GOVERNMENT POLYTECHNIC MUMBAI

(Academically Autonomous Institute of Government of Maharashtra)

Department of Mechanical Engineering

P19R Curriculum

Fifth Semester

GOVERNMENT POLYTECHNIC MUMBAI

(Academically Autonomous Institute, Government of Maharashtra)

Teaching and Examination Scheme (P19R)

Programme: Diploma in Mechanical Engineering (Sandwich Pattern) **Term / Semester -V**

Course Code	Course Title	Teaching Hours/Contact Hours				Credits	Examination Scheme (Marks)						
							Theory			PR	OR	TW	Total
		L	P	TU	Total		TH	TS1	TS2				
ME19R405 ME19R406 ME19R407	**Optional Course-II** ***(Select any One)*** TOOL ENGINEERING INDUSTRIAL MAINTENANCE INVENTORY CONTROL	3	2	--	5	5	60	20	20	--	--	25	**125**
ME19R310	METROLOGY & QUALITY CONTROL	3	2	--	5	5	60	20	20	25*	--	25	**150**
ME19R305	CNC MACHINES & AUTOMATION	3	2	--	5	5	60	20	20	--	--	25	**125**
ME19R302	INDUSTRIAL HYDRAULICS AND PNEUMATICS	3	2	--	5	5	60	20	20	--	--	25	**125**
ME19R311	DESIGN OF MACHINE ELEMENTS	3	2	--	5	5	60	20	20	--	--	25	**125**
ME19R303	SOLID MODELING	--	4	--	4	4	--	--	--	25*	--	25	**50**
ME19R308	PROJECT	--	4	--	4	4	--	--	--	--	50*	50	**100**
ME19R501	ENTREPRENUERSHIP DEVELOPMENT & MANAGEMENT	--	2#	--	2	2	--	--	--	--	--	--	--
	Total	**15**	**20**	**--**	**35**	**35**	**300**	**100**	**100**	**50**	**50**	**200**	**800**
Total Contact Hours					**35**								

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral,TW: Term Work (progressive assessment)

***** Indicates assessment by External Examiner else internal practical skill test, #indicates self, on- line learning Mode, **@** indicates on line examination

Note: Duration of Examination--TS1&TS2 -1 hour, TH- 2 hours 30 min, PR/OR – 3 hours per batch, SCA- Library -1 hour, Sports- 2hours, Creative Activity-2 hours

# indicates Self, on- line learning Mode through MOOCs/Spoken Tutorials /NPTEL/SWAYAM/FOSSEE etc.

Department Coordinator, Curriculum Development,

Head of Department Dept. of Mechanical Engineering

In-Charge Curriculum Development

Principal

Programme : **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code: ME19R405				Course Title: Tool Engineering						
Compulsory / Optional: Optional										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hrs 30 min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**-**	**5**	**60**	**20**	**20**	**-**	**-**	**25**	**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR 26.

Rationale:

Engineering Manufacturing industry uses conventional machining processes on large scale. Technicians/ supervisors are required to possess knowledge and skills regarding selection of tooling & their geometry, selection of machining parameters, design or use of jigs, fixtures and press tools. The accuracy and economy of machining depends on the application of appropriate machining strategies.

In this context, the mechanical engineering diploma student must be well versed with tool materials, tool geometry, coolants, principles of jig/ fixtures design, press tool design etc. Also the student can find out specialized career option in the field of tool engineering.

Hence it is apt to study this course with the objective to develop the competency of selection of appropriate tooling.

Course Outcomes: Student should be able to

CO1	Select appropriate tool materials and cutting fluids
CO2	Apply basics of theory of metal cutting for given conditions
CO3	Choose proper tool geometry for single point cutting tools, twist drills, reamers and milling cutters
CO4	Design and use press tools for various operations
CO5	Develop and use the jigs and fixtures for given components
CO6	Develop basic features of forging die for given simple component

Course Content Details:

Unit No	Topics / Sub-topics
1	**Tool Materials & Cutting Fluids** 1.1 Need to develop newer tool materials, Desired properties of tool materials, Tool materials, their composition, and applications- HSS, Cemented Carbides, Coated carbides, Cast alloy tools, Ceramics, Cermets, CBN, Diamond 1.2 Heat zones in metal cutting, Desired properties of cutting fluids, Functions of cutting fluids, Types of cutting fluids, Factors considered in selection of cutting fluids, Cutting fluid maintenance, Methods of applications of coolants, mist as coolant, MQL, Dry machining Environmental issues with cutting fluids **Course Outcome: CO1 Teaching Hours: 06 Marks:10(R-2, U-4, A-4)**

Unit No	Topics / Sub-topics
2	**Theory of Metal Cutting** 2.1 Parameters: Speed, feed, depth of cut, Types of chips and factors responsible for formation, Concepts of Orthogonal & Oblique cutting, Chip thickness ratio, determination of shear angle, shear stress, Graphical determination of velocities in orthogonal cutting, 2.2 Forces in orthogonal cutting, Merchant's Circle construction and graphical estimation of various forces, angle of friction 2.3 Tool wear, types of tool wear, Tool life definition, Taylor's Equation of tool life, factors affecting tool life/ tool wear 2.4 Machinability: Definition, factors affecting machinability, Machinability Index, Surface finish & accuracy possible with various machining processes **Course Outcome: CO2 Teaching Hours:08 Marks:10(R-2, U-4, A-4)**
3	**Cutting Tool Geometry** 3.1 Tool geometry of single point cutting (SPC) tool, definitions and functions of various tool angles, Tool signature, Classification of SPC tools, Design of single point cutting tool, surface finish generated by SPC tool, Designation code of carbide inserts 3.2 Milling Cutter: Elements and Tool geometry of plain milling cutter, up milling, down milling, specifications of milling cutters 3.3 Twist Drills & Reamers: Elements & geometry of twist drill and reamer, specifications of drills & reamers 3.4 Various types of tool holders **Course Outcome: CO3 Teaching Hours:06 Marks:10(R-2, U-4, A-4)**
4	**Press Tool Design** 4.1 Sheet metal operations, Shearing, Clearance between die and punch, angular clearance, Calculation of blanking force and estimation of press capacity for blanking, Method of reducing punching force by providing shear on die and punch, Elements of press tools & their functions, Types of press tools- Simple, Progressive, compound, combination, scrap stripe layout for blanking operation, percent utilization of stock, center of pressure 4.2 Drawing, deep drawing, Estimation of drawing force, Percent reduction, Calculation of blank size, defects in drawing operation & remedies 4.3 Bending: Bending allowance, Spring back, Calculation of bending force 4.4 Materials for manufacture of press tools components 4.5 Safety in press operations, Maintenance & repairs of dies, **Course Outcome: CO4 Teaching Hours:10 Marks:10(R-2, U-4, A-4)**
5	**Jigs & Fixtures Design** 5.1 Definition of Jig, fixture, Need and advantages, Parts of jigs/ fixtures, Considerations in Jig/ fixture design, Principles of Location, Locating elements, tolerance on locating elements, Use of diamond pin locator, Principles of clamping, clamping elements, Indexing elements, Fool proofing of jigs and fixtures 5.2 Drill Jig types, Types of bushes, Development of jig for given component operation, clearances on bush, 5.3 Types of fixtures, Development of fixture for given component operation 5.4 Introduction to Jigs/ fixtures for Aerospace industry, fluidized bed fixtures, modular fixtures 5.5 History cards for all types of cutting tools, dies and J & F for maintenance & regrinds **Course Outcome:CO5 Teaching Hours:10 Marks:10(R-2, U-4, A-4)**

Unit No	Topics / Sub-topics
6	**Forging Die Design** 6.1 Types of forging, Advantages and limitations of forging, Applications **6.2** Types of forging dies, Constructional features of forging dies, materials for forging dies **6.3** Factors considered in design of forging dies **6.4** Types of Impressions in drop forging dies, Graphical method for developing edging impression **6.5** Development of simple forging die for drop forging and upset forging **Course Outcome:CO6 Teaching Hours:05 Marks:10(R-2, U-4, A-4)**

Suggested Specifications Table (Theory):

Level of questions: R: Remember, U: Understand, A: Apply

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Tool Materials & Cutting Fluids**	2	4	4	10
2	**Theory of Metal Cutting**	2	4	4	10
3	**Cutting Tool Geometry**	2	4	4	10
4	**Press Tool Design**	2	4	4	10
5	**Jigs & Fixtures Design**	2	4	4	10
6	**Forging Die Design**	2	4	4	10
	Total	**12**	**24**	**24**	**60**

List of experiments/ Assignments:

Sr. No.	Unit No	COs	Title of the Experiments/ Assignment	Hours
1	1	CO1	Determination of cutting fluid mixture composition and architecture of cutting fluid handling system of the machine tool	2
2	2	CO2	Graphical estimation of forces & velocities in metal cutting	2
3	3	CO3	Design of Single Point Cutting Tool and SPC tool grinding	4
4	4	CO4	Development of scrap stripe layout (Group Activity)	4
5	4	CO4	Design of simple blanking die (Press Tool) (Group Activity)	4
6	5	CO5	Development of Drilling Jig (Group Activity)	4
7	5	CO5	Development of Fixture (Group Activity)	4
8	6	CO6	Development of drop/ upset forging die for given component (Group Activity)	4
9	4	CO4	Evaluation of drawability of sheet metal by Erichsen Cupping test	2

Sr. No.	Unit No	COs	Title of the Experiments/ Assignment	Hours
10	4	CO4	Design of Drawing Die (Group Activity)	2
Total				**30**

Note: For group activities, size of group should be 3-4 students. Experiments No. 1 to 8 are compulsory, Minimum 09 experiments/ assignments shall be completed. Remaining experiments are to be performed as per importance of the topic/ availability of time. Teacher may arrange the industry visit/ expert lecture as instructional strategy.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Tool Engineering & Design	Nagpal G. R.; Khanna Publishers, 6th Ed, 2006	978-8174-0920-38
2	Tool Design	Cyril Donaldson, George H Lecaine, VC Goold, McGraw Hill Education; 4th Ed, 2012	978-0070-1539-29
3	A Text Book of Production Engineering	P.C. Sharma, S. Chand, 4th Ed, 2009	978-8121-9011-16
4	Manufacturing Technology, Vol 2, Metal cutting and machine tools	P. N. Rao, Tata McGraw-Hill Education, 2nd Ed, 2013	978-1259-0625-75
5	Jigs and Fixtures	P. H. Joshi, Tata McGraw Hill, 3rd Ed, 2010	978-1259-0612-26
6	Production Technology	HMT, McGraw Hill Education, 2017	978-0070-9644-33

E-References:

1. https://www.youtube.com/watch?v=DGlJs7YhVcw
2. https://www.youtube.com/watch?v=7MkX-sW97rI
3. http://astakhov.tripod.com/MC/Cutting-Fluids.pdf
4. https://universe.bits-pilani.ac.in/uploads/4%20metal%20cutting.pdf
5. https://uni.edu/~rao/Mfg%20Tooling%20-10%20Prog%20Tools-2.pdf
6. http://staff.uny.ac.id/sites/default/files/pendidikan/aan-ardian-mpd/1g-handbook-die-design-2nd-edition.pdf
7. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-33.pdf

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	3	3	3	2	3	3	3	3
CO2	3	2	2	3	2	2	3	2	2
CO3	3	3	3	3	3	2	3	3	3
CO4	3	3	2	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3
CO6	3	1	2	3	3	3	3	3	2

Industry Consultation Committee

Sr. No	Name	Designation	Institute/Organisation
1	Shri. Uday Kudtarkar	Sr. DGM (Tool Engineering)	L&T Ltd, Powai
2	Shri. Samir B. Shah	Director	Emkey Fastners, Thane
3	Shri. Pratap Paldhe	Director	Micrograde Tools, Ambarnath
4	Shri. S. T. Patil	Director	Friends Engineering, Pune
5	Mr. Hitesh Vaishnav	Assistant Professor	Fr. Conceicao Rodrigues College of Engineering, Bandra
6	Dr. V. P. Rathod	Lecturer in Mechanical Engineering	Government Polytechnic, Ratnagiri
7	Dr. Ketan Jagtap	Lecturer in Mechanical Engineering	Government Polytechnic, Vikramgad
8	Shri. U.A. Agnihotri	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai
9	Dr. V.U.Rathod	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator, Head of Department

Curriculum Development, Department of Mechanical Engineering

Department of Mechanical Engineering

I/C, Curriculum Development Cell Principal

Programme : **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code: ME19R406				Course Title: Industrial Maintenance						
Compulsory / Optional: Optional										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hrs 30 min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**--**	**--**	**25**	**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination

Note: For Minimum passing marks under various heads, refer, examination rule AR 26.

Rationale:

Maintenance is one of the important functions in any type of industry. Also every mechanical engineer should be aware of basic principles of maintenance and maintenance management. With the advancements in manufacturing processes, machine tools and other service sectors, the employment opportunities in the field of maintenance are increasing.

This course in industrial maintenance provides the opportunity to students to get familiar with the maintenance procedures of simple mechanical systems/ components, basics of maintenance management and new approaches like TPM, 5S.

Course Outcomes: Student should be able to

CO1	Describe basic terminology in maintenance practices
CO2	Describe & select appropriate maintenance strategy for given equipment
CO3	Describe basics of TPM & 5S
CO4	Describe the procedure for the maintenance of given mechanical systems or components
CO5	Describe the spares management norms for maintenance and describe lubrication activities
CO6	Describe the documentation used in maintenance activities in industries.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Basics of Maintenance Engineering** 1.1 Definition, Need & Importance of maintenance, basic terminology related to maintenance- Mean time between failure (MTBF), mean time to repair (MTTR), Terotechnology, Reliability 1.2 Objectives and functions of maintenance department, consequences of equipment failures 1.3 Costs of maintenance 1.4 Organizational structure for maintenance, skills required for maintenance activities **Course Outcome: CO1 Teaching Hrs: 06 Marks:06 (R-2, U-4, A-0)**

Unit No	Topics / Sub-topics
2	**Maintenance Systems/ Maintenance Strategies** 2.1 Factors considered in deciding criticality of equipment, Maintenance Plan Preparation, 2.2 Maintenance strategies, their characteristics and applications: Break down/ corrective maintenance, Preventive maintenance, Condition based maintenance (CBM), Reliability based maintenance, equipments used for CBM 2.3 Equipment Life cycle- Bath Tub Curve and maintenance strategies, Factors considered in maintenance system design 2.4 Preparation of maintenance schedule for preventive maintenance, maintenance cycle, Preparing Check list for PM **Course Outcome: CO2 Teaching Hrs :08 Marks:12 (R-4, U-4, A-4)**
3	**Total Productive Maintenance (TPM)** 3.1 Philosophy of TPM, Six losses due to inferior maintenance, Concept of Autonomous Maintenance 3.2 Objectives and Benefits of TPM, Overall Equipment Efficiency (OEE) 3.3 Stages of implementation of TPM, Pillars of TPM 3.4 5S & its implementation **Course Outcome: CO3 Teaching Hrs:07 Marks:08(R-2, U-4, A-2)**
4	**Maintenance of Mechanical Systems & Components** 4.1 Maintenance of bearings, clutches, couplings, flexible drives, gears & gear drives, shafts 4.2 Maintenance of Pumps, Air Compressors, Condensers 4.3 Maintenance of Pneumatic systems: Common problems in pneumatic systems, Maintenance schedule of pneumatic systems 4.4 Maintenance of hydraulic Systems: Common problems in hydraulic systems, Maintenance schedule of hydraulic systems 4.5 Maintenance of Conveyors, Overhead Hoists, cranes 4.6 Safety in maintenance activities, Energy saving through planned Maintenance **Course Outcome: CO4 Teaching Hrs:12 Marks:16 (R-4, U-8, A-4)**
5	**Spares Management & Lubrication** 5.1 Classification of spares, norms for stock, stock of electrical spares, 5.2 Lubrication, different methods of lubrication 5.3 Lubricants, function of Lubricant, Properties of Lubricant, Types of Lubricant **Course Outcome: CO5 Teaching Hrs:06 Marks:10 (R-4,U-4,A-2)**
6	**Documentation for maintenance Activities** 6.1 Maintenance requisition Procedure, Work order, work permit system 6.2 Maintenance Manual, History Cards, Defect analysis, Down time analysis **Course Outcome: CO6 Teaching Hrs: 06 Marks:08 (R-0, U-4, A-4)**

Suggested Specifications Table (Theory):

Level of questions: R: Remember, U: Understand, A: Apply

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Basics of Maintenance Engineering	2	4	-	6
2	Maintenance systems/ Maintenance strategies	4	4	4	12
3	Total Productive Maintenance	2	4	2	8
4	Maintenance of mechanical systems and components	4	8	4	16
5	Spare management and lubrication	4	4	2	10
6	Documentation for maintenance activities	-	4	4	8
	Total	**16**	**28**	**16**	**60**

List of experiments/ Assignments:

Sr. No.	Unit No	COs	Title of the Experiments/ Assignment	Hours
1	1	CO1	Assignment on basics of maintenance engineering	2
2	2	CO2	Preparation of check list for preventive maintenance for assigned equipment/ machine in workshop or laboratory	4
3	3	CO3	Assignment on TPM/ Assignment on 5S	4
4	4	CO4	Performance of maintenance activity for assigned equipment/ machine (Group activity) & preparation of activity report	4
5	5	CO5	Preparation of lubrication schedule for assigned equipment/ machine and its implementation during term	4
6	6	CO6	Assignment on documentation for maintenance activities	2
7	1-6	CO1-CO6	Mini Project on assigned maintenance related activity in the group of four students [students to work throughout term and present work]	4
8	1-6	CO1-CO6	Expert lecture by maintenance professional or visit to maintenance department in industry	2
9	2	CO2	Condition based maintenance- using the equipments for measurement of signatures	4
10	4	CO4	Performance of maintenance activities on pneumatic systems	4
11	4	CO4	Performance of maintenance activities on hydraulic systems	4
		Total		**30**

Note: Experiments No. 1 to 8 are compulsory, Minimum 10 experiments/ assignments shall be performed.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Maintenance and spare parts management	P. Gopalkrishnan, A. K. Banerji, Prentice Hall of India, 2nd Ed; 2004	978-8120-3066-91
2	Principles and practice of Total Productive Maintenance	Bikash Bhadury, Allied Publishers Ltd, 1st Ed; 1998	978-8170-2380-58
3	Pneumatic Systems Principles and Maintenance	S.R. Mujumdar, Tata McGraw Hill Publishing Company Ltd, 1st Ed; 1995	978-0074-6023-17
4	Maintenance Fundamentals	R. Keith Mobley, Elsevier Butterworth–Heinemann, 2nd Ed., 2004	978-0750-6779-81
5	Industrial Maintenance	H P Garg, S Chand & company,3rd Ed., 1987	978-8121-9016-80
6	Plant maintenance engineering	R K Jain, Khanna publications, 2nd Ed; 2018	978-8174-0929-46
7	Maintenance engineering and management	R.C. Mishra and K Pathak, Prentice Hall of India Pvt. Ltd, New Delhi, 12th Ed; 2004	978-8120-3457-37
8	Total productive maintenance	K. S. Madhavan, Shingo institute of Japanese management, 1st Ed; 2014	978-8190-6715-52
9	Engineering maintenance- A modern approach	B. S. Dhillon, CRC Press, 1st Ed; 2002	978-1587-1614-21

E-References:

1. https://www.licensedelectrician.com/Store/Maintenance.htm
2. https://www.youtube.com/watch?v=f58SW0Hwcf0
3. https://www.youtube.com/watch?v=6Zh8_x17qhI
4. https://www.youtube.com/watch?v=foq43sPPmMo
5. https://easyengineering.net/me6012-maintenance-engineering/
6. www.sasurieengg.com/e-course-material/MECH/IV-Year%20Sem%208/ME2037%20ME.pdf
7. https://www.coursehero.com/file/46869813/ME6012-ME-Complete-Notespdf/

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	2	1	2	1	2	1	3	2	1
CO2	2	2	3	2	2	2	3	2	2
CO3	3	2	3	3	2	2	3	3	2
CO4	3	2	3	3	2	2	3	3	2
CO5	3	3	3	2	3	2	3	3	2

CO6	3	3	3	2	3	2	3	3	2

Industry Consultation Committee

Sr. No	Name	Designation	Institute/Organisation
1	Mr. Jawale S. M.	Ex. General Manager	Godrej & Boyce Mfg. Co. Pvt. Ltd. Mumbai
2	Mr. Sachin Khalkar	Deputy Manager	Mahindra & Mahindra Ltd; Nashik
3	Mr. Yogesh Gaidhani	Head of Department, Mechanical Engineering	K K Wagh Polytechnic, Nashik
4	Mr. Gajanan Gore	Lecturer in Mechanical Engineering	Government Polytechnic, Jalna
5	Mr. K. Z. Dhangare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai
6	Miss. A. R. Hagawane	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code:ME19R407				Course Title: Inventory Control						
Compulsory / Optional: Optional										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hrs 30min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**-**	**5**	**60**	**20**	**20**	**-**	-	**25**	**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR 26.

Rationale:

Engineering Manufacturing industry uses numerous types of inventories. Technicians/ supervisors are required to possess knowledge and skills regarding monitoring and controlling the inventories as inventories have direct impact on economics of manufacturing and continuity of manufacturing. Any person working in industry must be sensitive about inventory levels, their role in manufacturing, especially in modern manufacturing strategies like just in time systems.

In this context, the mechanical engineering diploma student must be well versed with techniques of inventory control, store operations, 5S etc. Also the student can find out specialized career option in the field of materials management, stores and purchase department.

Hence it is apt to study this course with the objective to develop the competency of selection of appropriate techniques of inventory control.

Course Outcomes: Student should be able to

CO1	Identify inventories and estimate EOQ/ EMQ
CO2	Apply the techniques of selective inventory control
CO3	Select appropriate replenishment system
CO4	Identify and apply control measures for WIP and basic understanding of ERP working
CO5	Apply procedures of stores activities
CO6	Apply Monte Carlo method of simulation for inventory management, 5S technique

Course Content Details:

Unit No	Topics / Sub-topics
1	**Basics of Inventory Control** 1.1 Need and objectives of Inventory Control, Symptoms of Poor Inventory control, Financial and operational effects of over and under inventory levels, Definitions: Inventory, Lead Time , Types of inventories, Seasonal, Decoupling, pipeline Inventories, Need of integrated approach for inventory control 1.2 Various costs associated with Inventory Carrying Cost, Procurement Cost, Set-up Cost, 1.3 Economic Order Quantity (EOQ), Economic Manufacturing Quantity (EMQ), with and without discounts **Course Outcome: CO1 Teaching Hours: 08 Marks: 10 (R-2, U-4, A-4)**

Unit No	Topics / Sub-topics
2	**Selective Control of Inventories** 2.1 ABC Analysis: Objective & Procedure 2.2 XYZ Analysis: Objective & Procedure 2.3 FSN Analysis: Objective & Procedure 2.4 VED Analysis: Objective & Procedure 2.5 Deciding strategy for control using combining ABC & XYZ and XYZ –FSN classification **Course Outcome:** CO2 **Teaching Hours: 07** **Marks: 10 (R-2, U-4, A-4)**
3	**Replenishment Systems** 3.1 Elements of Lead Time, Factors affecting Lead time, Safety Stock, Need and factors affecting safety stock, 3.2 Elements of Replenishment System: Reorder Quantity, Reorder Level, minimum level stock, Lead time consumption, Maximum stock, minimum stock, average inventory, Need for periodic review of replenishment system parameters 3.3 Fixed order quantity system, features, working, parameters, Limitations, suitability, Modification (Two Bin system) 3.4 Fixed-Order – Interval System, parameters, suitability, modification with fixed order quantity **Course Outcome: CO3** **Teaching Hours:08** **Marks:10 (R-2, U-2, A-6)**
4	**Inventory Control of Work in Process (WIP) & ERP** 4.1 Reasons for WIPs, Effects of increased WIP, factors influencing quantity of WIP, Manufacturing Cycle Efficiency 4.2 Strategies for reduction in WIP in Job, Batch, mass, Process manufacturing 4.3 Role of line manager in controlling WIP 4.4 Enterprise Resource Planning (ERP) - Concept, Need, objectives, modules, advantages & Limitations of ERP **Course Outcome: CO4** **Teaching Hours:07** **Marks: 10 (R-2, U-4, A-4)**
5	**Store procedures and management** 5.1 Purpose of store, Responsibilities and functions of store officer 5.2 Procedures for Materials receipt, Inspection, Issue, record keeping, interrelation with materials management department 5.3 Stock Verification: Need, Reasons for deviation between physical stocks and documented stock, Methods of stock verification: Annual stock taking, Continuous stock taking, Re-order point stock taking **Course Outcome: CO5** **Teaching Hours:07** **Marks: 10 (R-4, U-6,A-Nil)**
6	**Simulation and 5S** 6.1 Monte Carlo Method applied to inventory problems 6.2 Elements of 5S method, types of wastes, need, Implementation requirements 6.3 Recycling & reuse **Course Outcome: CO6** **Teaching Hours:08** **Marks: 10 (R-2, U-2, A-6)**

Suggested Specifications Table (Theory):

Level of questions: R: Remember, U: Understand, A: Apply

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Basics of Inventory Control	2	4	4	10
2	Selective Control of Inventories	2	4	4	10
3	Replenishment Systems	2	2	6	10
4	Inventory Control of Work in Process (WIP) & ERP	2	4	4	10
5	Store procedures and management	4	6	-	10
6	Simulation, 5S	2	2	6	10
	Total	**14**	**22**	**24**	**60**

List of experiments: All practical/assignments are compulsory

Sr. No.	Unit No	COs	Title of the Assignments/Experiments	Hours
1	1	CO1	Case Studies on EOQ and EMQ Estimation	04
2	2	CO2	Case Studies on Selective Inventory Control	04
3	3	CO3	Case studies on Replenishment Systems	04
4	4	CO4	Case studies on Work in Process	04
5	5	CO5	Assignment on functioning of Industrial Stores and documentation	04
6	6	CO6	Case studies on use of Simulation in formulating Inventory Control problems	04
7	1	CO1-6	Mini Project (Group Activity) Teacher to identify topics and assign topics to self formed groups	02
8	2	CO4	Hands-on on Inventory control module of any free ERP software or Development of excel sheet for given requirements of a small enterprise for Inventory control	04
	Total			**30**

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Inventory Management	L. C. Jhamb, Everest Publishing House, 18th Ed, 2005	978-8186-3145-48
2	Materials Management: An integrated approach	P. Gopalkrishnan, M. Sundaresan, PHI Learning Pvt. Ltd. 33rd Ed, 2011	978-8120-3002-79
3	Purchasing And Inventory Management	K. S Menon , Sarika Kulkarni, Shroff Publishers; 1st Ed, 2011	978-8184-0470-66
4	Computer-Aided Production Management	P. B. Mahapatra, Prentice-Hall of India Pvt.Ltd, Ed, 2004	978-8120-3174-20

5	Operations Management for competitive advantage	Richard B. Chase, F. Robert Jacobs, Nicholas J. Aquilano, Nitin K. Agarwal, Tata McGraw Hill, 11th Ed, 2006	978-0070-6044-83

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CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	3	2	-	2	2	3	2	2
CO2	3	2	2	3	3	2	2	2	2
CO3	3	3	2	3	2	2	2	2	2
CO4	3	2	2	3	2	2	2	2	2
CO5	3	-	-	-	3	2	3	2	2
CO6	3	-	3	2	2	2	1	2	2

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mrs. Manisha Talreja,	CEO	Vapcon Mfg. Engineers, Palghar
2	Mr. D.B. Jadhav	Head, Melting	Mahindra & Mahindra Ltd, Kandivali
3	Mr. Pravin R. Dhole	Manager	S.M. Auto Engineering Pvt. Ltd. Pune
4	Dr. V. P. Rathod	Lecturer in Mechanical Engineering	Govt. Polytechnic, Ratnagiri
5	Dr. H.P. Khairnar	Associate Professor	VJTI, Mumbai
6	U.A. Agnihotri	Lecturer in Mechanical Engineering	Govt. Polytechnic Mumbai
7	Dr. V. U. Rathod	Lecturer in Mechanical Engineering	Govt. Polytechnic Mumbai

Coordinator, Head of Department

Department of Mechanical Engineering Department of Mechanical Engineering

I/C, Curriculum Development Cell Principal

Programme : **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code:ME19R310				Course Title: Metrology & Quality Control						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hrs 30min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**-**	**5**	**60**	**20**	**20**	**25***	-	**25**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR 26.

Rationale:

Engineering industry uses variety of manufacturing processes. and processing different engineering materials, metals as well as non-metals. Mechanical engineering technicians require knowing the different types of measuring instrument to be used in variety of situation. While working in different domains of mechanical engineering, technicians shall possess the competence to select appropriate measuring instruments and quality control tools for required applications productively.

In this context, the mechanical engineering diploma student must be well versed with different types of measuring instrument to be used in variety of situations. Also the student is required to have hands on learning experience on different types of measuring instruments.

In the present global competitive scenario, an industry can only survive and flourish when its customers are satisfied. This satisfaction comes with quality product and services. This course imparts necessary knowledge so that students can perform the job of quality control supervisor effectively.

Hence it is apt to study this course with the objective to develop the competency of selection, use and applications of measuring instruments and various quality control tools.

Course Outcomes: Student should be able to

CO1	Describe the terminology related with metrology and calibration requirements
CO2	Select and use of suitable measuring instruments for linear measurement and describe construction, working and applications of comparators.
CO3	Use instruments for angle measurement and thread measurement.
CO4	Interpret tolerances, fits and design Go-No Go gauges from given data and perform machine tool alignment testing
CO5	Select and use of suitable measuring instruments for surface roughness and flatness
CO6	Describe the elements of Quality management, TQM, Six Sigma and apply the technique of statistical quality control, acceptance sampling and estimation of process capability

Course Content Details:

Unit No	Topics / Sub-topics
1	**Basics of Engineering Metrology** 1.1 Disciplines of Metrology: Scientific metrology, industrial metrology and Legal Metrology, Measuring characteristics of instruments & their significance: Least count, range, precision, accuracy, repeatability, sensitivity 1.2 Traceability and calibration: Need of Calibration, General requirements for the competence of testing and calibration laboratories (as per ISO 17025 - 2017 and NABL-129 related with dimensional metrology, Types and Sources of errors in measurement, concept of uncertainty 1.3 Types of standards: Line standard, End standard and wavelength standard, their comparison. **Course Outcome: CO1 Teaching Hours: 06 Marks: 10 (R-2, U-4, A-4)**
2	**Linear measurement and Comparators** 2.1 Basic Measuring Instruments: Principle, construction and application/operation of Vernier calipers, Micrometer, Height gauge, Feeler gauges, Radius gauges, Screw pitch gauges, Slip gauges: specification, wringing and combination, Applications of slip gauges 2.2 Definition and Classification of comparators, requirements of good comparator 2.3 Working and applications of comparators: Dial indicator, Sigma comparator, Pneumatic Comparator **Course Outcome:** CO2 **Teaching Hours: 06 Marks: 10 (R-2, U-4, A-4)**
3	**Angular Measurement** and **Thread Measurement** 3.1 Concept of angle measurements, Working and use of universal bevel Protractor, Sine Bar, Sine Centre, Sine table and Spirit Level 3.2 Principle and Working of Clinometers, Angle dekkor, Angle Gauges: combination for setting required angle 3.3 Definitions and measurement of different thread elements such as major diameter, minor diameter, effective diameter, pitch for external threads 3.4 Construction, working and use of Thread Micrometer, floating carriage micrometer, Errors in threads, Pitch errors **Course Outcome: CO3 Teaching Hours:07 Marks:10 (R-2, U-4, A-4)**
4	**Gauge Design and Machine Tool Testing** 4.1 Concept of Limits, Fits, And Tolerances, interchangeability, Hole and Shaft Basis System (IS-919-1993), Tolerance staking: worst scenario method and SD method 4.2 Classification of gauges, Taylor's Principle for gauge design, Design of Go-No Go Gauges from given data 4.3 Concept of Parallelism, Straightness, Squareness, Roundness, Run out 4.4 Alignment Test: Significance of alignment tests, Tools required, Procedure of alignment tests for Lathe, milling machine and drilling machine as per IS standard **Course Outcome: CO4 Teaching Hours:07 Marks: 10 (R-2, U-4, A-**

Unit No	Topics / Sub-topics
	4)
5	**Surface Roughness, Flatness Testing and Modern Metrology** 5.1 Terminology as per IS 3073- 1967, , CLA, Ra, RMS values and their interpretation, 5.2 Various techniques of qualitative analysis 5.3 Talysurf roughness tester: construction and working 5.4 Principles of interferometry, Use of Optical flat for flatness testing 5.5 Introduction to laser metrology 5.6 Coordinate measuring machines (CMM): Construction, working and industrial applications. **Course Outcome: CO5 Teaching Hours:05 Marks: 10 (R-2, U-4,A-4)**
6	**Quality Tools and Quality Management** 6.1 Definitions of quality and quality control, Quality characteristics, Quality of design, Quality of conformance, Quality of performance, Quality cost & its components, Comparison between Quality assurance and Quality Control, Inspection: Need, Types of inspection. Inspection stages, 6.2 Principles and concept of 'Total Quantity Management', Quality Audit, and its type, Six sigma concept, Needs of quality standards, Introduction of ISO 9001 recent version, Revision of quality standards 6.3 **Statistical Quality Control:** Significance of SQC, Variables and attributes, Population and sample, Causes of variation assignable and random variations. Normal distribution curve. 6.4 Control charts: Plotting of Control charts for variables (X & R charts), control charts for attributes (P, C charts), selection of appropriate type of chart, Process capability: estimation (Cp & Cpk), interpretation: Statistically capable and in capable processes. 6.5 Acceptance Sampling: Concept of sampling inspection, Comparison with 100% inspection, Different types of sampling plans, IS 4905-1968, working of various sampling plans, factors affecting on selection of sampling plan, Operating Characteristic Curve. consumer's risk and producer's risk **Course Outcome: CO6 Teaching Hours:14 Marks: 10 (R-2, U-4, A-4)**

Suggested Specifications Table (Theory):

Level of questions: R: Remember, U: Understand, A: Apply

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Basics of Engineering Metrology	2	4	4	10
2	Linear measurement and Comparators	2	4	4	10
3	Angular Measurement and Thread Measurement	2	4	4	10
4	Gauge Design and Machine Tool Testing	2	4	4	10
5	Surface Roughness, Flatness Testing and Modern Metrology	2	4	4	10
6	Quality Tools and Quality Management	2	4	4	10
	Total	**12**	**24**	**24**	**60**

List of experiments:

Sr. No.	Unit No	COs	Title of the Assignments/Experiments	Hours
1	-	-	Know your laboratory (Safety, care and maintenance)	2
2	1,2	CO1, CO2	Calibration Procedure for Vernier Caliper and Micrometer	2
3	2	CO2	Use of basic measuring instruments: Surface plate, V-block, feeler gauge, radius gauge, thread gauge and height gauge	2
4	2	CO2	Inspection of components using Pneumatic comparator	2
5	2	CO2	Use of dial indicator as mechanical comparator	2
6	3	CO3	Angle measurement using Sine bar	2
7	3	CO3	To measure major diameter, minor diameter, effective diameter, using floating carriage diameter measuring machine/thread micrometer.	2
8	3	CO3	To measure major diameter, minor diameter, pith, depth of thread and thread angle using profile projector/ Tool Maker's Microscope	2
9	4	CO4	Assignment on Gauge Design	2
10	4	CO4	Alignment testing on center lathe / drilling machine	2
11	5	CO5	Surface flatness characterization using optical flats	2
12	6	CO6	Construct X,R chart and interpret the results/ Plotting of control chart for variables	2
13	6	CO6	Construct P/C- chart and interpret the results/ Plotting of control chart for attributes	2

14	6	CO6	Sampling Inspection	2
Total				**30**

Note: Any 11 experiments covering all COs

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Engineering Metrology	R. K. Jain, Khanna Publisher, Delhi, 22nd Ed; 2015	**978-8189-4012-69**
2	Text Book of Metrology	M. Mahajan, Dhanpat Rai & Co; 4th Ed, 2012	**978-8177-0005-11**
3	Text Book of Metrology	I.C. Gupta, Dhanpat Rai & Co; 4th Ed, 2018	**978-8189-9284-52**
4	Statistical Quality Control	M. Mahajan, Dhanpat Rai & Co.4th Ed, 2016	**978-8177-0006-58**
5	Statistical Quality Control	Douglas C Montgomery, Students' Resource Manual, Wiley India Pvt. Ltd. 5th Ed; 2002	**978-0471-6781-06**
6	Total Quality Management	Dale H. Besterfield and others, Pearson, Revised Ed, 2011	**978-0130-9930-69**

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CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	3	3	2	3	2	2	3	3
CO2	3	2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	2
CO4	3	3	2	3	3	2	3	3	3
CO5	3	2	2	2	2	2	2	2	2
CO6	3	3	3	3	2	2	2	2	2

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. Malvankar Pundalik	Director	Sacardande Engg. Pvt. Ltd., Navi Mumbai
2	Mr. Mohanish Puralkar	Manager, R & D	Miles Ahead Tech Pvt. Ltd Mumbai
3	Mr. Rao V. B.	Assistant Professor	Fr. CR. College of Engg Mumbai
4	Mr. Moizuddin M.	Lecturer in Mech. Engg.	M.H.S.S. Polytechnic, Mumbai
5	Mr. Joshi S. V.	Lecturer in Mech. Engg.	Government Polytechnic, Mumbai
6	Mr. Ansari N. N.	Lecturer in Mech. Engg.	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal


GOVERNMENT POLYTECHNIC MUMBAI
GPM
ESTD. 1960
MAKING KNOWLEDGE TO WORK

Programme: **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code: ME 19R305				Course Title: CNC Machines & Automation						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2Hrs 30 min)	TS1 (1Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**--**	**--**	**25**	**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination

Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill tests are to be conducted. First skill test at midterm and second skill test at the end of the term.

Rational:

In Recent years, the manufacturing environment has undergone dramatic changes. For achieving market of goals, it is essential to produce quality parts in less time. Intervention of information technology in manufacturing has great impact on manufacturing techniques. The strategic requirements such as minimum lead time and high quality cannot be met without the adaption of computerized numerical control (CNC) technology. CNC machines normally are not limited to machine tools only but realm of CNC has widened in almost all areas of manufacturing processes and support activities. It is therefore very important for Mechanical diploma engineer's to master CNC technology.

In this course learner can develop skills required for programming, selection of tooling etc for CNC machine.

Course Outcomes: At the end of the course student will be able to:

CO1	Identity different axes, machine zero, home position, systems and controls CNC machines
CO2	Select, mount and set cutting tools and tool holders on CNC.
CO3	Prepare part programming using ISO format for given simple components with and without use of MACRO, CANNED CYCLE and SUBROUTINE using ISO format.
CO4	Describe working principle Automatic Tool Changing device
CO5	Apply maintenance practices for CNC machines.
CO 6	Describe the different components of automated system.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction to CNC Machines** 1.1 Classification of CNC machines 1.2 Important terms related to CNC machining 1.3 Calibration of CNC machines 1.4 Axis standards and its identification 1.5 Drives used in CNC system 1.6 Construction and working of CNC Machines 1.7 Feedback, measurement & correction System **Course Outcome:CO1 Teaching Hours:06 Marks: 08 (R-4, U-4, A-0)**
2	**Constructional features and working of CNC Machines** 2.1 Bed and machine frame construction 2.2 Spindle constructional details 2.3 Constructional details and working of ball screw and L. M .guide ways 2.4 Various spindle drives used in CNC machines 2.5 working of machine control unit 2.6 Types of lubrication system **2.7** working of swarf removal arrangement **2.8** Working of hydraulic and pneumatic systems used for Chuck, tool and pallet changing in CNC machines. **Course Outcome: CO 2 Teaching Hours: 08 Marks:14 (R-4, U-6, A-4)**
3	**CNC Part Programming** 3.1 NC words , G codes M codes 3.2 Programming format, word statement, block format 3.3 Tool offset and tool wears compensation 3.4 Part programming containing subroutines, Do-loops and canned cycle 3.5 Introduction to Macro Programming **Course Outcome: CO3 Teaching Hours: 10 Marks: 12 (R-2, U-4, A-6)**
4	**Tooling for CNC machines** **4.1** Introduction **4.2** Types of CNC Cutting tools **4.3** Types of indexable inserts with it geometry **4.4** Construction of tool holding assembly **4.5** Tool presetting procedure **4.6** Working of Automatic Tool Changing (ATC) device and types of tool magazine **4.7** Safety procedure, alarms, fool-proof procedures **4.8** Online measurement of dimensions, cutting forces, Adaptive controls, communication with servers **4.9** Fixtures used in CNC machines. **Course Outcome:CO4 Teaching Hours: 08 Marks:12 (R-2, U-4, A-6)**

Unit No	Topics / Sub-topics
5	**Common Problems in CNC Machines** 5.1 Common problems In mechanical, electrical, pneumatic, electronic and PC components of NC machines **5.2** Diagnostic study of common problems and remedies **5.3** Use of on-time fault finding diagnosis tools in CNC machines. **Course Outcome: CO5 Teaching Hours:08 Marks:06(R-2, U-0,A-4)**
6	**Industrial Automation** 6.1 Meaning of Automation 6.2 Need of Automation 6.3 Types of Automation 6.4 Advantages and Disadvantages of Automation 6.5 Components of Automated system 6.6 Introduction to Plant Automation & Introduction to Industry 4.0 **Course Outcome: CO6 Teaching Hours:08 Marks:06 (R-2, U-2, A-4)**

Suggested Specifications Table (Theory):
Level of questions: R: Remember, U: Understand, A: Apply

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Introduction to CNC machines	4	4	-	8
2	Constructional features and working of CNC machines	4	6	4	14
3	CNC part programming	2	4	6	12
4	Tooling for CNC machines	2	4	6	12
5	Common Problems in CNC machines	2	-	4	6
6	Industrial Automation	2	2	4	8
	Total	16	20	24	60

List of Experiments: Minimum 10 experiments out of 12 experiments

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Study the constructional details of CNC lathe	2
2	1	CO1	Study the constructional details of CNC milling machine	2
3	2	CO2	Study the constructional details and working of- i) Automatic tool changer and tool setter ii) Multiple pallets iii) Swarf removal iv) Safety Devices	2

Sr. No.	Unit No	COs	Title of the Experiments	Hours
4	2	CO2	Use of software for turning operations on CNC turning center	2
5	2	CO2	Use of software for milling operations on milling center	2
6	3	CO3	Develop a part programme for following lathe operations and make the job on CNC lathe- i) Plain turning & facing operation ii) Taper turning operations iii) Thread cutting operations iv) Operation along contour using circular interpolation.	4
7	3	CO3	Develop a part programme for following milling operations and make the job on CNC milling machine- i) Plain milling ii) Slot milling iii) Pocket milling	4
8	3	CO3	Preparation of work instructions for machine operator while working on CNC machine	2
9	4	CO4	Study of CNC Cutting tools & Tool presetting procedure	2
10	5	CO5	Preparation of preventive maintenance schedule for CNC machines	4
11	6	CO6	Demonstration through Industrial visit for awareness of Industrial Automation.	2
12	2	CO2	Visit to **CNC** machine (production) shop to observe construction and working of CNC machining center/ CNC machines. Write visit report.	2
Total				**30**

References/ Books

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Mechatronics & Machine Tools	HMT, Bangalore, McGraw-Hill, International Ed, 1998	978-0071-3463-44
2	CNC Machines	Pabla B.S.& M. .Adithan, New age International Ltd. 4th Ed, 2018	978-8122-4342-62
3	CAD/CAM (Computer Added Design & Manufacturing)	Groover, Zimmer, Pearson Education India, 1st Ed, 2006	978-8177-5841-65
5	CAD/CAM/CAE	Chougule N.K., SciTech publication Pvt Ltd. 1st Ed, 2010	978-8183-7117-53
6	CNC Programming Made Easy	Binit Kumar Jha, Vikas Publication House Pvt.l Ld. New Delhi, Revised edition, 2010.	978-8125-9118-07

E-References:

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- **https://swayam.gov.in/nd1_noc19_me46/preview**
- **https://youth.be/il28Fz69E80**

CO Vs PO and CO Vs PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	2	1	1	3	1	2	2	2	3
CO2	3	2	2	3	1	2	3	2	3
CO3	2	3	2	2	1	2	3	1	3
CO4	2	3	2	3	1	2	3	2	3
CO5	2	1	1	3	1	2	2	2	3
CO6	3	2	2	3	1	2	3	2	3

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. Dharme G.S.	Workshop Superintendent	Agnel Polytechnic, Bandra, Mumbai
2	Mr. Mane M.A.	Assistant Professor	Suman Ramesh Tulsiani Technical Campus Kamshet, Pune
3	Mr.Raut N.N.	Deputy General Manager-Oprations	Sunrise Industries (India) Limited, Vadodara, Gujrat
4	Mr.Joshi S.V.	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai
5	Mr. Ansari N.N.	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai
6	Mr. Jamnik Y.B.	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

Programme: **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code: ME19R302				Course Title: Industrial Hydraulics and Pneumatics						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hrs 30 min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**--**	**--**	**25**	**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at midterm and second skill test at the end of the term

Rationale:

Hydraulic and pneumatic operated machines and equipment are widely used in various industries due to its versatility adaptability to automation. Mechanical engineering technologist are required to maintain such systems in different segments of industries. This competency needs the knowledge of construction and working of different components of hydraulic and pneumatic systems.

This course will give the students the basic skills and knowledge to use and maintain different types hydraulic systems and pneumatic systems.

Course Outcomes: Student should be able to

CO1	Identify various components of hydraulic and pneumatic systems.
CO2	Select pump and other accessories for oil operated system.
CO3	Select control valves and actuators for given fluid operated system.
CO4	Select compressor and other component for air operated system.
CO5	Develop different hydraulic circuits for given application
CO6	Develop different pneumatic circuits for given application

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction to Hydraulic and Pneumatic systems** **1.1.** General layout of Oil Hydraulic system. **1.2.** Practical applications of Hydraulic system. **1.3.** Merits and limitations of Hydraulic system. **1.4.** ISO symbols used in Hydraulic system. **1.5.** General layout of Pneumatic system. **1.6.** Practical applications of Pneumatic system. **1.7.** Merits and limitations of Pneumatic system. **1.8.** ISO symbols used in Pneumatic system. **Course Outcome: CO1 Teaching Hrs:04 Marks: 08 (R-2, U-4, A-2)**

2	**Pumps and Accessories in Hydraulic system** **2.1.** Pump: Classification of Pump, Construction and working of Gear pump, Vane pump, Screw pump, Piston pump **2.2.** Accessories: Oil reservoir, pipes, hoses, fittings, oil filters, seals and gaskets, accumulators, heat exchangers **2.3.** Types of hydraulic oils used in hydraulic systems and their specifications **Course Outcome: CO2 Teaching Hrs:06 Marks: 10 (R-4, U-4, A-2)**
3	**Control Valves and Actuators** **3.1.** Classification of Control Valves **3.2.** Pressure Control Valves: Construction and working of Pressure relief valve, Pressure reducing valve, Unloading valve. **3.3.** Direction Control Valve: Check valve, 2/2, 3/2, 4/2, 4/3, 5/2, 5/3 DC valve used in Hydraulics and Pneumatics system. **3.4.** Flow Control Valves: Variable flow control valve Pressure compensated, Non compensated flow control valve, **3.5.** Classification of Hydraulic and Pneumatic actuators, Construction and working of Linear and Rotary actuators **Course Outcome: CO3 Teaching Hrs:10 Marks: 10 (R-4, U-4, A-2)**
4	**Compressor and Pneumatic Components** **4.1.** Types, Construction, working principle of Reciprocating and Rotary compressor **4.2.** Construction, working principle of FRL unit, Dual (Twin) pressure valve, Shuttle valve, Quick exhaust valve, Time delay valve **Course Outcome: CO4 Teaching Hrs: 08 Marks:10 (R-4, U-4, A-2)**
5	**Oil Hydraulic Circuits** **5.1.** Simple oil Hydraulic circuits- Single and Double acting hydraulic cylinders, motors **5.2.** Speed control- Meter in, Meter out, Bleed off circuit. **5.3.** Regenerative, Synchronizing, Sequencing circuits. **5.4.** Hydraulic circuit for Milling machine, Shaper machine, Grinding machine **5.5.** Remedies and fault detection in Hydraulic circuits **Course Outcome: CO5 Teaching Hrs: 09 Marks: 12 (R-2, U-4, A-6)**
6	**Pneumatic Circuits** **6.1.** Direct and indirect control of Single Acting and Double Acting air cylinders, Motors **6.2.** Speed control circuit for cylinders and motors **6.3.** Sequencing circuits **6.4.** Remedies and fault detection in Pneumatic circuits **Course Outcome: CO6 Teaching Hrs: 08 Marks: 10 (R-2, U-2, A-6)**

Suggested Specifications Table (Theory):

Level of questions: R: Remember, U: Understand, A: Apply

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Introduction to Hydraulic and Pneumatic systems	02	04	02	08
2	Pumps and Accessories in Hydraulic system	04	04	02	10
3	Control Valves and Actuators	04	04	02	10
4	Compressor and Pneumatic Components	04	04	02	10
5	Oil Hydraulic Circuits	02	04	06	12
6	Pneumatic Circuits	02	02	06	10
Total		**18**	**22**	**20**	**60**

List of experiments:

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Identify components of Hydraulic system.	02
2	1	CO1	Identify components of Pneumatic system.	02
3	1	CO1	List and draw symbols used in hydraulic system.	02
4	1	CO1	List and draw symbols used in pneumatic system.	02
5	2	CO2	Use Pump and other components mounted on hydraulic trainer kit	02
6	3	CO3	Use of control valve and actuators in hydraulics and pneumatics	02
7	4	CO4	Use of compressors, FRL unit and accessories in pneumatics	02
8	5	CO5	Assemble & actuate meter in, meter out hydraulic circuit	04
9	5	CO5	Develop circuit for simple machine tool application such as milling machine, shaper machine, grinding machine	02
10	5	CO5	Assemble & actuate sequencing hydraulic circuit	04
11	6	CO6	Construct and actuate speed control pneumatic circuits	02
12	6	CO6	Develop any suitable pneumatic sequencing circuit	04
Total				**30**

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Oil Hydraulic system-principles and maintenance	Majumdar S.R. McGraw Hill, New Delhi, 7th Ed; 2002	978-0071-4066-97
2	Pneumatic Systems principles and maintenance	S.R. Mujumdar, Tata McGraw Hill Publishing Company Ltd, 1st Ed., 1995	978-0074-6023-17
3	Fluid Power with applications	Esposito, Anthony, Pearson Education Inc, New Delhi , 7th Ed., 2008	978-0135-1369-04
4	Hydraulics and Pneumatics	Stewart, Harry, Taraporewala Publication, 1st Ed., 1984	978-0672-2341-25
5	Pneumatic Controls	Joji B, Wiley India Publication, New Delhi, 1st Ed., 2008	978-8126-5154-24
6	Hydraulics and Pneumatics A Technicians and Engineers Guide	Parr, Andrew Butterworth-Heinemann Publisher, 3rd Ed.,2011	978-0080-9667-48
7	Industrial Hydraulics Manual	Vickers Systems International, Eaton Hydraulics, (Training Manual) 2nd Ed; 2006	978-0963-4162-09

E-References:

1. Hydraulic Pumps: https://en.wikipedia.org/wiki/Hydraulic_pump
2. Hydraulic Pumps: www.hydraulicspneumatics.com/...HydraulicPumpsM/.../TechZOne-HydraulicPumps.
3. Animation of Hydraulic pumps: https://www.youtube.com/watch?v=Qy1iV6EzNHg
4. Animation of Hydraulic pumps: https://www.youtube.com/watch?v=pWuxYnqYDnk
5. Pneumatic control valves animation: https://www.youtube.com/watch?v=XAItnsUcES0
6. Control valve symbol generation: https://www.youtube.com/watch?v=yIot4shcOkE
7. Animation of DC valve: https://www.youtube.com/watch?v=jsMJbJQkGTs
8. Animation of 4/2, 4/3 DC valve: https://www.youtube.com/watch?v=CQPwvWXbV3w
9. Animation of Hydraulic cylinder: https://www.youtube.com/watch?v=bovfDsAYSbc
10. Pneumatic cylinder: https://www.youtube.com/watch?v=MmYpzgh6Gok
11. Speed control hydraulic circuit: https://www.youtube.com/watch?v=4eCuPVxezzY
12. Telescopic cylinder animation: https://www.youtube.com/watch?v=icaqvfAtccY

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	2	1	2	1	2	1	3	2	1
CO2	2	3	3	2	2	2	3	3	2
CO3	3	3	3	3	2	2	3	3	2
CO4	3	3	3	3	2	2	3	3	2
CO5	3	3	3	2	3	2	3	3	3
CO6	3	3	3	2	3	2	3	3	3

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. Sachin Khalkar	Deputy Manager	Mahindra & Mahindra Ltd; Nashik
2	Mr. Tushar Mestry	Deputy Manager Production	Jurchen Technology India Pvt. Ltd; Boiser
3	Mr. Yogesh Gaidhani	Head of Department	K K Wagh Polytechnic, Nashik
4	Mr. Kiran B. Salumkhe	Lecturer in Mechanical Engineering	Government Polytechnic, Thane
5	Mr. K. Z. Dhangare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai
6	Miss. A. R. Hagawane	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator, Head of Department
Curriculum Development, Department of Mechanical Engineering
Department of Mechanical Engineering

I/C, Curriculum Development Cell Principal

Programme : **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code: ME19R311				Course Title: Design of Machine Elements						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (3 Hrs 30 min)	TS1 (1 Hr 30 min)	TS2 (1Hr 30 min)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**--**	**--**	**25**	**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at midterm and second skill test at the end of the term

Rationale:

Design of Machine Elements is an applied technology subject. This course needs essential fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials, Machine Drawing and Theory of Machines. A diploma holder in mechanical discipline is expected to design and draw simple machine components used in industries.

This course aims for developing analytical abilities to give solutions to engineering design problems.

Course Outcomes: Student should be able to-

CO1	Define basic concepts in design, Factor of safety and Theories of failures.
CO2	Prepare design for eccentric loading, joints, levers and offset links
CO3	Design keys, shafts and couplings
CO4	Design of bolts for brackets and welded joints
CO5	Design power screws
CO6	Design of helical springs.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction to Design of Machine Elements** **1.1. Basic Design Considerations:** Design philosophy and Procedures, General Considerations in design, Types of loads, concepts of stress ,strain, Stress – Strain Diagram for Ductile and Brittle Materials, True Stress-Strain and Engineering stress strain diagram , Types of Stresses such as Tension, Compression, Shear, Bending, Crushing and Bearing pressure, Concept of Creep, Fatigue, S-N curve, Endurance Limit **1.2. Factors of Safety and Material Designation:** Factor of Safety and Factors affecting its selection, Stress Concentration – Causes & Remedies, Converting actual load or torque into design load/torque using design factors, Designation of materials as per IS and

Unit No	Topics / Sub-topics
	introduction to International standards, advantages of standardization, use of design data book and use of standards in design **1.3. Variable stresses:** Fluctuating stresses, fatigue, fatigue failure,, S-N curve, Endurance limit, stress concentration and its remedies **1.4. Theories of Elastic Failures:** Principal normal stress theory, Maximum shear stress theory & maximum distortion energy theory **1.5.** Modern design considerations, Ergonomic and Aesthetic consideration and concept of product design **Course Outcome: CO1 Teaching Hours: 08 Marks: 10 (R-2, U-4, A-4)**
2	**Design of Joints and Offset links** **2.1.** Design of Cotter Joint, Knuckle Joint and Design of bell crank lever **2.2.** Design of Off-set links, C – Clamp, Overhang Crank **Course Outcome: CO2 Teaching Hours:07 Marks: 10 (R-0, U-4, A-6)**
3	**Design of Shafts, Keys and Couplings** **3.1. Design of Keys and Shaft:** Design of Rectangular, parallel sunk keys, Effect of Keyways on strength of shaft. Types of Shafts, Shaft materials, Standard Sizes, Design of shafts (Hollow and Solid) using strength and rigidity criteria, ASME code of design for line shafts supported between bearings with one or two pulleys in between or one overhung pulley. **3.2. Design of Couplings:** Protected type Flanged coupling and Bush-pin type flexible coupling. **Course Outcome: CO3 Teaching Hours: 08 Marks: 10 (R-4, U-0, A-6)**
4	**Design of threaded and welded joints** **4.1.** Stresses in Screwed fasteners, bolts of Uniform Strength. **4.2.** Design of Bolted Joints for brackets when the load is parallel and perpendicular to the axis of the bolt considering axial and eccentric loading **4.3.** Design of parallel and transverse fillet welds, axially loaded symmetrical sections. ASME codes for welded joints **Course Outcome: CO4 Teaching Hours: 07 Marks: 10 (R-2, U-4, A-4)**
5	**Design of Power Screws** **5.1. Basic concepts:** Thread Profiles used for power Screws, relative merits and demerits of each, Self-locking and overhauling property, Torque required to overcome thread friction, efficiency of power screws, types of stresses induced. **5.2.** Design of Screw Jack. **Course Outcome: CO5 Teaching Hours: 07 Marks: 10 (R-4, U-0, A-6)**
6	**Design of springs** **6.1.** Classification and Applications of Springs, Spring - terminology, materials specifications. Stresses in springs, Wahl's correction factor, Deflection of springs, Energy stored in springs, construction and application of Leaf spring.

Unit No	Topics / Sub-topics
	6.2. Design of Helical tension and compression springs subjected to uniform applied loads like I.C. engine valves, weighing balance, railway buffers and governor springs. **6.3.** Design of leaf spring without considering prestressing for the leaves **Course Outcome: CO6 Teaching Hours: 08 Marks: 10 (R-4, U-0, A-6)**

Suggested Specifications Table (Theory):

Level of questions: R: Remember, U: Understand, A: Apply

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Introduction to Design	02	04	04	10
2	Design of Joints, Levers and Offset links	--	04	06	10
3	Design of Shafts, Keys and Couplings	04	--	06	10
4	Design of threaded, welded joints and Introduction to Bearings	02	04	04	10
5	Design of Power Screws	04	--	06	10
6	Design of Springs	04	--	06	10
	Total	**16**	**12**	**32**	**60**

List of experiments:

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Assignment based on Fundamental Design Concepts	02
2	2	CO2	**Design of Knuckle/Cotter Joint/ Levers:** Observe the system where transmission of reciprocating forces or static compression/tensile load takes place through the links of a mechanism. Get the required information regarding load transmitted. By selecting suitable materials from design data book, design the Knuckle/ Cotter/Turn Buckle/Levers. Prepare design report, details and assembly drawing indicating overall dimensions, tolerances, fits and surface finish. Also prepare bill of materials. (Activity should be completed in a group of maximum four students)	06
3	3	CO3	**Design of Protected Type Rigid Flange/ Bushed Pin Type Flexible Coupling:** Observe the system where transmission of power takes place through shaft, Keys, coupling, pulley and belt drive. Get the required information regarding power transmitted (power output by motor or engine etc.). By selecting suitable materials from design data book, design the coupling. Prepare design report, details and assembly drawing indicating overall dimensions, tolerances, fits and surface finish. Also prepare bill of materials. (Activity should be completed in a group of maximum four students)	06
4	3	CO3	**Design of Stepped Solid/Hollow Shaft:** Observe the system where transmission of power takes place through shaft, Keys, coupling, pulley and belt drive. Get the required information regarding power transmitted (power output by motor or engine etc.). By selecting suitable materials	04

Sr. No.	Unit No	COs	Title of the Experiments	Hours
			from design data book, design the Stepped solid/hollow shaft subjected to combined bending and torsional stresses. Prepare design report, indicating overall dimensions, tolerances, fits and surface finish. (Activity should be completed in a group of maximum four students)	
5	5	CO5	**Design of Screw Jack:** Observe the System where transmission of power takes place through power Screws. (e.g. Lead screw of lathe, feed screws of machine tools, Clamping screws, Screw Jack.). Get the required information regarding effort, clamping force, etc., and selecting suitable materials from data book design screw, nut and different simple components in assembly. Prepare design report, details and assembly drawing indicating overall dimensions, tolerances, fits and surface finish. Also prepare bill of materials. (Activity should be completed in a group of maximum four students)	06
6	2/5	CO2 CO5	Prepare CAD Drawing for Practical No 2 or 5 in practical and print out of sheet should be attached.	02
7	4	CO4	Assignment based on design of welded joints and bolts.	02
8	6	CO6	Assignment on design of helical springs	02
Total				**30**

Note: All the design sheets and assignments are compulsory.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	A Text book of Machine Design	R S. Khurmi and J. K Gupta., S. Chand Publication, 34th edition, 1979	978-8121-9253-72
2	Design of Machine Elements	V B. Bhandari, Tata Mc-Graw Hill Publication, 4th Edition, 2016	978-9339-2211-26
3	Schaum's Outline of Machine Design	Alfred S. Hall, A. R. Holowenko, H. G. Laughlin, Tata Mc-Graw Hill Publication, 1st Edition, 2007	978-0070-6345-89
4	Machine Design Data Book	V B Bhandari, Tata Mc-Graw Hill Publication, 2nd Ed; 2019	978-9353-1663-04
5	Handbook of Mechanical Design	Gitin M. Maitra, L. V. Prasad, Tata Mc-Graw Hill Publication, Ed, 2001	978-0074-6023-86
6	Shigley's Mechanical Engineering Design	Richard G. Budynas, Keith J. Nisbett, Tata Mc-Graw Hill Publication, 11th Ed, 2020	978-0073-3982-11
7	Machine Component Design	Robert C.Juvinall, Wiley India Edition	978-8126-5597-32
8	Design Data: Data Book of Engineers	Compiled by: Faculty of Mechanical Engineering, 8th , Published by: Kalaikathir Achachgam, Coimbatoree	PSG College Technology Coimbatore

IS Codes

a) IS 4218: 1967 ISO Metric Threads
b) IS 2693: 1964 Cast Iron Flexible Couplings
c) IS 2292: 1963 Taper keys & Keyways
d) IS 2293: 1963 Gib Head Keys & Keyways
e) IS 2389: 1963 Bolts, Screws, Nuts & Lock Nuts
f) IS 4694: 1968 Square threads
g) IS 808: 1967 Structural Steel

E-References:

1. https://ndl.iitkgp.ac.in/
2. https://www.slideshare.net/anjanpatel1/design-of-springs
3. https://www.pdfdrive.com/search?q=machine+design+theory&pagecount=&pubyear=&searchin

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	2	2	2	2	2	2	3	2	2
CO2	2	3	3	2	2	2	3	3	2
CO3	3	3	3	2	2	2	3	3	2
CO4	**3**	3	3	2	2	2	3	3	2
CO5	3	3	3	2	2	2	3	3	2
CO6	3	3	3	2	2	2	3	3	2

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Vinit Jawale,	Technical Specialist	John Deere Technology Center India, Cybercity, Magarpatta City, Hadapsar, Pune 411013
2	Mr. Saurabh Singh	Scientist/Engineer	Liquid Propulsion System Centre, I.S.R.O. LPSC resident office , C/o M/s Godrej & Boyce, Plant 16A, Vikhroli , Mumbai 400079
3	Mr. K V Patil, ,	Sr. Lecturer	Government Polytechnic Thane, Near Phadke Pada,khardi Gaon,Mumbra,Thane.
4	Mr. Prashant K Ambadekar	Assistant Professor	SIES Graduate School of Technology, Sri Chandrasekarendra Saraswati Vidyapuram, Plot 1C-E, Sector V, Nerul, Navi Mumbai – 400 706.
5	Dr Sunil B Mahagaonkar,	Sr. Lecturer	Government Polytechnic Mumbai,49, Ali Yavar Jung Marg, Kherwadi, Bandra East, Mumbai, Maharashtra 400051
6	Dr. Avinash A Lonkar	Sr. Lecturer	Government Polytechnic Mumbai,49, Ali Yavar Jung Marg, Kherwadi, Bandra East, Mumbai, Maharashtra 400051

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code: ME19R303				**Course Title: Solid Modeling**						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hrs 30min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
--	**4**	**--**	**4**	**--**	**--**	**--**	**25***	**--**	**25**	**50**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination.

Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill test are to be conducted. First skill test at mid term and second skill test at the end of the term

Rationale:

Manufacturing industries have to design, develop, and manufacture the products in minimum possible time, at economical rate, and mainly without negotiating on the quality aspects, to sustain in competitive market. Hence, design and production department has to work together in an integrated approach. An application of computer in design, development, and manufacturing has created the way for highly flexible, accurate and fast integrated approach in manufacturing the parts. The process begins with conceptualizing the machine components and assemblies in automobiles, machine tools, and earth movers etc. as 3D models, making application of solid modeling software as a need of time in industries. In this context, the mechanical engineering diploma student must be well conversant with use of different features of solid modeling software. Students are also required to know the fundamentals of computer aided manufacturing. This course deals with the concept of solid modeling to enhance the solid modeling skills of the diploma engineering students. This course will enable the students to inculcate solid modeling concepts to solve engineering problems.

Course Outcomes: Student should be able to

CO1	Create and Constraint 2D sketches
CO2	Generate 3D models of machine components
CO3	Prepare assembly of 3D modelled components.
CO4	Create 3D surface models
CO5	Generate orthographic views/ drawings of models / assemblies.
CO6	Simulate tool path and create NC files

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction & 2D Sketching** 1.1 Introduction, Need of solid modeling, Different software's for Solid Modeling, Applications, Benefits. 1.2 Getting familiar with User Interface, Navigation tools, Drawing Units 1.3 Print setup, Layout preparation, 1.4 Making basic sketches- rectangle, circle etc., making polygons, circular/rectangular sketch patterns, 1.5 Modifying 2D sketches using trim, extend, offset etc. Geometrical constraints, 1.6 Export the drawing in dxf/ dwg,/ svg,/ pdf formats , and Print /Plot the drawings **Course outcome : CO1**
2	**3D Modeling** 2.1 3D modeling using extrude, revolve, sweep, etc. 2.2 Modifying 3D models by fillet, chamfer, use of rectangular and circular patterns, move, copy etc. Boolean operation : union, subtract, intersection 2.3 Making construction /reference planes 2.4 Modeling of simple machine components, such as spur gear, 3D spanner, nut bolts, pipe Joints, bearings, couplings, brackets, tools etc. 2.5 Export model in IGES/ STEP/ STL/dxf/ dwg,/ svg,/ pdf formats, and Print /Plot the 3D models **Course outcome : CO2**
3	**Assembly Modeling** 3.1 3D Modeling of assembly components (Assembly should have minimum three components like screw jack, bearings, tails stock, pipe vice, tool holders, couplings, pipe joints etc.) 3.2 Joints/constraints in Assembly, 3.2 Assembly motion, 3.3 Exploded view of assembly 3.3 Export assembly in IGES/ STEP/ STL/dxf/ dwg,/ svg,/ pdf formats & Print /Plot the Assembly **Course outcome : CO3**
4	**Surface Modeling** 4.1 Introduction, Creating free form surfaces 4.2 Creating free form surface models like water bottle, flower pot, heating iron, detergent bottle, soap case etc. 4.3 Export model IGES/ STEP/ STL/dxf/ dwg,/ svg,/ pdf formats, and Print /Plot the surface model. **Course outcome : CO4**
5	**Drafting** 6.1 Generate 2D drawings from 3D models 6.2 Insert base view, projected views - front view, top view, side view, sectional views, isometric views, etc. 6.3 Drafting of Assemblies 6.4 Dimensioning, 6.5 Bill of material for assemblies

	6.6 Export drawing in IGES/ STEP/ STL/dxf/ dwg,/ svg,/ pdf formats, and Print /Plot the drawing of model/ assemblies **Course outcome : CO5**
6	**Introduction to CAM** 7.1 Setup, Tool Manager, Drilling tool path, 2D tool path, simulate, setup sheets, post NC files 7.2 3D Printing, export to STL 7.3 Print /Plot the tool path and NC files **Course outcome : CO6**

List of experiments:

Sr. No.	Unit No	COs	Title of the Experiments	Hours
			Lab Orientation & Safety Instructions	02
1	1	CO1	Introduction to Graphics User Interface, Demonstrate the use of navigating tools, sketching of 2D sketches and constraints. **Prepare minimum four 2D sketches and printing/ plotting the drawings.**	08
2	2	CO2	Demonstrate to prepare 3D models from 2D sketches involving use of extrude, revolve, sweep, etc. commands, and modify commands. **Prepare minimum four 3D Models of machine components and printing / plotting the models.**	10
3	3	CO3	Demonstration of assembling the 3D models, establishing the motion in components of assembly. **Prepare an assembly from 3D modelled components, establish motion in assembly components, and printing/plotting an assembly.**	06
4	3	CO3	Demonstration of creating exploded view of an assembly. **Prepare exploded view of an assembly from prepared assembly and printing/plotting exploded view of an assembly.**	04
5	4	CO4	Demonstration of creating free form surfaces such as water bottle, flower pot, heating iron, detergent bottle, soap case, table lamp etc. **Prepare minimum four freeform surface models and printing / plotting the surface model.**	08
6	5	CO5	Demonstration of creating drafting i.e. base view, projected views, sectional views, isometric views of models. **Prepare the drafting of minimum four 3D models and printing / plotting the different views of 3D model.**	04

Sr. No.	Unit No	COs	Title of the Experiments	Hours
7	5	CO5	Demonstration of creating drafting i.e. base view, projected views, sectional views, isometric views of assembly, and bill of materials. **Prepare the drafting of minimum one assembly, bill of material (BoM), and printing / plotting the different views of assembly.**	06
8	6	Co6	Demonstration for Computer Aided Manufacturing for machining of the given component. **Select the tool, and simulate tool path for machining of the modelled component, and print / plot the tool path.**	08
9	6	CO6	Demonstration for Computer Aided Manufacturing for machining of the given component. **Generate the G codes for machining of the given component and print / plot the codes.**	04
Total				**60**

References/ Books:

1. User guides/ manual of Fusion 360 software

E-References:

1. https://thesourcecad.com/fusion-360-tutorial/
2. https://academy.autodesk.com/node/125076/take?q-nr=4

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	3	3	3	2	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	2
CO4	3	3	2	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3
CO6	3	3	2	3	2	3	3	3	3

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. Amit Gunjal	CEO	Milestone PLM Solutions, Thane
2	Mrs. Sameera Dhanawade Rawle	Managing Director	United Technologies, Virar
3	Dr. Shirish Dhobe	Lecturer in Mech. Engg.	Government Polytechnic, Thane
4	Dr. Sandeep Anasane	Associate Professor	College of Engineering, Pune
5	Shri. U.A. Agnihotri (Curriculum Content Designer)	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai
6	Dr. V. U. Rathod (Curriculum Content Designer)	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator, Head of Department
Curriculum Development, Department of Mechanical Engineering
Department of Mechanical Engineering

I/C, Curriculum Development Cell Principal

Programme: **Diploma in Mechanical Engineering (Sandwich Pattern)**										
Course Code: ME19R308				Course Title: Project						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hrs 30 min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
--	**4**	**--**	**4**	**--**	**--**	**--**	**--**	**50***	**50**	**100**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at midterm and second skill test at the end of the term

Rationale:

Diploma technicians is expected to integrate and apply the theory and practical skills to solve the industrial issues. This requires the abilities for problem identification, definition and problem analysis, development of alternatives and implementation of solution. The comprehensive understanding of various courses studied and application of basics to derive solution need to be developed within technicians.

This course provides the opportunity for learners to solve the problem, using technical knowledge and skills gained during previous semesters. It also simulates the situation for team working, leading and self-motivation through work.

Course Outcomes: Student should be able to

CO1	Identify, Analyze and Define the problems.
CO2	Derive solutions to the problem and select most appropriate solution.
CO3	Use various information resources to collect information related to project idea.
CO4	Manage conflicts and work effectively in team.
CO5	Design, Develop, and Manufacture the machine/equipment.
CO6	Prepare project related documentation, communicate and present work done.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Methodology:** **1.** This course will be completed in the fifth semester. **2.** Course registration will be at the beginning of the fifth semester. **3.** A batch will be formed of maximum four students. **4.** A project dairy is to be maintained by each student giving details of planning, work executed, information collected etc. on weekly basis and the same should be shown to the guide concerned.

	5. Project report should be of about 50 to 70 pages of Times New Roman font. Font size of main heading, subheading and text should be 16, 14, 12 respectively. The report should consist of text, drawing, graphs, tables, photographs etc. of about 5000 words 6. Batch formation, project identification, project selection, survey work, production of model, if any presentation should be completed during the fifth semester.
2	**Following is the suggestive list of topics for selection of project:** 1. A fabrication of small machine / test rig/ devices etc. 2. Design and fabrication of mechanisms, machine and devices etc. 3. Development of computer programming. 4. Industry supported project. 5. Literary based survey project. 6. Investigative type project. 7. Maintenance based project 8. Industrial Engineering-based project 9. Low cost automation project 10. Creativity based engineering project 11. Environment based project 12. Market survey project 13. Project in recent trends in mechanical engineering 14. Appropriated technology related to rural areas
3	**Project Report preparation:** Suggested contents of the Project Report (Guide can make required changes as per nature of project) • Title page (with name of team members and mentor teacher) • Certificate • Acknowledgments • Abstract • Content page 1. Chapter -1 Introduction & Project Definition 2. Chapter-2 Literature survey

	3. Chapter-3 Project Planning **4.** Chapter-3 Design & Solid Modelling **5.** Chapter-4 Fabrication/ Manufacturing **6.** Chapter-5, Trials & Experimentation **7.** Chapter-6 Costing **8.** Chapter-7 conclusion and future scope **9.** Appendix (if any) **10.** References and Bibliography

Rubric 1: For Project Oral

Criterion No	Criterion	CO	Max Marks	Not Satisfactory (1-4)	Satisfactory (5-6)	Good (7-8)	Excellent (9-10)
1	Literature survey	CO1 CO2 CO3	10	Information is gathered from a single source.	Information is gathered from a limited number of sources.	Information is gathered from multiple sources.	Information is gathered from multiple, research-based sources.
2	Organization of presentation	CO2	10	Audience cannot understand presentation because there is no sequence of information	Audience has difficulty following presentation because student jumps around.	Student presents information in logical sequence which audience can follow	Student presents information in logical, interesting sequence which audience can follow.
3	Graphics (use of PowerPoint)	CO4	10	Uses graphics that rarely support text and presentation	Uses graphics that relate to text and presentation	Uses graphics that explain text and presentation	Uses graphics that explain and reinforce text and presentation

4	Elocution and eye contact	CO2 CO4	10	Mumbles and/or Incorrectly pronounces some terms/ Voice is low; difficult to hear	Voice fluctuates from low to clear; difficult to hear at times	Voice is clear with few fluctuations; audience can hear well most of the time	Voice is clear and steady; audience can hear well at all times
				Reads most slides, no or just occasional eye contact	Refers to slides to make points, occasional eye contact	Refers to slides to make points, eye contact majority of time	Refers to slides to make points, engaged with audience
5	Oral	CO1 CO2 CO3 CO4 CO5 CO6	10	Does not understands question /no answer to question	Answers some questions but not clearly and completely	Answers to most of the questions clearly and completely	Answers to all questions confidently

Rubric 2: For Project TW

Criterion No	Criterion	CO	Max Marks	Not Satisfactory (1-4)	Satisfactory (5-6)	Good (7-8)	Excellent (9-10)
1	Problem Identification	CO1	10	Little or no background information is presented to help the audience understand the history and significance of the project.	Background information is provided, an explanation of why the project was undertaken, to help put the presentation in context.	Background information is provided, including references to the work of others and an explanation of why the project was undertaken, to help put the presentation in context.	Insightful and in-depth background information is provided to illuminate the issues through inclusion of history relevant to the presentation, a succinct description of the significance of the project.
2	Literature Review	CO1 CO2	10	Very few and not relevant	Few and relevant	Relevant information from multiple sources	Information is gathered from multiple, research-based sources.

3	Planning of Project Work And Team Structure	CO3 CO4	10	Time frame not properly specified, In-appropriate distribution of project work	Time frame properly specified, but not being followed, Distribution of project work un-even	Time frame properly specified and being followed Distribution of project work inappropriate	Time frame properly specified and being followed, Appropriate distribution of project work
4	Testing	CO5	10	Testing done not done properly , no correct method of testing	Testing done in single condition , required modification not done after testing	Testing done in multiple condition , required modification not done after testing	Testing demonstrates engineering skill , required modification done after testing
5	Project Report	CO6	10	Project report not prepared according to the specified format, References and citations are not appropriate.	Project report is according to the specified format but some mistakes In-sufficient references and citations	Project report is according to the specified format, References and citations are appropriate but not mentioned well	Project report is according to the specified format References and citations are appropriate and well mentioned

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	3	3	3	2	2	3	3	3
CO2	3	3	3	3	2	3	3	3	3
CO3	3	3	3	2	2	2	3	3	3
CO4	3	3	3	3	2	2	3	2	3
CO5	3	3	3	3	2	3	3	3	3
CO6	3	3	2	2	2	2	3	3	2

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. Gautam Patil	Deputy Manager Die Shop	Mahindra & Mahindra Ltd, Nashik
2	Mr. Amit Khatale	Team Leader	Tata Technologies, Pune

3	Mr. Yogesh Gaidhani	Head of Department	K K Wagh Polytechnic, Nashik
4	Mr. Jayram Rathod	Lecturer in Mechanical Engineering	Government Residential Womens' Polytechnic, Nanded
5	Mr. K. Z. Dhangare	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai
6	Miss. A. R. Hagawane	Lecturer in Mechanical Engineering	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal