Jharkhand University of Technology, Ranchi
Diploma (Mechanical Engineering)

III[rd] Semester

S.No.	Course Code	Course Title	Hours per week				Cr	FM	Overall Pass Marks	Internal	External	Categorization
			L	T	P	J						
01	MEC301	Mechanics of Materials	3	1	0		4	100	40	30	70	MEC
02	MEC302	Machine Tool Technology	3	1	0		4	100	40	30	70	MEC
03	MEC303	Manufacturing Processes	3	1	0		4	100	40	30	70	MEC
04	MEC304	Fluid Power Engineering	3	1	0		4	100	40	30	70	MEC
Total			**12**	**4**	**0**		**16**	**400**	--	--	--	--
Practical			**L**	**T**	**P**		**Cr**	**FM**		**Internal**	**External**	**Categorization**
05	MEC301P	Mechanics of Materials	0	0	4		2	50	25	30	20	MEC
06	MEC302P	Machine Tool Technology	0	0	4		2	50	25	30	20	MEC
07	MEC303P	Manufacturing Processes	0	0	4	6	2	50	25	30	20	MEC
08	MEC304P	Fluid Power Engineering	0	0	4		2	50	25	30	20	MEC
Total			**0**	**0**	**16**		**8**	**200**	--	--	--	--
Audit Course			**L**	**T**	**P**		**Cr**	**FM**		**Internal**	**External**	**Categorization**
09	AUC301	Professional Skills	3	0	0		Passing in Audit Course shall be mandatory.					
10	AUC301P	Sports/NCC/NSS/YOGA/Painting/Music/ Classical Dance	6				Student shall participate actively in one of the activities and for Passing of the semester "Participation Certificate" in activity will be mandatory. Student participation shall be monitored and participation record shall be maintained at institute level.					
Total			**0**	**0**	**0**		**0**	--	--	--	--	--
Grand Total			**12**	**4**	**23**	**6**	**24**	**600**	--	--	--	--

***PC: Programme Core: - AU- Audit Course; L: Lecture, T: Tutorial, P: Practice.**
J- Self learning hours shall not be reflected in the Time table. Self-learning includes micro project/ assignment/ other activities as mentioned in earlier semester.

Jharkhand University of Technology, Ranchi
Diploma (Mechanical Engineering)

IVth Semester

S.No.	Course Code	Course Title	Hours per week				Cr	FM	Overall Pass Marks	Internal	External	Categorization
			L	T	P	J						
01	MEC401	Operations Management	3	1	0		4	100	40	30	70	MEC
02	MEC402	CNC Programming and Machining	3	1	0		4	100	40	30	70	MEC
03	MEC403	Product Design and Development	3	1	0		4	100	40	30	70	MEC
04	MEC404	Elements of Industrial Automation	3	1	0		4	100	40	30	70	MEC
Total			**12**	**4**	**0**		**16**	**400**	--	--	--	--
Practical			**L**	**T**	**P**		**Cr**	**FM**		**Internal**	**External**	**Categorization**
05	MEC401P	Operations Management	0	0	4		2	50	25	30	20	MEC
06	MEC402P	CNC Programming and Machining	0	0	4		2	50	25	30	20	MEC
07	MEC403P	Product Design and Development	0	0	4	6	2	50	25	30	20	MEC
08	MEC404P	Elements of Industrial Automation	0	0	4		2	50	25	30	20	MEC
Total			**0**	**0**	**16**		**8**	**200**	--	--	--	--
Audit Course			**L**	**T**	**P**		**Cr**	**FM**		**Internal**	**External**	**Categorization**
09	AUC401	Mastering Personal Finance (Basic to Advance Strategies)	3	0	0		Passing in Audit Course shall be mandatory.					
10	AUC401P	Sports/NCC/NSS/YOGA/Painting/Music/ Classical Dance	6				Student shall participate actively in one of the activities and for Passing of the semester "Participation Certificate" in activity will be mandatory. Student participation shall be monitored and participation record shall be maintained at institute level.					
11	INT401P	Summer Internship	6-8 Weeks				2	--	--	**1/0**	--	INT
Total			-	-	-		**2**	--	--	--	--	--
Grand Total			-	-	-	**6**	**26**	**600**	--	--	--	--

Note-

1. **MEC: - Mechanical Engineering, AUC- Audit Course; L: Lecture, T: Tutorial, P: Practice, CIE- Continuous Internal Evaluation, SEE- Semester End Evaluation.**
2. **INT- Internship (Completion of internship will be marked as-1; Non-completion of internship will be marked as-0 by the institution; The submitted write up & presentation record shall be kept safely by the institution).**
3. **J- Self learning hours shall not be reflected in the Time table. Self-learning includes Micro project/ assignment/ other activities as mentioned in earlier semester.**

Jharkhand University of Technology
Ranchi, 834010

SYLLABUS

For Diploma Program in

Mechanical Engineering

(Effective from 2024-25)

DEPARTMENT OF MECHANICAL ENGINEERING

(3rd – SEMESTER)

Mechanics of Materials

Subject Code -MEC301

1. Rationale

In this course, Diploma engineers are required to analyse the reasons for failure of components and select the suitable materials for a given applications. For this purpose, it is essential to study the concepts, principles, applications and practices covering stress, strain, stress concentration, weak points, deformations, bending moment and shearing force. The students will also study the basic principles of Finite Elements Analysis and perform stress strain analysis using Ansys software to understand and quantify the effects of real-world conditions on a part. These simulations, will allow Diploma engineers to locate potential problems in a design, including areas of tension and weak spots. FEA becomes a tremendous productivity tool, helping engineers in reducing product development time and cost. Hence, FEA is introduced in this course. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles to the solution of applied problems and to develop the required skill and competencies

2. Course Outcomes: At the end of the Course, the student will be able to:

CO-01	Analyse Simple Stresses and Strains on given Structural member that is subjected to Tensile, Compressive and Shear loads by using Destructive Test.
CO-02	Draw Shear force Diagram (SFD) and Bending moment Diagram (BMD) and Also, Analyse Bending Stresses in a Beam using Finite element methods(FEM) software
CO-03	Demonstrate the application of finite element formulations to solve both One dimensional and Two dimensional Problems.
CO-04	Demonstrate the application of FEM software for Validation of both One dimensional and Two dimensional Problems

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	01	1. Introduction to Force- Types of Forces-Resolution of forces	Refer Table 1	Resolution of forces by Graphical Method
			2. Problems on Resolution of forces- Analytical Method		Verification of Forces by Lami's Theorem
			3. Problems on Resolution of forces- Analytical Method		
2	01	01	1. Types of Loads-Tensile, Compression, Shear, Impact, Stress- Types- Strain- Types- - Hooks Law- Young's Modulus		Conduct Tensile test for the given Specimen and Determine Stress- Strain- Young's Modulus, Yield Stress- Maximum Stress-

			2. Stress - Strain Diagram - Elastic constants- Linear strain, Lateral Strain, Poison's Ratio, Volumetric Strain, Bulk Modulus, Rigidity Modulus , Fatigue - Endurance Limit 3. Stress concentration, Factor of Safety(FOS), Concept of Temperature stresses	Refer Table 1	Breaking Stress- % Elongation in Length and % Reduction in Area Also, Draw Stress- Strain Diagram for the above Parameters
3	01	01	1. Simple Problems on Stress, Strain and Elastic constants 2.. Simple Problems on Stress, Strain and Elastic constants 3. Simple Problems on Stress, Strain and Elastic constants	Refer Table 1	Conduct Compression test for the given Specimen and Determine Stress- Strain- Young's Modulus, Yield Stress- Maximum Stress- % Reduction in Length and % Increase in Area Also, Draw Stress- Strain Diagram for the above Parameters
4	01	01	1. Problems on Members subjected to combined Stresses 2. Problems on Members subjected to combined Stresses 3. Problems on Members subjected to combined Stresses	Refer Table 1	Conduct Shear test for the given specimen
5	02	02	1. Types of Beams-Types of Loads acting on Beams- Concept of Shear force - Bending moment 2 Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for Cantilever subjected to Point Load and Uniformly Distributed loads (UDL) 3. Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for Cantilever subjected to Point Load and Uniformly Distributed loads (UDL)	Refer Table 1	Conduct Bending test for the given specimen

6	02	02	1. Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for a Simply supported beam subjected to Point Load and Uniformly Distributed loads (UDL) 2. Draw SFD and BMD for Simply supported and Cantilever beam subjected to Point Load and UDL Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for a Simply supported beam subjected to Point Load and Uniformly Distributed loads (UDL) 3 Draw SFD and BMD for Simply supported and Cantilever beam subjected to Point Load and UDL Draw Shear force Diagram (SFD) and Bending Moment Diagram (BMD) for a Simply supported beam subjected to Point Load and Uniformly Distributed loads (UDL)	Refer Table 1	Present You tube videos in Stress, Strain and Bending Stresses on Different mechanical members Prepare a report on the observations made Eg: https://www.youtube.com/watch?v=C-FEVzI8oe8
7	02	02	1. Pure Bending- Assumptions- Neutral Axis- Bending Equation 2. Problems on Bending Equation 3. Problems on Bending Equation	Refer Table 1	Present You tube videos in Stress, Strain and Bending Stresses on Different mechanical members Prepare a report on the observations made
8	03,04	01	1. Introduction to Finite Element Methods (FEM), Need-Back Ground 2. Methods employed in FEM- Steps in FEM 3. Advantages and Disadvantages, Limitations, Applications of FEM-Concept of Discontinuity	Refer Table 1	Practice on FEM software (Eg: Ansys)
9	02,03,04	01,02,04	1. Phases of FEA(Finite Element Analysis) 2. Discretization Process 3. Meshing –Element type	Refer Table 1	Validate Bending Equation Problems solved in Week 7 using FEM software (Eg: Ansys)
10	02,03,04	01,02,04	1. Stiffness Matrix of a Bar Element 2. Global Stiffness Matrix- Properties of stiffness matrix	Refer Table 1	Validate Bending Equation Problems solved in Week 7 using FEM software (Eg: Ansys)

			3. Boundary Conditions- Methods –Types		
11	03,04	02,04,07	Problems on 1-D elements	Study the latest technological changes in this course and present the impact of these changes on industry	Validate using FEM software (Eg: Ansys)
12	03,04	02,04,07	Problems on 1-D elements		Validate using FEM software (Eg: Ansys)
13	03,04	02,04,07	Problems on 2-D elements		Validate using FEM software (Eg: Ansys)
Total in hours			**39**	**13**	**52**

5. Reference:

Sl. No.	**Description**
1	Schaum Outlines, "Strength of Materials", 5 Edition
2	RAMAMURTHAM. S., "Strength of Materials", 14th Edition, Dhanpat Rai Publications, 2011
3	KHURMI R S, "Applied Mechanics and Strength of Materials", 5 Edition, S.Chandand company
4	NASH W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co., New York, 1995.
5	RYDER G.H, "Strength of Materials", 3rd Edition, Macmillan India Limited, 2002.
6	BANSAL R. K, "Strength of Materials", Laxmi Publications, New Delhi, 2012.
7	Schaum series, Strength of Materials
8	TIMOSHENKO S.P, "Elements of Strength of Materials", Tata McGraw-Hill, Delhi,
9	Introduction to Finite Elements in engineering by TRIRUPATHI R, CHANDRUPATLA, ASHOK D BELEGUNDA, Pearson Publications.
10	Practical Finite Element Analysis by NITIN S GOKHALE,SANJAY S DESHPANDE, Finite to Infinite Publications
11	ANSYS free software tutorial((Student version) https://www.google.co.in/search?biw=1024&bih= 667&q=ansys+software+ tutorial&sa=X&ved=0ah UKEwjm5o MndHNAh UBsI8KHbRWDhUQ1QIIXygE

6. LIST OF SOFTWARE/LEARNING WEBSITES

1. www.nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024htm
2. www.wikipedia.org/wiki/Shear_and_moment_diagram
3. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
4. www.engineerstudent.co.uk/stress_and_strain.html
5. www.**ansys**.com/Student
6. http://www.mece.ualberta.ca/tutorials/ansys

7. Equipment/software list

Sl. No.	Particulars	Specification	Quantity
01	Universal testing machine	Computerized 100 Ton Capacity With all attachments to conduct shear, bending , compression and tensile test	
02	Ansys software		
03	Desktop Computer	Latest configuration	

Machine Tool Technology

Subject Code -MEC302

1. Rationale: Diploma Engineers are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, knowledge about various machining processes is required to be imparted. The students are to be trained and equipped with adequate theoretical and practical knowledge about Metal Cutting Phenomenon and various processes like turning, drilling, milling, grinding etc. Hence, this course is introduced to provide hands on experience on various machine tools used in the manufacturing stream and to provide foundation for diploma engineers who want to further specialise in the field of precision manufacturing

2. Course Outcomes: At the end of the Course, the student will be able to:

CO-01	List relevant work place Occupational health and safety standards and explain the importance of the need to comply with them.
CO-02	Explain the importance of Cutting tool Geometry, list various Cutting Parameters, the role and use of the right Coolants and Lubricants for the given machining processes.
CO-03	Demonstrate turning operation for a given component drawing and object, prepare a process chart and estimate the cost of its production as per drawing.
CO-04	Demonstrate milling and drilling operation needed as per a given component drawing, list all the machine tools needed for the operation, prepare a process chart and estimate the cost of its production as per the drawing.

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	05	1. Educate about Safety standards Practiced in the machine Shop - Importance of housekeeping and good Shop floor Practices(5S) 2. Understand the Principles of First Aid. Preventive measures to be taken during Fire and Electrical emergency	Refer Table 1	1. Read and interpret the safety signs displayed in the Machine shop Instructor has to show various Safety sign charts and Personnel Protective Equipment (PPE) and ask the trainees to identify and record in the dairy 2. Read and interpret the PPE

			Types of Fire extinguisher (Class A,B,C,D) 3. Knowledge about Safety and Environment Regulations		First aid and basic training Identify and Segregate waste material (cotton waste, metal chips, burrs etc.) Arrangement of waste in bins 3. Hazards identification and avoidance Preventive measure for electrica accidents Select the fire extinguisher according to type of fire 4. Operate the Fire extinguisher and extinguish the fire Preventive measure for Oil leakages and related Hazards Practice the safety norms whil working on Deferent Machine Tool
2	02	01,04	1 Lubrication- Need of Lubrication- Selection of Lubricant as per ISO standard. 2. Theory of metal Removal- Traditional & Non Traditional material removal process- Chip forming & Non chip forming 3. Types of cutting tools- Single point tools-Multi point tools – Specification of Single Point Cutting Tool, Parting , Knurling Tool, V- tool	Refer Table 1	1. Instructor has to display all the Lubricants used in the section and brief about its uses 2. Select a Proper lubricant and demonstrate the lubrication of various m Ask the students to record in the Dairy 3. Instructor has to show all the tools, machineries and measuring instruments used in the machine shop and brief about its uses. Ask the students to record in the Dairy. 4. Identify the type of Chips formed and record in the dairy
3	02	01	1. Grinding- Abrasives- Applications of Natural abrasives- stand stone (Quartz), Corundum and Emery Diamond and Garnets- Application of Manufactured Abrasives- Silicon Carbide, Aluminum Oxide Cubic boron Nitride 2. Explain – Grit, Grade, Structure, Bond, Type ISO Designation of Grinding Wheels 3. Tool Geometry-Tool materials and Designation-Tool life & Wear	Refer Table 1	1. Practice on Grinding machine 2 Grinding Practice of Single point tool as per tool Geometry

			Concept of Cutting speed-Depth of cut-Feed		
4	03	01	1. Introduction to Surface Texture- Indication of Roughness Symbols- Complete surface symbol chart, Grade and Numbers,- Tolerances- Unilateral and Bilateral 2. Introduction to Lathe-Types of lathe- Capstone and Turret Lathe, Automatic Lathe and others - Specification of a Center Lathe -. Cutting Fluids- Selection of cutting fluids- 3. Explain Work holding Devices- Tool Holding Devices	Refer Table 1	1. Read and interpret the Surface finish and Tolerances in the given Production drawing. 2. Identify the main Parts of Lathe and its functions Identify the movements in Lathe Parts • Carriage • Cross Slide • Tail Stock 3. Remove the Chuck from Spindle Nose and again mount on it 4. Demonstration of holding Work piece in 3-Jaw and 4-Jaw chuck 5. Idle operation of Lathe. Rotation of spindle in Clockwise and Counter clockwise direction 6 .Identify the Lubrication Parts in Lathe 7. Set the Spindle speed - Feed -Lever Position.
5	03	01,02, 04	1. Explain Plain turning, Step turning, Knurling and Chamfering Operations 2. Prepare the Process plan as per the given drawing for Plain Turning, Step Turning, Knurling and Chamfering 2. Estimate the Production cost per Piece as per the given drawing for Plain Turning, Step Turning, Knurling and Chamfering (Consider all Direct and Indirect costs)	Refer Table 1	1. Read and Understand the given Drawing 2. Select the suitable Raw material 3. Fix the given material between headstock and Tail Stock after performing Facing and Countersinking. 4. Select the Speed and Feed 5. Select and set the appropriate cutting tools as per the sequence of operations 5 Perform all operations as per the process plan 6. Check the dimensions using measuring instruments 7. Observe and Identify the Chip Formation
6	03	01,02, 04	1. Explain Taper turning operations by different methods- Calculate Taper angles for	Refer Table 1	1. Read and Understand the given Drawing

			different Taper turning component Drawings 2. Prepare the Process plan as per the given drawing for Taper Turning 3. Estimate the Production cost per Piece as per the given drawing for Taper Turning(Consider all Direct and Indirect costs)		2. Mark the required dimensions as per the given drawing for Taper turning 3. Fix the given material between headstock and Tail Stock 4. Select and Set the tools to perform Taper turning 5. Select the Speed and Feed 6. Perform the Taper Turning operations and record the machining time. 7. Measure the Taper angle in the given specimen using Bevel Protractor
7	03	01,04	1. Explain Thread cutting Mechanism a) Half Nut Mechanism b) Tumbler Gear Mechanism 2. Prepare the Process plan as per the given drawing for Thread cutting 3. Estimate the Production cost per Piece as per the given drawing for Thread cutting (Consider all Direct and Indirect costs)	Refer Table 1	1. Read and Understand the given Drawing 2. Fix the given material between headstock and Tail Stock 3. Select and Set the tools to perform Thread cutting operations 4. Select the Speed ,Feed and lubricant 5. Perform the thread cutting operations Measure the Pitch of the thread for the given specimen by using Pitch Gauge
8	04	01,04	1. Introduction to Milling – Types of milling machine – Specification of a Milling machine 2. Types of Milling cutters and their uses- Milling Cutter Nomenclature- Specification of Milling Cutter 3. Methods of Milling-Up Milling and Down Milling- Work holding devices	Refer Table 1	1. Identification of Milling machine Parts and its Usage 2. Demonstrate the working Principle of Milling machine and movements of Table and Arbor 3. Setting of Vice and Job on the Table of Milling Machine 4. Set the Cutter on the Arbor 5. Illustrate the safety points to be observed while working on the Milling machine 6. Identify and Select the different Milling Cutters 7. Demonstrate the Up-milling and Down – Milling Process
9	04	01,02, 04	1. Explain Plain Milling Operation 2.. Prepare the Process plan as per the given drawing(Solid Block) for Plain Milling 3. Estimate the Production cost per Piece as per the given drawing for Plain Milling	Refer Table 1	1. Perform Plain Milling of Six faces of a Solid Block 2. Check the accuracy of the Job with suitable Measuring Instruments

			Operation (Consider all Direct and Indirect costs)		
10	04	01,02, 04,07	1. Explain Key way and V- slot Operation 2. Prepare the Process plan as per the given drawing for Key way and V- slot 3. Estimate the Production cost per Piece as per the given drawing for Key way and V-slot	Study the latest technological changes in this course and present the impact of these changes on industry	1. Perform Milling of Keyway and V Slot 2. Check the dimensional accuracy with suitable Measuring Instrument
11	04	01,02, 04,07	1. Explain Gear cutting by Indexing Methods 2. Prepare the Process plan as per the given drawing for Gear cutting 3. Estimate the Production cost per Piece as per the given drawing for Gear cutting		1. Demonstrate Indexing Head 2. Set and Align Indexing Head with reference to the Job on Milling machine Table 3. Perform Gear Teeth on a Blank by Simple Indexing Method

12	04	01,02, 04,07	1. Introduction to Drilling – Types of Drilling Machines- Specification of Drilling Machines-Specification of Drill Bit, Reamer , Die and Taps 2. Nomenclature of Drill Bit, Reamer, Die and Taps- Standard sizes of Drill Bits Explain Operations performed in Drilling Machines- Drilling, Counter sinking, Reaming, Boring, Tapping 3. Prepare the Process plan as per the given drawing and Estimate the Production cost per Piece as per the given drawing		1. Identification of Drilling machine Parts 2. Demonstrate the working Principle of Drilling machine 3. Set the Vice and Job on the Table of Drilling machine 4. Illustrate the safety points to be observed while working on the Drilling machine 5. Identify and Select the different Drill Bits 6. Set the Drill bits on the spindle. 7. Drill Equally spaced holes (Circular/Square/Rectangul ar plate) 8. Finish the pre-drilled hole with a Reamer
13	01, 02, 03, 04		Demonstrate the manufacturing of following components using YouTube Videos 1. Fasteners 2. Propeller Shaft 3. Gears 4. Piston manufacturing Discuss and Prepare a Report on the videos Presented for each manufactured component.		Demonstrate the manufacturing of following components using YouTube Videos 1. Tube and Piston Rod Manufacturing. 2. Cylinder manufacturing etc., 3. Single point tool 4. Drill bits Etc. Discuss and Prepare a Report on the videos Presented for each manufactured component
Total in hours			**39**	**13**	**52**

5. Reference:

Sl. No.	Description
1	Mechanical estimation and costing T.R.Banga and S.C.Sharma Khanna publishers
2	Mechanical Estimation Malhothra
3	Industrial Organization and Engineering Economics T.R. Banga and S.C.Sharma Khanna publishers
4	Mechanical Estimation NITTTR Chennai NITTTR Chennai
5	Mechanical costing and Estimation. Singh and Khan Khanna Publishers
6	Process Planning & Cost Estimation M.Adithan New age International
7	Rao, P.N., Manufacturing Technology, Vol I & II, Tata Mcgraw Hill Publishing Co., New Delhi, 1998
8	Seropekalpakjian, Steven R Schmid Manufacturing Engineering and Technology- Pearson Education-Delhi
9	Sharma, P.C., A Textbook Of Production Technology – Vol I And II, S. Chand & Company Ltd., New Delhi, 1996
10	HMT – "Production Technology", Tata Mcgraw-Hill, 1998

6. LIST OF SOFTWARES/ LEARNING WEBSITES:

1. http://calculatoredge.com/index.htm#mechanical
2. www.nptel.ac.in/courses/112105126/36
3. www.youtube.com/watch?v=T5gjkYvMg8A
4. www.youtube.com/watch?v=ESKoaZtoB1E
5. www.freevideolectures.com

7. Equipment list

Sl. No.	Particulars	Specification	Quantity
01	Center lathe With all accessories and attachments(Gear driven)	Max 50mm Dia Holding capacity 500mm Center distance .Swing over dia 200mm	
02	HSS cutting tool	20*20*150MM	
03	HSS cutting tool	10*10*150MM	
04	Cemented carbide tipped tools with holder brazed	For turning	
05	Knurling tool Rough	Standard	
06	Knurling tool Smooth	Standard	
07	Vernier calipers	300mm	
08	Outer caliper	5omm OD	
09	Steel scale	300mm	
10	Dial gauge for setting of work	Standard	
11	Counter sunk Drill Bit	6mm Taper shank	
12	Upright Drilling Machine	Upto 24mm drill With all attachment	

13	Sensitive Drilling Machine	Upto 18mm drill	
14	Machine Vice (To hold Job)	120mm Jaw Gap	
15	Drill Bit set	6mm to 24mm	
16	Marking Divider	200mm dia	
17	Marking punch	Standard	
18	Combination Set Square	Standard	
19	Surface plate	300*300mm	
20	Column and Knee type Vertical MILLING machine With all attachments	.Table Travel of 800mm .24mm cutters Bore dia (ID)	
21	Plain milling Cutter 24mm ID/Slab milling	Standard Size for Practice	
22	Key way cutter	6mm	
23	Key way cutter/Slot cutter	12	
24	Gear cutter (Spur teeth)	Standard Size for Practice	
25	Concave Milling cutter	Standard for Size Practice	
26	Convex Milling cutter	Standard Size for Practice	
27	Key way Milling cutter	40mm dia	
28	End Milling Cutter	24mm dia	
29	Bench Grinder	300mm wheel dia Rough and Smooth	

Manufacturing Processes

Subject Code -MEC303

1. Rationale: Diploma Engineers are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, knowledge about various manufacturing processes is essential. This requires training the students in casting and metal forming domain so as to equip them with adequate theoretical and practical knowledge about the various metal casting and forming processes like rolling, forging, drawing, extrusion, Sheet metal work etc. Hence this course is introduced to provide hands on experience on various manufacturing processes.

2. Course Outcomes: At the end of the Course, the student will be able to

CO-01	Produce patterns, moulds, and casting of a given component drawing and estimate the cost of casting.
CO-02	Demonstrate forging operation for a given component drawing and estimate the cost of forging.
CO-03	Prepare sheet metal drawing, demonstrate sheet metal operation and estimate the costs of Sheet metal operation.
CO-04	Explain rolling and extrusion operation and list applications of metals forming processes.

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	01,04	1. Introduction to foundry – You tube videos on foundries Explain the safety Precautions to be taken in foundries 2. Explain the need of a Pattern- Types of Patterns—Solid or Single Piece pattern, Split Pattern, Loose Piece Pattern, Match Plate Pattern, Gated Pattern, Sweep Pattern, Skeleton-Pattern 3. Allowances- Materials used for Pattern	Refer Table 1	1. Identify the tools and equipment used in foundry with application 2. Prepare a single Piece wooden Pattern considering all allowances
2	01	01,04	1. Molding Sand-Types 2. Ingredients and Properties of Molding Sand	Refer Table 1	1. Prepare a molding sand 2. Preparation of Mold with the help of Pattern

			3. Importance of Core and Core prints-Gates-Runner-Riser		3. Melt the metal (wax) and pouring it into the mold cavity
3	01	01,04	1. Explain Defects in Casting 2. Inspection of Casting 3. Determination of Production Cost of a given material considering Raw material, Process cost, Overheads and other expenses	Refer Table 1	1. Cutting Runner and riser in the casted component 2. Cleaning of the casted component 3. Inspection of the casted component 4. Record the defects, if any
4	02	01,04	1. Introduction to basic Metal Forming Process and Applications- Show You tube Video's on Metal Forming Process 2. Explain Hot and Cold Working Process with Application Show You tube Videos on Hot and Cold Working Process 3. Introduction to forging operation- Types of forging- Hand forging and Power forging	Refer Table 1	1. Demonstrate safety precautions to be followed in Forging 2. Identify the tools and equipment's used in forging 3. Forging Practice (Hammering)
5	02	01,04	1. Explain forging Operations - Upsetting, drawing down, Cutting, Bending 2. Explain Punching and Drifting, Setting down and Finishing, Forge Welding 3 Estimation of Length of Raw material required to convert Circular rod to Square and Calculate the Production Cost considering direct and Indirect expenses.	Refer Table 1	Conversion of Circular rod to Square
6	02	01,04	1. Estimation of Length of Raw material required to convert Circular rod to Hexagon and Calculate the Production Cost considering direct and Indirect expenses. 2. Explain the working principle of Power hammer 3. Show the you tube videos on components produced by Power forging	Refer Table 1	Conversion of Circular rod to Hexagon
7	02	01,04	1. Estimation of Length of Raw material required to convert Hexagon to" L" shaped Nail and Calculate the Production Cost considering direct and Indirect expenses 2. Explain Forging losses- Forging Defects	Refer Table 1	Conversion of Hexagon to " L" Nail as per the given drawing

			3. Show the you tube videos on components produced by forging operations		
8	03	01,04	1. Introduction to sheet metal- Show You tube videos on sheet metal operations and Applications 2. Explain sheet metal materials – Standard Gauges of sheet - Specification of Sheet 3. Explain different Sheet metal operations	Refer Table 1	1. Identify and demonstrate the various tools used for sheet metal operations. 2. Measure the gauges of sheet 3. Demonstrate the operations performed on Shearing machine
9	03	01,04	1. Explain the Development of Cone and Cylinder 2. Explain the Development of Prism and Pyramid 3. Explain the Development of Funnel	Refer Table 1	1. Prepare Cone, Cylinder, Prism, Pyramid and Funnel 2. Join end surfaces by means of Seam Joint
10	03	01,04	1. Explain the Development of Tray 2. Explain the Development of Transition pieces 3. Explain the Development of Transition pieces	Refer Table 1	1. Prepare a Tray 2. Prepare any Transition Piece
11	03	01,04 07	1. Find the total Production cost of a sheet metal components like Open container, Cylindrical Drum 2. Introduction to Power Press -Press size- Press tools – Die Accessories 3. Types of Die and its operations	Study the latest technological changes in this course and present the impact of these changes on industry	1. Present You tube Videos on Press work operations 2. Record the observations made and prepare a report.
12	04	01,07	1. Introduction to Rolling- Nomenclature of Rolled Products- Dies used in rolling process 2. Types of Rolling mills-2 high mill- 3 High mill – 4 High mill- Cluster mill, Tandem Mill, Planetary mill, Defects in Rolling 3. Introduction to Extrusion and Drawing – Types of Extrusion Process. Wire and Tube Drawing Process, Dies used in Extrusion and Drawing Process		Video/ Virtual exposure on Rolling and Extrusion
13	04	01,07	Demonstrate the manufacturing of following components using YouTube Videos 1. Crank Shaft 2. Valves 3. Wheel 4. Gear case 5. Hair springs		Demonstrate the manufacturing of following components using YouTube Videos 1. TMT Steels 2. Channel sections 3. Pump Casings 4. Rolling of Sheets

			Discuss and Prepare a Report on the videos Presented for each manufactured component		5. Tooth paste tube 6. Pipes 7. Tubes etc., Discuss and Prepare a Report on the videos Presented for each manufactured component
Total in hours			**39**	**13**	**52**

Reference:

Sl. No.	Description
1	Elements of Workshop Technology (Vols. 1 and II) by Hajra Chaudhary
2	Production Technology By R.K. Jain
3	Foundry Technology By O.P.Khanna
4	Engineering Drawing Vol-2 By K.R.Gopala Krishna
5	Engineering Drawing By N.D.Bhat

Equipment list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	Moulding box	300*300*100mm	
02	Moulding Rammer	Standard size	
03	Moulding tool kit	Standard size	
04	Electric furnace for melting (Wax/Low melting point metal with crucible and ladder for pouring)	Standard size	
05	Portable grinder for cleaning of casting	Standard size	
06	Sand Blaster	Standard size	
07	Ball peen Hammer	½ lb	
08	Pattern Making Tool kit	Standard size	
09	Anvil For Forging	Standard size	
10	Sledge hammer	2 LB	
11	Hand hammer	1 lb	
12	Flatteners	Standard size	
13	Flat Tongs	Standard size	
14	Round Tongs	Standard size	
15	Steel scale	300mm	
16	G I Bucket for Quenching	15 lts capacity	
17	Open Heart Furnace with stand and Blower	Standard size	
18	Hot Chisel	24mm size	
19	Sheet shearing Machine(Manual or M/c type)	Standard size	
20	Sniper for cutting sheet	Standard size	
21	Metal stake	Standard size	
22	Wooden mallet	Standard size	
23	Plastic Hammer	Standard size	
24	Bench vice for Bending of sheet	Standard size	
25	Brazing Gun	Standard size	

Fluid Power Engineering

Subject Code -MEC304

1. Rationale: Fluid power is one of the basic building blocks of modern automation and is most widely used system to convert fluid energy into useful work through the use of pump, compressor, control valves, actuators and other controlling elements. This technology is used to power a range of items such as tools, construction equipment and machineries, automotive and machineries in manufacturing sectors. Fluid power engineering involves study of properties of fluids, laws governing flow of fluids, working principles of fluid machineries and knowledge of control of machine movements. This course allows the students to develop the knowledge and understanding of the operational requirements of fluid power system and be able to recognise circuit components and build the circuits for applications needed in daily life

2. Course Outcomes: At the end of this course, student will be able to

CO-01	Measure fluid discharge through Channels and Pipes using instruments and estimate the size of the pipe needed for a given population size.
CO-02	Select the right hydraulic machinery to be used in a specific application for a given head and discharge.
CO-03	List the various components and its use in a given fluid power system.
CO-04	Build a simple fluid power system for a given application

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	01,04	1. Explain classification and Properties of fluids- Units- Conversion of Cubic meters- Liters – Gallons -TMC 2. Explain Pascal Law, Equation of continuity, Concept of Total Energy 3. Explain Bernoulli's equation and its Applications- Venturi meter, Pitot tube, Orifice meter	Ref Table 1	1. Find Discharge of a fluid through Venturimeter
2	01	01,04	1. Explain Discharge through Rectangular Notch -Numerical Problems 2. Explain Discharge through V- notch - Numerical Problem 3. Explain Flow through Pipes- Major and Minor Losses	Ref Table 1	1. Finding Discharge through Rectangular Notch 2. Finding Discharge through V- Notch

3	01	01,04	1. Determine co-efficient of friction by using Chezy's and Darcy's formulae 2. Design a Pipe for a given number of Inhabitants 3. Design a Pipe for a given discharge	Ref Table 1	1. Finding Co-efficient of Friction in Pipes 2. You tube presentation on fluid flow through pipes and notches
4	02	01,02,04	1. Classification of Pumps 2. Explain the Working Principle of Centrifugal Pump and its Application 3. Explain the Working Principle of Monoblock and its Application	Ref Table 1	1. Find the discharge through Centrifugal Pump 2. Servicing and Repair of Centrifugal Pumps
5	03	01,02,04	1. Explain the Working Principle of Submersible pump and its application 2. Explain the Working Principle of Reciprocating pump and its application 3. Select a suitable Pump for a given Application	Ref Table 1	Servicing and Repair of Submersible pumps
6	02	01,04	1. Classification of Hydraulic Turbines 2. Select a suitable Turbine for a given Head 3. Explain the Working Principle of Impulse Turbine and its Application	Ref Table 1	Determine Performance of Pelton wheel
7	02	01	1. Explain the Working Principle of Reaction Turbine and its Application 2. Explain the Importance of Draft tube, Penstock and Surge Tank 3. Video on Hydraulic Power Plant	Ref Table 1	Video on fluid flow from source to End application Eg: Oil Refineries, Hydraulic Power plant, Water distribution through pipe lines
8	03	01	Identify the basic components of Fluid power Systems with Symbols and Application • Air compressor • Air Drier • FRL Unit • Gear Pump • Pressure control Valve- Pressure Reducing Valve, Pressure Intensifier • Direction control Valves - 3/2 , 5/2, 4/2 • Flow control Valve • Needle Valve • Check Valve • Shuttle Valve • Quick Exhaust Valve • Time Delay Valve	Ref Table 1	Video on Working principles of components used in Fluid Power Systems
9	03	01	• Explain Valve Actuating mechanisms - Spring, Lever, Push button, Solenoid • Explain the role of Accumulators in fluid power systems. • Explain working principle of Actuators- Single Acting, Double acting Air Cylinders, Air Motors	Ref Table 1	Video on Working principles of components used in Fluid Power Systems

			• Explain the importance of Seals and Packages		
10	04	01,04	• Build a Fluid Power circuit to Control Speed of a Single Acting cylinder • Build a Fluid Power circuit to Control Speed of a Double Acting cylinder • Build a Fluid Power circuit for Pilot control Double Acting Cylinder	Ref Table 1	Execute the circuit Practiced in the Class using Trainer Kit or Simulation Software
11	04	01,04,07	• Build a Fluid Power circuit for double Acting Cylinder being controlled by 4/2 DC Solenoid Operated Valve • Build a Circuit for Stamping operation by using 3/2 DC Valve with Single Acting Cylinder • Build a Circuit for Automatic Opening and Closing of Door by /using double Acting Cylinder being controlled by 4/2 DC Valve	Study the latest technological changes in this course and present the impact of these changes on industry	Execute minimum 2 Circuits Practiced in the Class using Trainer Kit or Simulation Software
12	04	01,03,07	• Build a Fluid Power circuit for Automatic reciprocating motion of a double acting Cylinder • Build a circuit for feeding a strip with following sequences: Holding the strip, moving the strip forward on to the tool, maintaining the strip in that position and returning the strip to its original position after work is over. • Design a Circuit to press fit a pin to a hole with a precondition that while actuating of the cylinder, both the hands of the operator should be engaged		Execute minimum 2 Circuits Practiced in the Class using Trainer Kit or Simulation Software
13	04	01,07	• Build Circuit for a machine device driven by a single acting cylinder with actuation at least two mutually operated DC valves (Safety circuit with OR and AND Gates) • Build Circuit for the Clamping Device of a Drilling Machine of a Drilling machine such that the clamps are activated before the drill is fed to the Work • Build a Circuit for your Own Application		Execute minimum 2 Circuits Practiced in the Class using Trainer Kit or Simulation Software, including developing your Own Pneumatic Circuit to perform certain function

Total in hours	**39**	**13**	**52**

Reference:

Sl. No.	Description
1	Bansal. R.K.,"Fluid Mechanics and Hydraulics Machines", 9th Edition, Laxmi Publications Private Limited, New Delhi. 2011.
2	R.S.Khurmi, "Fluid Mechanics and Machinery",S.Chand and Company, 2nd Edition, 2007.
3	Hydraulics & Pneumatics – Andrew Parr, Jaico Publishing House New Delhi.
4	Hydraulic and Pneumatic Controls Understanding Made Easy- K.S.Sundaram,- S.chand Company Delhi
5	Ramamrutham. S, "Fluid Mechanics, Hydraulics and Fluid Machines", Dhanpat Rai & Sons, Delhi, 2004.
6	P. N Modi and S. M. Seth, "Hydraulics and Fluid Mechanics Including Hydraulics Machines", 19th Edition, Standard Book House, 2013
7	Hydraulic and Pneumatic Controls- Srinivasan, R.- Vijay Nicole Imprints Private Limited, 2/e, 2008
8	Pneumatic And Pneumatics Controls -Understanding Made Easy - K.S.Sundaram,-S.chand Company Delhi
9	Pneumatic Systems - Majumdar, S.R. -Tata McGraw-Hill Publication, 3/e, 2013

5. LIST OF SOFTWARES/ LEARNING WEBSITES:

1. www.youtube.com/watch?v=VyR8aeioQrU
2. http://www.youtube.com/watch?v=R6_q5gxf4vs
3. www.howstuffworks.com
4. . http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-_KANPUR/machine/ui/TOC.htm
5. https://www.youtube.com/watch?v=F_7OhKUYV5c&list=PLE17B519F3ACF9376
6. https://www.youtube.com/watch?v=zOJ6gWDMTfE&list=PLC242EBB626D5FFB5
7. http://www.youtube.com/watch?v=0p03UTgpnDU
8. http://www.youtube.com/watch?v=A3ormYVZMXE
9. http://www.youtube.com/watch?v=TjzKpke0nSU
10. http://www.youtube.com/watch?v=vl7GteLxgdQ

11. http://www.youtube.com/watch?v=cIdMNOysMGI
12. www.boschrexroth.co.in
13. http://www.automationstudio.com/
14. http://www.howstuffworks.com/search.php?terms=hydraulics
15. http://hyperphysics.phy-astr.gsu.edu/hbase/fluid.html#flucon
16. http://www.youtube.com/watch?v=FVR7AC8ExIM
17. http://www.youtube.com/watch?v=iOXRoYHdCV0
18. http://www.youtube.com/watch?v=qDinpuq4T0U
19. http://www.youtube.com/watch?v=xxoAm3X4iw0
20. www.festo.com
21. www.boschrexroth.co.in
22. www.nptel.iitm.ac.in

23 .http://www.howstuffworks.com/search.php?terms=pneumatics

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	Bench mounted Test Rig for Venturi meter	----------	
02	Bench mounted Test Rig for Notches	……	
03	Bench mounted Test Rig for Friction through pipes	……..	
04	Centrifugal Pumps FOR Maintaines and Servicing	Used one	
05	Mano block Pumps FOR Maintenance and Servicing	……do…….	
06	Submersible Pumps FOR Maintenance and Servicing	……do……	
07	Pneumatics Trainer Kit with all standard accessories.	Standard size	
08	Compressor for Pneumatics Trainer Kit	6 Bar pressure Single phase 50 Hz	
09	Hose pipes for Pneumatics Trainer Kit	……..	
10	Bench mounted Test Rig for Pelton wheel	Standard size	

(4th – SEMESTER)

Operations Management

Subject Code -MEC401

1. Rationale: The success of any organisation not only depends on quality of its products and services but also depends on the people within it. Thus, an operational manager has to play a prominent role in an organisation with human capital and machines. Therefore, managerial skills are essential for enhancing their employability and carrier growth. This course is therefore designed to provide basic concepts in operations management, forecasting techniques, capacity planning, aggregate planning, master production schedule, quality, and inventory and supply chain management for effective utilisation of resources and competitive advantage through operational excellence

2. Course Outcomes: On Completion of course, the student will be able to:

CO-01	Prepare a production capacity utilization plan based on demand forecast and available production capacity for a given product.
CO-02	Prepare a master production plan based on a production capacity utilization plan and a material management plan for a given product.
CO-03	Prepare a process plan using time study, motion study and other appropriate methods to ensure process efficiency.
CO-04	Prepare a quality assurance plan based on a given quality model which is suitable for either a product or a service organisation.

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	01	**Introduction to Operation Management** 1. Introduction to Operation Management - Operation Functions 2. Evolutions and Historical Events in Operational Management 3. Productivity and Competitiveness, Strategy and operation	Ref Table 1	• Virtual Tour Organization (You tube) • Problems on Productivity
2	01	01	**DEMAND FORECASTING** 1.Demand Forecasting- Demand Behavior-Trend Cycle - Seasonal Background - Steps in Forecasting Process 2. Short range and Long Range Forecast 3. Qualitative Forecast methods	Ref Table 1	Problems on • Qualitative Forecast - Delphi method, Market Research method • Quantitative Forecast - Time series Method a) Moving average (Naive forecast , Simple moving Average, Weighted moving Average)
3	01	01	1. Quantitative Forecast methods 2. Seasonal Adjustments 3. Forecast Accuracy	Ref Table 1	Problems on b) Exponential smoothing
4	01	01	**CAPACITY AND AGGREGATE PLANNING** 1. Need for Capacity Planning – Capacity expansion Strategies – Capacity planning Models. 2. Aggregate planning- Methods 3. Master production Schedule	Ref Table 1	Problems on • Capacity Planning, • Aggregate planning • Master production Schedule

5	01	01	**PROCESS PLANNING** 1. Make or Buy Decision Outsourcing- Factors for Outsourcing decision- Process Selection – Batch , Mass ,Continuous Components of e-manufacturing	Ref Table 1	• Virtual Tour on Batch, Mass and continuous Process • Develop an Operation Sheet indicating Process Plan and Process flow chart for a given component.
6	03	01	1.Motion Study 2. Man- Machine chart 3. Concepts on Time Study	Ref Table 1	• Develop Job Process chart with Process Symbols for a given Process. • Develop Man- Machine chart for a given Process. • Case study on Time Study Principles for a given process.
7	02	01	**INVENTORY MANAGEMENT** 1. Elements of Inventory Management- Inventory Costs- Carrying, Ordering and Shortage Costs 2.Inventory Control Systems- Continuous Inventory System (Fixed-Order-Quantity System) Periodic Inventory System (Fixed-Time-Period System) 3. Concept on ABC Classification, Economic Order Quantity Models, Production Quantity Model	Ref Table 1	Problems on • ABC Classification System • Economic Order Quantity Models • The Production Quantity Model
8	02	01,02	1. Order Quantity for A Periodic Inventory System Order Quantity with Variable Demand 2. JIT -Pull System 3 Kanban's System	Ref Table 1	Case study on JIT (Eg:Toyoto Production System)
9	02	01	**Supply Chain Management** 1.Supply Chains Supply Chains for Service Providers 2.Value Chains The Management of Supply Chains 3.Vendor Selection- Vendor	Ref Table 1	Study on • The Bullwhip Effect • Risk Pooling • Green Supply Chains

			evaluation and Vendor Development, Negotiations		
10	02	01	1.Supply Chain Uncertainty and Inventory 2.E-Business, Electronic Data Interchange 3.Supply Chain Integration-Collaborative Planning, Forecasting, And Replenishment	Ref Table 1	Study on • Information Technology: Supply Chain Enabler • Bar Codes • Radio Frequency Identification • Build-To-Order (BTO)
11	02	01,07	1.Material Requirements Planning (MRP) Enterprise Resource Planning (ERP), 2. Warehouse Management Systems Collaborative Logistics, Distribution Outsourcing 3.Finance/Accounting-Sales/Marketing-Production/Materials Management-Human Resources	Study the latest technological changes in this course and present the impact of these changes on industry	Case study on Procurement-Outsourcing. • E-Procurement • E-Market places • ERP MODULES
12	04	01,04,07	QUALITY MANAGEMENT 1. Quality from The Customer's Perspective Dimensions of Quality for Manufactured Products Dimensions of Quality for Services 2. Quality from The Producer's Perspective A Final Perspective On Quality The Cost of Quality The Cost of Achieving Good Quality 3. The Cost of Poor Quality The Quality–Productivity Ratio Quality Management System		Practice on Quality Tools • Process Flowcharts • 5 Whys, Cause-And-Effect Diagrams • Check sheets And Histograms • Pareto Analysis • Scatter Diagrams
13	04	04,05,07	1. TQM and QMS The Focus of Quality Management—Customers 2. Quality Management in The Supply Chain The Role of Employees in Quality Improvement Kaizen and Continuous Improvement Quality Circles 3. Process Improvement Teams Six Sigma The Breakthrough Strategy: DMAIC		Practice on The Deming Wheel (PDCA Cycle) • Process Control Charts • Statistical Quality Control • ISO 9000 • ISO14000
Total in hours			**39**	**13**	**52**

Reference:

Sl. No.	Description
1	Production and Operations Management – Creating Value along the Supply Chain By Russel and Taylor , Wiley Publications , 7 Edition
2	Modern Production and Operation Management By Buffa and Sarin, Wiley Publications, 8 edition
3	Production and Operations Management By Chary, Tata Mc Graw Hill Publications
4	Production and Operations Management- Concepts, Models and Behaviour By Adam and Ebert, Prentice Hall Publications

LIST OF SOFTWARES/ LEARNING WEBSITES:

1. www.youtube.com/watch?v=SF53ZZsP4ik
2. www.youtube.com/watch?v=iPZlQ3Zx5zc

Tools/ Equipment/ Software's Required

1. ERP Software

CNC Programming and Machining

Subject Code -MEC402

1. Rationale: In recent years the manufacturing environment has undergone dramatic change. For achieving market goals, it is essential to produce quality parts in less time. Evolution of information technology, variety manufacturing concepts with zero lead time demand and quality consciousness have supported fast adaption of computerized numerical control (CNC) machines. As in human beings' mental ability is becoming more important than physical ability to do the manual work, similarly CNC programming in the same way has more importance along with selection and use of CNC tooling. In this course therefore an attempt has been made to develop skills required for programming, tooling etc for CNC machine. 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 Diploma mechanical engineers to master CNC technology.

2. Course Outcomes/Skill Sets: At the end of this course, student will be able to:

CO-01	Identify various components of a CNC machine and list the use of those components for any given CNC operation.
CO-02	Study a given production drawing and list the right tools needed to produce a product as per the drawing.
CO-03	Write a CNC turning and milling program for a given production drawing, simulate the program and execute the program in production mode.
CO-04	Develop and/or import a 3-D model of a given component drawing, generate the CNC programming codes using CAM software and execute the program in production mode.

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	01	1. Introduction to CNC Machines- Advantages of CNC machines over Conventional machines 2. Explain the Construction features of CNC machine- Machine Structure, bed, spindle motor and drive, axes motor and ball screws using Multimedia 3. Explain Guide ways, LM guides, console, control switches, coolant system, hydraulic system using Multimedia	Ref Table 1	1. Demonstrate Personal, Conduct, Shop etiquettes and general safety practices in CNC machine Comply safe handling of CNC machines, tools and Equipment. 2. Demonstration of CNC machine and its parts - bed, spindle motor and drive, axes motor and ball screws, guide ways, LM
					guides, console, control switches, coolant system, hydraulic system, 3. Identification of safety switches, machine over travel limits and emergency stop. Machine starting & operating in Reference Point, JOG and Incremental Modes

2	01,02	01	1. Explain Axis convention of CNC machine 2. Explain Cutting tool materials, cutting tool geometry – insert types, holder types, insert cutting edge geometry. 3. ISO nomenclature for turning tool holders, boring tool holders, indexable inserts. - Tool holders and inserts for radial grooving, face grooving, threading, drilling	Ref Table 1	1. Conduct a preliminary check of the readiness of the CNC machine viz., cleanliness of machine, referencing – zero return, 2. Functioning of lubrication, coolant level, correct working of sub-system
3	01,02	01,04	1. Explain Automatic tool exchanger using Multimedia 2. Explain the importance of Tool length compensation, Tool nose Radius compensation and Tool Wear compensation. 3. Explain Machine Zero and Work Zero	Ref Table 1	1. Perform Work and tool setting: - Job zero/work coordinate system and tool setup and live tool setup 2. CNC machining centre operation in various modes: JOG, EDIT, MDI, SINGLE BLOCK, AUTO 3. Setting the tool offsets, entry of tool nose radius and orientation in CNC console
4	03	01,04	1. Explain Programming sequence and format - Absolute and Incremental System 2. Explain G codes and M codes 3. Explain Linear interpolation and Circular Interpolation	Ref Table 1	1. Geometry Wear Correction. Geometry and wear offset correction in CNC Console 2. Program checking in dry run, single block modes
5.	03	01	1. Explain cutting Parameters – Feed, Speed and depth of cut w.r.t CNC machine as per Catalogue 2. Explain Canned Cycle, Mirroring and Subroutines	Ref Table 1	1. Learn various numerical keys, Address Keys, functional Keys of operational console
6.	03	01,04	Write the Part Program for Facing, Turning, Step turning and Taper turning (Write Program for 3 models and execute any one on the machine)	Ref Table 1	1. Input the Program into the Simulator and operate the Simulator 2. Transfer the simulated Program to machine
					3. Set the machine with necessary tools and Job 4. Execute the Program in Auto mode to produce the Job.

7.	03	01,04	Write the Part Program for Turning, Profile turning and Thread cutting (Write Program for 3 models and execute any one on the machine)	Ref Table 1	1. Input the Program into the Simulator and operate the Simulator 2. Transfer the simulated Program to machine 3. Set the machine with necessary tools and Job 4. Execute the Program in Auto mode to produce the Job
8.	03	01,04	Write a CNC milling program for Pocket machining (Write Program for 3 models and execute any one on the machine)	Ref Table 1	1. Input the Program into the Simulator and operate the Simulator 2. Transfer the simulated Program to machine 3. Set the machine with necessary tools and Job 4. Execute the Program in Auto mode to produce the Job
9	03	01,04	Write a part program for drilling 4 holes in a plate Six holes along PCD on a circular plate	Ref Table 1	1. Input the Program into the Simulator and operate the Simulator 2. Transfer the simulated Program to machine 3. Set the machine with necessary tools and Job 4. Execute the Program in Auto mode to produce the Job
10.	03	01,04,07	Write a Program using Mirroring Write a Program using Subroutines	Ref Table 1	1. Input the Program into the Simulator and operate the Simulator 2. Transfer the simulated Program to machine 3. Set the machine with necessary tools and Job 4. Execute the Program in Auto mode to produce the Job
11	04	01,04,07	Generate the Part Program for Component requiring Turning, Step turning Profile turning and Thread cutting by using CAM software (Program for 3 models and execute any one on the machine)		1. Transfer the simulated Program to machine 2. Set the machine with necessary tools and Job 3. Execute the Program in Auto mode to produce the Job

12	04	01,04,07	Generate a CNC program for component having Pocket machining using CAM software (Program for 3 models and execute any one on the machine)	Study the latest technological changes in this course and present the impact of these changes on industry	1. Transfer the simulated Program to machine 2. Set the machine with necessary tools and Job 3. Execute the Program in Auto mode to produce the Job
13			Demonstrate the manufacturing of following components on CNC machines using YouTube Videos 1. CNC Turning 2. Rollers 3. Spacers 4. Brackets Discuss and Prepare a Report on the videos Presented for each manufactured component		Demonstrate the manufacturing of following components on CNC machines using YouTube Videos 1. Spindles 2. Frames 3. Engine Block 4. Ball Bearings Discuss and Prepare a Report on the videos Presented for each manufactured component
Total in hours			**39**	**13**	**52**

Reference:

Sl. No.	Description
1	Automation, Production Systems, and Computer- Aided Manufacturing by Mikell P. Groover Prentice-Hall International publication
2	CAD/CAM Principles and Applications P N Rao McGraw Hill Education
3	CNC Machines. Pabla B.S., Adithan M. New Age International, New Delhi,2014(reprint)
4	Computer Numerical Control-Turning and Machining centers. Quesada Robert Prentice Hall 2014

LIST OF SOFTWARES/ LEARNING WEBSITES:

1. http://www.nptel.ac.in
2. http://www.youtube.com/watch?v=M3eX2PKM1RI
3. http://www.youtube.com/watch?v=EHQ4QIDqENI&list=PLBkqkLQO2nAt5MNLo
4. http://www.youtube.com/watch?v=hJFLcvtiNQ I
5. http://www.youtube.com/watch?v=BIM1AyxfYkw .
6. http://www.mtabindia.com
7. http://www.swansoftcncsimulator.com

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	CNC Turning Centre (Tutor or Productive)	Minimum diameter 25 mm, Length 120 mm with ATC. (Approximate)	

02	CNC Milling Centre (Tutor or Productive) X axis travel - 225 mm, Y axis travel - 150 mm, Z axis travel - 115 mm, With ATC.(Approximate)	X axis travel - 225 mm, Y axis travel - 150 mm, Z axis travel - 115 mm, With ATC.(Approximate)	
03	Simulation software likes: CNC Simulator Pro, Swansoft CNC, etc.		
04	Latest version of CAD/CAM integration software like MASTER CAM, NX CAM OR EDGE CAM		
05	Desk top computer	Latest configuration	

Product Design and Development

Subject Code -MEC403

1. Rationale: Design department of industry is one of the major job areas for Diploma engineers. The fundamental knowledge of Strength of Materials, Engineering Materials, and Computer Aided Design and Drafting is essential to meet job requirement in this sector. To enable a student to work here, they should know how to design a simple machine element, usual procedures in development of product, fundamental knowledge in design of simple machine elements such as shafts, springs, couplings etc, codes, norms, standards and guidelines for selection of appropriate material. In addition to this, Diploma engineers are required to read and interpret the drawings. Therefore, it is essential that they have competency in preparing drawings of machine parts. This course aims at developing analytical abilities in the student to give solutions to simple engineering design problems using standard procedures. Hence this course has been introduced with the expectations that efforts will be made to provide appropriate learning experiences in the use of basic principles to the design solution for applied problems to develop the required skill and competencies.

2. Course Outcomes/Skill Sets: At the end of the Course, the student will be able to:

CO-01	Explain the key principles of product design considering Strength, Aesthetic and Ergonomic
CO-02	Design simple machine elements like shafts, springs, couplings and knuckle joints using standard data.
CO-03	Prepare CAD Part and Assembly drawings for couplings and knuckle joints based on designed parameter.
CO-04	Produce Component based on designed Parameters using 3- D Printing Techniques

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	01	**Product Development and Design**: 1. Explain Product Development- Stages of Product Development- Need and Feasibility study 2. Explain Development of design- Selection of Materials and Process 3. Explain Protype –launching of product –Product life cycle	Ref Table 1	Discuss case studies of Product development by using Video
2	01	01	**General consideration in design:** Based on • Functional requirement • Effect on environment • Life, Reliability, Safety	Ref Table 1	Case study

			• Principles of Standardization • Assembly Feasibility • Maintenance-Cost-Quantity • Legal issues and Patents • Aesthetic and Ergonomic factors • Choice of Materials • Feasibility of Manufacturing Processes		
3	01	01	**Aesthetic and Ergonomic consideration in Design:** • Explain Aesthetic considerations- Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry Contrast etc. • Morgan's color code. • Ergonomic considerations- Relation between man, machine and environmental factors. Design of displays and controls.	Ref Table 1	Case Study on Ergonomics and Aesthetic design principles.
4	02	03,04	**Torsion of Shaft:** 1. Assumptions in Shear stress in a shaft subjected to torsion – Strength and Rigidity (Solid and Hollow shaft) 2. Power Transmitted by Solid and Hollow shaft - ASME and BIS Code for power Transmission 3. Problems on Shafts subjected to only Shear based on Rigidity and Strength	Ref Table 1	1. Validate the Problems on Shafts for Strength and Rigidity using Ansys (One each on Strength and Rigidity)
5	02	03,04	1. Problems on Shafts subjected to only Shear based on Rigidity and Strength 2. Problems on Shaft subjected to only Bending 3. Problems on Shaft subjected to only Bending	Ref Table 1	1. Recap of CAD commands 2. Practice on Section of Solids- a) Prisms b) Pyramid
6	02	03,04	1 Problems on Shaft subjected to combined Shear and Bending. 2. Problems on Shaft subjected to combined Shear and Bending 3. Problems on Shaft subjected to combined Shear and Bending	Ref Table 1	1. Practice on Section of Solids- a) Cylinder b) Cone
7	02,03	03,04	**Springs:** 1. Classification of springs- Application of springs- Leaf springs –Application	Ref Table 1	Sections on Simple Machine Elements (CAD) a) Sectional front view, Front view with

			2. Terminology of Helical spring- Materials and Specification of springs 3. Design of helical spring		Right half in Section, Front view with Left half in Section b) Sectional Top View c) Sectional Side View
8	02,03	03,04	Design of helical spring	Ref Table 1	Sections on Simple Machine Elements (CAD) a) Sectional front view, Front view with Right half in Section, Front view with Left half in Section b) Sectional Top View c) Sectional Side View
9	02,03	03,04	**Coupling:** Design of Muff coupling	Ref Table 1	Using CAD, prepare Part Models for Muff coupling based on designed parameter and assemble the same. Extract the Sectional views for the above machine element indicating Surface Texture and Bill of Materials
10	02,03	03,04	Design of Protected type Flange Coupling	Ref Table 1	Using CAD, prepare Part Models for Protected type Flange Coupling based on designed parameter and assemble the same. Extract Sectional views for the above machine element indicating Surface Texture and Bill of Materials
11	02,03,	03,04,07	Design of Knuckle Joint		Using CAD, prepare Part Models for Knuckle Joint based on designed parameter and assemble the same. Extract Sectional views for the above machine element indicating Surface Texture and Bill of Materials
12	04	03,04,07	**3D Printing** 1. Introduction, Process, Classifications, Advantages of		

			additive over conventional Manufacturing, Applications, Modelling for Additive Manufacturing 2. Additive Manufacturing Techniques, 3D Printing Materials and its forms, Post Processing Requirement and Techniques. 3. Product Quality, Inspection and Testing, Defects and their causes, Additive Manufacturing Application Domains	Study the latest technological changes in this course and present the impact of these changes on industry	Preparation of 3D Printer for printing – Modelling, Saving CAD file into STL file, Slicing, Material loading and printing parameter selection
13	04	03,04,07	1. Working of Fused Deposition Modelling (FDM) Machine- Single and Multi Nozzle printers, Machine Configuration- Cartesian, Delta, Polar and robotic arm configuration 3D printers 2. Common FDM materials- PLA, ABS, PA, TPU,PETG, PEEK and PEI, Printer Parameters - Temperature of the nozzle and the platform, the build speed, the layer height, Warping, Layer Adhesion, Support Structure, In-fill & Shell Thickness 3. Benefits & Limitations of FDM, Software Tools- 3D modelling, Slicers & 3D Printer Hosts		Printing of Designed and Modelled component (flange coupling and knuckle joint) on any available 3D printing machine and carryout post processing of additively manufactured product (Inspection and defect analysis).
Total in hours			**39**	**13**	**52**

Reference:

Sl. No.	Description
1	A Text book of Machine Design R.S. Khurmi & J.K.Gupta S. Chand publication
2	Machine design S G Kulkarni McGraw Hill Education Publications
3	Introduction to Machine design V B Bhandari McGraw Hill Education Publications
4	Design Of Machine Elements Vol I, Vol II J.B.K. Das , P.L.Srinivas Murthy Sapna Publication
5	Machine Component Design William Orthwein Jaico publication
6	Design Data Hand Book for Mechanical Engineers K Mahadevan & K Balaveera Reddy CBS publications
7	Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
8	J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013
9	D.T. Pham and S.S. Dimov, "Rapid manufacturing: The technologies and applications of rapid prototyping and rapid tooling", London-New York, Springer, 2001

10	Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
11	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
12	CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017
13	L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001
14	Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012

LIST SOFTWARES/WEBSITES

1. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_home.html 2 http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod4. html

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	Latest version of CAD software	----------	
02	Desk top computer	Latest configuration	
03	Laser printer	----------	
04	3-D Printing Machine		

Elements of Industrial Automation

Subject Code -MEC404

1. Rationale: In present scenario, Manufacturing industries are moving towards complete automation. Small and medium industries are in a phase of switching to PLC and SCADA technology for data acquisition and control. Industrial automation systems are used to control and monitor a process, machine or device in a computerized manner that usually fulfils repetitive functions or tasks. They are intended to operate automatically in order to reduce and improve human work in the industry. Advantages of this technology is commonly attributed to higher production rates and increased productivity, more efficient use of materials, better product quality, improved safety, shorter workweeks for labour, and reduced factory lead times. The Automation Engineer will design, program, simulate and commission automated machines and plant- wide processes to perform many job functions. Depending on the size of the organization, the engineer will perform some or all of these responsibilities. Therefore, it is necessary for diploma engineers to have knowledge of both PLC and SCADA technology. This course attempts to provide basic theoretical and practical aspects of automation technologies to develop operational competency. Hence this course is the foundation for diploma engineers who want to further specialise in the field of industrial automation

2. Course Outcomes: At the end of this course, student will be able to

CO-01	Select the right sensor and/or actuator for automating a given application and demonstrate process variables using sensors and/or transducers.
CO-02	Perform specified control functions using a Programmable Logic Controller (PLC) and list various applications of embedded systems.
CO-03	Design and test an automation system for a required operational specification and troubleshoot to resolve any given issue(s).
CO-04	Explain the concepts of SCADA, HMI and DCS and list their various applications

3. Course Content

Week	CO	PO*	Lecture (Knowledge)	Tutorial (Activity)	Practice (Skill)
1	01	01	Introduction:	Ref Table 1	Study the following appliances/ automation

			1. Need and benefits of Industrial Automation, Automation Hierarchy, Basic components of automation system, description of each component 2. Automation technology as a part of engineering sciences, Key development milestones in the history of automation technology, Effects of automation on people. 3. Types of automation system:- Relay logic and PLC		systems and identify various elements used and their function 1. Air conditioning System 2. Automatic water level control 3. Elevator(for Three Floor) 4. Washing Machine Write the Block Diagram For each and explain with a Multimedia Presentation
2	01	01	Programmable logic controller: 1. Introduction, Compare Relay Logic Control and PLC Logic Control, Internal Architecture of PLC 2. I/O Modules (Interfaces), Memory organization. Input devices: • Mechanical Switches • Proximity Switches 3. Input devices: • Photo electric Sensors and Switches • Encoders • Temperature Sensors • Position/Displacement Sensors	Ref Table 1	Demonstrate the working of below shown Switches/Sensor. a. Various industrial Switches (Push Button, ON/OFF, Toggle, Emergency, Rotary Switches etc.) b. Proximity- Inductive, Capacitive and Optical Sensor c. Temperature Sensor d Float Sensors **Note: Connect each sensor directly to the LED/Lamp with appropriate power supply**
3	01	01	1. Input devices: • Strain Gauges • Pressure Sensors • Liquid level detectors 2. Input devices: • Fluid flow measurement • Smart Sensors 3. Output Devices: • Relay • Directional control Valve	Ref Table 1	You tube presentation on Input and Output devices

4	01	01	1. ADC and DAC 2.Motors- DC motor, Synchronous motor, Servo motor, 3.Induction motor, Stepper motor	Ref Table1	Demonstrate the Forward and Reversal of Stepper, Servo and DC Motors with the help of Drivers. **Note: Demonstrate the above without using any controllers**
5	02	02	PLC Programming: 1. Programming standards, List Different PLC Programming, Ladder diagram, 2. Standard IEC 1131-3 Symbols used for I/O Devices 3. Ladder diagram for logic gates. AND,OR,NOT,NAND,NOR,XOR, XNOR	Ref Table1	• Execute energized motor or bulb using Switches in series or Parallel • Write ladder diagram to test digital logic gates and Execute/Simulate the same.
6	02	01	1. Writing Equivalent ladder diagram for Electric Switch, Belt drive , motor circuit Latching, Sequential O/P 2. Introduction to Timer functions. Applications of timing functions in process control -- On Delay Timer Function, Off-delay Timer Function	Ref Table 1	• There are 3 mixing devices on a processing line A,B ,C. After the process begin mixer-A is to start after 7 seconds elapse, next mixer-B is to start 3.6 second after A. Mixer-C is to start 5 seconds after B. All of then remain ON until a master enable switch is turned off. Develop PLC ladder diagram, timing diagram and simulate the same • Write a Ladder Program to count the number of Items moving

			3. PLC counter functions, Applications of PLC counter function in process control		on a conveyor Belt and Execute/Simulate the same
7	03	02	1) Relay, Jumps and Subroutines 2) Develop Ladder Program for relay based motor control automation such that the motor reverses its direction when the limit switches are activated 3) Develop a PLC ladder diagram to construct an alarm system which operates as follows. - If one input is ON nothing happens. - If any two inputs are ON, a red light goes ON. - If any three inputs are ON, an alarm sirens sound. - If all are ON, the fire department is notified.	Ref Table 1	• Execute the Ladder Program for relay based motor control automation such that the motor reverses its direction when the limit switches are activated and also Demonstrate by interfacing with PLC • Simulate the PLC ladder diagram developed for an alarm system and also Demonstrate by interfacing with PLC
8	03	02	1 & 2) Develop PLC program for the following application a) Traffic Light 3)Develop PLC program for the following application b) Water Level Indicator	Ref Table 1	Execute a PLC program for the following applications i) Traffic light controlling ii) Water level controlling
9	03	02	1 & 2) Develop automatic door system using optical sensor and linear actuator 3) Develop Automatic Elevator control	Ref Table 1	• Execute automatic door system using optical sensor and linear actuator • Design ladder diagram for an Automatic Elevator control Also, Test and simulate the ladder diagram designed to operate and control the Automatic Elevator control

10	03	02	1 & 2) Design ladder diagram for car parking. (Hint: car is to be detected and enter the parking space to a particular location if space is available. If there is no space, a lamp should indicate that parking is full) 3) Design ladder diagram for operating and controlling the Lift.	Ref Table 1	• Simulate a ladder diagram for car parking. • Test and simulate a ladder diagram designed to operate and control the Lift
11	02	02,07	1) Embedded System- Block Diagram of Embedded System 2) Applications of Embedded System • Robotics Drones • Braking System • Air conditioning, Refrigerator • Engine control System, 3)Applications of Embedded System • Automatic Washing machine • Microwave Oven • Keyless entry in Automobiles.	**Study the latest technologica l changes in this course and present the impact of these changes on industry**	You tube Presentation on Applications of Embedded System
12	04	01,07	1) Concepts on Distributed control System, 2) Concepts on HMI 3)Introductions to SCADA		• Multi media Exposure to DCS system • Demonstrate the HMI interface to control Light in AND/OR Logic
13	04	01,07	1) Typical SCADA block diagram, 2) Benefits of SCADA, 3) Applications of SCADA		• Multi media Exposure to SCADA system OR • Make case study visiting any nearby industry (Packaging/Milk Dairy/Processing) using HMI, SCADA/DCS systems.

Total in hours	**39**	**13**	**52**

5. Reference :

Sl. No.	Description
1	Programmable logic Controllers By W. BOLTON
2	Digital electronics By FLYOD
3	Exploring PLC with applications By PRADEEP KUMAR SRIVATSAVA
4	Automation , Production systems and Computer integrated Manufacturing By MIKELL GROOVER
5	Sensors Hand book-SABRIE SOLOMAN-MC-GRAW HILL publications
6	Hand book of Modern Sensors" Physics ,Designs and Applications- JACOB FRADEN-Springer Publications
7	Electric Motors and Drives BY AUSTIN HUGHES and BILL DRURY

6. LIST OF SOFTWARE/LEARNING WEBSITES

1. http://www.vlab.com
2. http://www.mtabindia.com
3. http://www.nptel.ac.in

7. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	PLC Trainer Kit with the following Modules		
	• Door Controller • Car Parking Application • Water Level Controller • Conveyor Controller Application • Lift control Application With different Length Patch Cords		
02	Switches • Mechanical Switches • Proximity Switches • Photo electric Sensors and Switches		
03	Sensors • Temperature Sensors • Position/Displacement Sensors • Strain Gauges • Pressure Sensors • Liquid level detectors • Fluid flow measurement • Smart Sensors • Proximity Sensors		
04	Induction Motor with DOL Starter	3 Phase Ac 50 Hz	
05	Synchronise Motor with DOL Starter	3 Phase Ac 50 Hz	
06	Stepper Motor	Standard size	
07	Relays	Standard size	
08	Counter and Timers	Standard size	