GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: MANUFACTURING SYSTEMS
(COURSE CODE: 3361904)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	Sixth

1. RATIONALE.

Manufacturing processes converts raw material to finished product for customer usage. Customer is the key player in 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. Performance of a product depends on its quality in terms of accuracy of size, shape and constraints/relation between its features. Conversion cost and time can be optimized by judicious usage of energy, motions, resources, time etc without affecting the quality desired by the customer.

Manual operations have limitations in terms of power, precision and repetitions. Recent techniques / electronics devices provide precision machine control compare to conventional machines. Objective of leaning this subject is to make aware the students about the advance manufacturing practices/methods being implemented at leading industries across the globe, which ultimately leads to more customer satisfaction in terms of low cast and high quality.

2. COMPETENCY.

The course content should be taught and implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Identify and use the proper manufacturing systems to manufacture products at internationally competitive price with innovation and better quality.**

3. COURSE OUTCOMES (COs).

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Explain role of computers and information technology in manufacturing systems.
ii. 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.
iii. Recognize use of robotics, programmable logic controllers, microcontrollers and recent advances in the field of manufacturing.

4. TEACHING AND EXAMINATION SCHEME.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

5. COURSE CONTENT DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Introduction.**	1a. Develop familiarity with transformation and manufacturing systems. 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 Evolution of transformation & manufacturing systems. 1.2 Need of attitude, knowledge & skill required for application of manufacturing systems. 1.3 Need for system approach. 1.4 Role of computers and information technology in manufacturing and manufacturing systems. 1.5 Product life cycle & its importance. 1.6 Technology life cycle. 1.7 Scope, importance and challenges in Indian context to manufacture products at international competitive price with better quality& innovation.
Unit – II **Group Technology (GT) & Cellular Layout.**	2a. Select type of production layouts for given parts. 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.	2.1 GT - concept, definition, need, scope, & benefits. 2.2 Production layout-types, 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 Steps of cell design and cell layout.
Unit – III	3a. Identify role of major elements of FMS. 3b. Develop simple FMS layout for given data	3.1 Flexible Manufacturing System (FMS) –concept, definition and comparison with other manufacturing systems.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Flexible Manufacturing System (FMS).	and family of components.	3.2 Major elements of 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 FMS layout illustrations (Minimum two).
Unit – IV **Robotics.**	4a. Describe the importance of robotics in industry. 4b. Select appropriate sensor for given application.	4.1 Robots-concept, definition, benefits and various areas of application in manufacturing systems. 4.2 Terminology used in robotics. 4.3 Robots-types, physical configuration, classification and selection criterion. 4.4 Axes nomenclature. 4.5 Types and uses of Manipulators & Grippers. 4.6 Sensors- types, classifications, working principle and applications of position, force & torque, proximity, vision, velocity & acceleration sensors. 4.7 Overview of robot programming methods & languages.
Unit – V **Programmable Logic Controller (PLC) & Micro-Controllers (MC).**	5a. Explain the need and importance of PLC and microcontrollers used in various equipments. 5b. Select appropriate control system for given situation. 5c. Prepare the circuit diagram for given condition using logic gates.	5.1 Role of control system in instrumentation 5.2 Open and close loop control system, types and block diagram. 5.3 Servomechanism and regulators with suitable examples. 5.4 Basic control actions - on-off, proportional, derivative, integral control, proportional derivative (PD), proportional integral (PI), p proportional integral and derivative (PID) control. 5.5 Basic digital logic gates: symbol, operation, truth-table and examples of

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR gates. 5.6 PLC: Concept, general constructional features, types of diagrams, working and major applications in manufacturing systems. 5.7 Use of SCADA (Supervisory Control And Data Acquisition) in PLC design. 5.8 Microcontrollers: introduction, hardware components, i/o pins, ports; selection of micro controllers & embedded controllers, applications.
Unit – VI **Recent Trends**	6a. Identify the applications of various advance techniques used in manufacturing	6.1 Computer Aided Process Planning (CAPP) - concept, types, features, methods and importance. 6.2 Computer Integrated Manufacturing (CIM): need, block diagram, functional areas covered and their importance. 6.3 Protocols in CIM- their features, functions and applications. 6.4 Computer Aided Inspection (CAI) - concept, benefit, types, working and examples. Coordinate Measuring Machine (CMM) - its working and applications. 6.5 Rapid Prototyping (RP): working principles, methods, applications and limitations, rapid tooling, techniques for rapid prototyping. 6.6 Artificial intelligence- concept, definition and application areas, neural network: working principles, applications and limitations. 6.7 Lean manufacturing - concept, sources of waste, benefits and applications. 6.8 Factory of future (FOF).

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY).

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	04	02	04	00	06

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II	Group Technology (GT) & Cellular Layout.	06	04	04	04	12
III	Flexible Manufacturing System (FMS).	06	04	04	04	12
IV	Robotics.	10	07	04	04	15
V	Programmable Logic Controller (PLC) & Microcontrollers.	10	07	04	04	15
VI	Recent Trends.	06	06	04	00	10
	Total	42	30	24	16	70

Legends: R = Remember U= Understand; A= Apply and above levels (Bloom's revised taxonomy).

Notes:

a. This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.
b. If mid-sem test is part of continuous evaluation, unit numbers I, II, IV and VI are to be considered.
c. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of Course Outcomes related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours. required
1	--	**Presentation on "How it's made":** 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". Note: Each student will make his/her folder having the name as <batch number_Enrollment number> and will save his/her	04

		downloaded content. A DVD is to be made which will contain folders of all students. Same DVD is to be submitted.	
2	II	**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 process plans will be as home assignment. Fcaulty 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. e. Select GT coding system and assign GT code to each part.	04
3	III	**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 a. 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. Utilisation factor of FMS unit. d. Prepare process time matrix. (Suggested format is attached as per Annexure-III). e. Determine type and number of work stations. f. Perform necessary calculations and prepare conceptual FMS layout.	06
4	IV	**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. PLC-anyone. iv. MC-anyone. v. Control system-anyone. b. Sketch following. i. Configuration sketch of robot demonstrated. ii. Working sketch of sensors demonstrated. iii. Block diagrams of PLC and MC demonstrated. iv. Circuit diagram of control system demonstrated.	06

5	All	**Mini project (In the group of 4-6 students):** Students would: a. Prepare at least one from the following (as approved by the faculty): i. Prepare simple circuit using application of sensor. ii. Prepare simple robot using available kit. iii. Prepare ladder diagram for any one real life PLC application. iv. Build and operate the functionality of basic or advance logic gates. b. Prepare report which includes sketches, specifications, observation tables, parameters, truth tables, applications, etc. (as applicable). c. Present the project.	04
6	All	**Industrial visit and report :** Students would: Visit any one advanced manufacturing system /CAD-CAM based industry/centre of excellence/exhibition and prepare brief report on it.	04
		Total Hours	**28**

Notes:

a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.PA component of practical marks is dependent on continuous and timely evaluation and submission of exercises.
b. Term work report must not include any photocopy /ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. Mini project and presentation topic/area has to be assigned to the group of specified students in the beginning of the term by batch teacher.
d. For practical ESE part, students are to be assessed for competencies achieved. They should be given to:
    i. Code the given part using GT coding system.
    ii. Identify the features of given part.
    iii. Prepare simple FMS layout based on given inputs.
    iv. Prepare simple circuit diagram for given conditions using logic gates.
    v. Prepare simple ladder diagram for given conditions for PLC.
    vi. Select the suitable sensor for given conditions.
    vii. Identify robotic elements. Select suitable gripper for given part. Sketch geometrical configuration of given type of robot. Identify various terminologies with robot model/sketch.

8. SUGGESTED LIST OF STUDENT ACTIVITIES.

Sr. No.	Activity
i.	Prepare a list of mechanical features based product/products in the market that faces challenges related to quality or cost; but has a market potential.
ii.	Visit nearby industry and present a case study covering the scope of this subject.
iii.	Visit or participate in the technical events, exhibition, conference, seminar (with presentation).
iv.	Collect / download videos / presentations / case study on advances in manufacturing systems.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr. No.	Unit	Unit Name	Strategies
i.	I	Introduction.	Presentation, Video.
ii.	II	Group Technology (GT) & cellular layout.	Presentation, Video, Assignment, Industrial Visit, demonstration of real parts with features identification.
iii.	III	Flexible Manufacturing system (FMS).	Presentation, Video, Simulated models.
iv.	IV	Robotics.	Demonstration, Video, Presentation, Industrial Visit, Mini Project.
v.	V	Programmable Logic Controller (PLC) & Microcontrollers.	Demonstration, Video, Presentation, Industrial Visit, Mini Project.
vi.	VI	Recent trends.	Video, Case study, Industrial Visit, Seminars.

10. SUGGESTED LEARNING RESOURCES.

A. List of Books:

S. No.	Title of Book	Author	Publication
i.	CAD/CAM/CIM.	P. Radhakrishnan & S. Subranarayan.	New Age Intentional
ii.	Computer Integrated Design & Manufacturing.	Bedworth, Wolfe and Anderson	McGraw Hill International Publication.
iii.	Mechatronics.	-	HMT
iv.	Introduction to Robotics.	Arthur J. Critchlow	McMillan publication
v.	Robotics for engineers.	Yorom Koran	McGraw Hill Publication
vi.	Computer aided manufacturing.	Rao, Tiwari & Kundra.	Tata McGraw Hill Publication
vii.	Computer Aided Design & Manufacturing.	Dr Sadhu Singh.	KP
iii.	Computer Integrated Manufacturing.	S.K.Vajpayee.	PHI
ix.	Automation, Production and Computer integrated Manufacturing.	Mikell P. Groover.	PHI
x.	Mechatronics.	Bradleg and Offers.	Chapman and Hall
xi.	Practical Robotics.	Willium C. Burns Jr. & Janet Evans Worthington	PHI
xii.	Basic electronics.	Mehta ,V.K.	S.Chand Publication, New Delhi.

B. List of Major Equipment/ Instrument with Broad Specifications:

Sr.No.	Resource with brief specification.
i.	Kits on robotics.
ii.	Set of sensor / transducer demonstration and operation trainer kit. (This should include sensors/transducers as per syllabus.)
iii.	Analog to digital and digital to analog trainer modules.
iv.	Digital logic trainer board.
v.	PLC trainer.
vi.	Microcontroller trainer.

C. List of Software/Learning Websites.

i. http://www.vlab.com
ii. http://www.mtabindia.com
iii. http://www.nptel.ac.in

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics.

- **Prof. J. P. Parmar**, Lecturer in Mechanical Engineering, C. U. Shah Polytechnic, Surendranagar.
- **Ms A. Y. Pathak**, Lecturer in Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.
- **Prof. M. M. Jikar** HOD, Mechanical Engineering Department, N. G. Patel Polytechnic, Bardoli.
- **Prof. A. M. Talsaniya**, Lecturer in Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.

Coordinator and Faculty Members from NITTTR Bhopal.

- **Dr. K.K. Jain,** Professor, Department of Mechanical Engineering
- **Dr. A.K. Sarathe,** Associate Professor; Department of Mechanical Engineering.

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	Any other as specified by teacher.
16	Electrical wires / cables.		
17	Steel wire ropes.		
18	Electrical switches.		
19	Pouch printing.		
20	Cloth manufacturing. (Textile).		
21	Cloth printing (Textile).		
22	Embroidery machine working.		
23	Bottling. (Of soda, beverages, etc.)		
24	Lathe bed.		
25	Bikes engine.		
26	Computer's hard disc.		
27	Circlips.		
28	Oil seals.		
29	Semiconductors.		
30	Product made from Micro machining .		

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 numbers in sketch)	Clamping surface (Give surface numbers in sketch)	Time		Remarks
				speed	feed	Depth of cut					Set up (Min.)	Machining (Min.)	

ANNEXURE – III
PROCESS TIME MATRIX

PART NUMBER	QUANTITY PER UNIT TIME (MAY BE PER WEEK OR MONTH OR YEAR)	TIME PER PIECE (IN MINUTES) AND TOTAL TIME FOR GIVEN QUANTITY FOR MAJOR PROCESSES FROM WORK CENTRE POINT OF VIEW.													
		TURNING													
		TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME
TOTAL															

SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			II
	iv.		2			II
	v.			2		III
	vi.			2		III
	vii.				2	IV
	viii.				2	IV
	ix.		2			VI
	x.		2			VI
2	a.		7			IV
		OR				
	a.		7			IV
	b.			4		V
		OR				
	b.			4		V
	c.		3			V
		OR				
	c.		3			V
3	a.				4	II
		OR				
	a.				4	II
	b.				4	III
		OR				
	b.				4	III
	c.		3			V
		OR				
	c.		3			V
	d		3			VI
		OR				
	d		3			VI
4	a.				4	V
	a.				4	V
	b.		3			VI
		OR				
	b		3			VI
	c.			4		IV
	d			3		VI
5	a.			4		I
	b.			4		II
	c.		6			III