions.
7	Identify various terminologies with robot model/sketch.
8	Select the suitable sensor for given conditions.
9	Sketch geometrical configuration of given type of robot.
10	Identify robotic elements. Select suitable gripper for given part.
11	Identify various terminologies with robot model/sketch.
12	Identify 7 waste in nearby industry and apply principal of lean manufacturing.
13	Prepare detail report on history of Flexible manufacturing system and group technology.
14	Prepare Case study on rank order clustering method for group technology.
15	Prepare detail report with example group technology machine sequence method.
16	Identify various additive manufacturing process and system and prepare report

- **Faculty member can give their own creative and innovative micro project related to subject and topic covered**

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	CAD/CAM/CIM	P. Radhakrishnan & S. Subranarayan	New Age Intentional
2	Computer Integrated Design & Manufacturing	Bedworth, Wolfe and Anderson	McGraw Hill International Publication
3	Mechatronics	-	HMT
4	Introduction to Robotics	Arthur J. Critchlow	McMillan publication
5	Robotics for engineers	Yorom Koran	McGraw Hill Publication
6	Computer aided manufacturing	Rao, Tiwari & Kundra	Tata McGraw Hill Publication
7	Computer Aided Design & Manufacturing	Dr. Sadhu Singh	KP
8	Computer Integrated Manufacturing	S. K. Vajpayee	PHI
9	Automation, Production and Computer integrated Manufacturing	Mikell P. Groover	PHI
10	Mechatronics	Bradleg and Offers	Chapman and Hall
11	Practical Robotics	William C. Burns Jr. & Janet Evans Worthington	PHI
12	Lean Six Sigma Pocket Tool book	George Metal	McGraw-Hill Publishers
13	Materials and Processes in Manufacturing	E.P. DeGarmo, J.T. Black, R. Kohser & B. Klamecki	Hoboken, NJ: John Wiley & Sons Inc.
14	Industrial Automation and Robotics	A.K.Gupta S.K.Arora JR.Wescott	Mercury learning and Information
15	Industry 4.0 Current Status and Future Trends	Edited by Jesús Hamilton Ortiz	Intech Open(Published in UK)

14. SOFTWARE/LEARNING WEBSITES

I. http://www.vlab.com
II. http://www.mtabindia.com
III. www.cadcim.com
IV. https://www.leanproduction.com/
V. https://intelitek.com
VI. https://instrumentationtools.com/plc-trainer-demo-download

VII. https://www.siemens.com/global/en/products/automation
VIII. https://www.tinkercad.com/

15. PO-COMPETENCY-CO MAPPING

Advance Manufacturing System (Course Code: 4351906)							
Competency & Course Outcomes	**POs and PSOs**						
	PO 1 Basic & Discipline specific knowledge	**PO 2** Problem Analysis	**PO 3** Design / development of solutions	**PO 4** Engineering Tools, Experimentation &Testing	**PO 5** Engineering practices for society, sustainability & environment	**PO 6** Project Management	**PO 7** Life-long learning
CO 1: Explain role of computers and information technology in manufacturing systems with concept of technological life cycle and product life cycles.	3	-	-	-	-	-	3
CO 2: Develop an FMS (Flexible Manufacturing System) layout for given simple part family, using group technology concepts to and make proper grouping as per their attributes.	3	2	2	2	-	-	2
CO 3: Recognize use of Automation and control technology in industries.	3	3	2	3	2	-	3
CO 4: Recognize use of robotics Industrial automation, programmable logic controllers in modern manufacturing system.	3	2	3	3	2	2	2
CO 5: Recognize use of recent trends in modern manufacturing system.	3	-	-	-	-	2	2

Legend: '3' for high, '2' for medium, '1' for low ,and '-'f or no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Vinitkumar K. Modi	B.& B Institute of Technology, Vallabh Vidyanagar	9428661810	modi_vinit@yahoo.com
2.	Vimalkumar Palsanwala	Dr. S & S S Ghandhy College of Engineering and Technology, Surat	9824703832	vppalsanawala@rediffmail.com
3.	Suhailkhan Zafarullakhan Pathan	Government Polytechnic, Jamnagar	9925479189	er.suhailkhan@gmail.com

17. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS (Chairman & HOD Mechanical Engineering)	Government Polytechnic, Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel (BOS Member & HOD Mechanical Engineering)	B. & B. Institute of Technology, Vallabh Vidyanagar	9825523982	rakeshgtu@gmail.com
3.	Dr. Atul S.Shah (BOS Member & Principal)	B. V. Patel Institute of Technology, Bardoli	7567421337	Asshah97@yahoo.in

ANNEXURE – I

LIST OF PARTS FOR "HOW IT'S MADE"

SR. NO.	TOPIC	SR. NO.	TOPIC
1	Glass.	31	Plastic bags.
2	Capsules (medicine).	32	PVC room/mobile house.
3	Tablets (medicine).	33	Pipes-ERW, seam less, PVC/steel, small to very large size.
4	Safety pin.	34	Oil paint.
5	Plastic chair.	35	Refilling of gas cylinders.
6	Springs.	36	Televisions / computer monitors.
7	Chain (cycle).	37	Drug (liquid) manufacturing.
8	Bearings.	38	Diamond polishing.
9	Plastic bottle.	39	Lamps- conventional (resistance).
10	Milk/oil pouch packaging.	40	CFL lamps.
11	PCBs.	41	LED lamps.
12	Nut/bolts.	42	Car assembly.
13	Crank shaft.	43	Truck assembly.
14	Piston/cylinder.	44	Aero plane assembly.
15	Vitrified tiles.	45	Screw Driver
16	Electrical wires / cables.	46	Glass bottles
17	Steel wire ropes.	47	Flange couplings
18	Electrical switches.	48	Worm Gear
19	Pouch printing.	49	Helical Gear
20	Cloth manufacturing. (Textile).	50	Mobile phone
21	Cloth printing (Textile).	51	Turbine Blade
22	Embroidery machine working.	52	Direction Control valves
23	Bottling. (Of soda, beverages, etc.)	53	Pulley and Belt
24	Lathe bed.	54	Screw Conveyor
25	Bikes engine.	55	Stepper Motor
26	Computer’s hard disc.	56	Servo motor
27	Circlips.	57	Piston and piston ring
28	Oil seals.	58	Spark plug
29	Semiconductors.	59	Carburetor
30	Product made from Micro machining.	60	Any other specified by faculty

ANNEXURE –II

PROCESS SHEET/DETAILS- TO BE MADE FOR EACH PART SEPARATELY.

Part No/Id:		**Raw material:**	
Name of the Part:		**Raw weight:**	
Drawing No:		**Finished wt:**	

Op. No	**Name of Operation**	**Size, tolerance, surface finish, etc. required**	**Machine details**	**Machining Parameters**			**Tools, Jig, Fixture, coolant, etc. required**	**Measuring instruments required**	**Locating surface (Give surface**	**Clamping surface (Give surface**	**Time**		**Remarks**
				speed	**feed**	**Depth of cut**					**Set up (Min.)**	**Machining (Min.)**	