Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Curriculum Structure

IV Semester Scheme of Studies- Diploma in Mechanical Engineering

Sl. No.	Course Category / Teaching Department	Course Code	Course Name	Hours per week			Total contact hrs /week	Credits	CIE Marks		SEE Marks		Total Marks	Min Marks for Passing (including CIE marks)	Assigned Grade	Grade Point	SGPA and CGPA
				L	T	P			Max	Min	Max	Min					
Integrated Courses																	Both SGPA & CGPA
1	PC/ME	20ME41P	Operations Management	3	1	4	8	6	60	24	40	16	100	40			
2	PC/ME	20ME42P	CNC Programming and Machining	3	1	4	8	6	60	24	40	16	100	40			
3	PC/ME	20ME43P	Product Design and Development	3	1	4	8	6	60	24	40	16	100	40			
4	PC/ME	20ME44P	Elements of Industrial Automation	3	1	4	8	6	60	24	40	16	100	40			
Audit Course																	
5	AU/ME	20ME45T	Indian Constitution	2	0	0	2	2	50	20	-	-	50	20			
Total				**14**	**4**	**16**	**34**	**26**	**290**	**116**	**160**	**64**	**450**	**180**			

***PC: Programme Core:: AU-Audit Course:: L: Lecture:: T: Tutorial:: P: Practice**

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Mechanical Engineering	**Semester**	IV
Course Code	20ME42P	**Type of Course**	Programme Core
Course Name	**CNC Programming and Machining**	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

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)**
			3 hours/week	1 hour/week	4 hours/week (2 hours/batch twice in a week)
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)	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
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)		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**

- ***PO= Program Outcome as listed and defined in year 1 curriculum**
- **Course Co-Ordinator must prepare PO – CO mapping with strength (Low/Medium/High) before course planning**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl.No.	Suggestive Activities for Tutorials
01	Discuss the steps for choosing the Right CNC machine tool using various parameters like operator experience, Material to be cut, Part difficulty and complexity, LM guides, Control systems, Cost per part, Availability of space. www.hwaheonasia.com
02	Presentation on Macros and Parametric Programming in CNC by discussing basic macro skill-Macro capability, common features and applications- Macro structure www.thomasnet.com
03	Discuss and present a report on influence of coolant in CNC by explaining Purpose- delivery methods of coolants- Types of coolants- Health and safety issues- Properties- Recycling and disposal of cutting lubricants www. Industr.com
04	Each student has to Present minimum 5 CNC Programming on Machining involving Turning, Milling and Drilling. (Course coordinator has to ensure no repetition of the Programs)

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20l tests 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
				Total CIE Marks	60
		Semester End Examination (Practice)	180	100	40
				Total Marks	**100**

5. Format for CIE written Test

Course Name	**Operation Management**	Test	I/II/III	Sem	IV
Course Code	**20ME41P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels(R/U/A)	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

5 . (a) CIE Skill Test -4 Duration: 240 Min

SL. No.	CO	Particulars/Dimension	Marks
1	02,04	**One Question on Writing CNC program For Turning Model ,Simulation and Preparation of the MODEL on CNC Machine** • Writing CNC program—30 Marks • Editing the program—30 Marks • Simulation and Preparation of the MODEL on CNC Machine - 30 Marks	**90**
2	02,04	**Portfolio evaluation based on the average of all Practice Sessions (1-6 Weeks)**	**10**
Total Marks			**100**

5 . (b) CIE Skill Test -5 Duration: 240 Min

SL. No.	CO	Particulars/Dimension	Marks

1	02,03	One Question on Writing CNC program For Milling Model ,Simulation and Preparation of the MODEL on CNC Machine • Writing CNC program—25 Marks • Editing the Program—15 Marks • Simulation and Preparation of the MODEL on CNC Machine-10 Marks	50
2	02,04	One Question on Generating CNC Turning Program/Milling Program, Using CAM Software, Simulation and Preparation of the MODEL on CNC Machine. • Preparation of Solid Model for a given Drawing using software - 25 marks • Generate Turning Program/Milling Program, Using CAM Software - 05 Marks • Interface with the CNC machine and produce the model -10 Marks	40
3	02,03,04	**Portfolio evaluation based on the average of all Practice Sessions (7-12 Weeks)**	**10**
Total Marks			**100**

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. 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

8. 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

9. SEE Scheme of Evaluation **Duration: 180 Min**

SL. No.	**CO**	**Particulars/Dimension**	**Marks**

1	02,03	One Question on Writing CNC program For Turning Model ,Simulation and Preparation of the MODEL on CNC Machine • Writing CNC program—30 Marks • Simulation and Preparation of the MODEL on CNC Machine-20Marks **OR** One Question on Writing CNC program For Milling Model ,Simulation and Preparation of the MODEL on CNC Machine • Writing CNC program—30 Marks • Simulation and Preparation of the MODEL on CNC Machine-20 Marks	50
2	02,04	One Question on Preparing a Solid Model and Generating CNC Turning Program/Milling Program, Using CAM Software, • Preparation of Solid Model for a given Drawing using software – 20 marks • Generate CNC Turning Program/Milling Program, Using CAM Software - 10Marks	30
3	01,02,03,04	Viva voce	20
Total Marks			**100**

10. 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)	01
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)	01
03	Simulation software likes: CNC Simulator Pro, Swansoft CNC, etc.		20 user
04	Latest version of CAD/CAM integration software like MASTER CAM, NX CAM OR EDGE CAM		20 user
05	Desk top computer	Latest configuration	20 no

Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Mechanical Engineering Diploma	**Semester**	IV
Course Code	20ME43P	**Type of Course**	Programme Core
Course Name	**Product Design and Development**	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

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)
			3 hours/week	1 hour/week	4 hours/week (2hours/batch twice in a week)
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**

- ***PO= Program Outcome as listed and defined in year 1 curriculum**
- **Course Co-Ordinator must prepare PO – CO mapping with strength (Low/Medium/High) before course planning**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl.No.	Suggestive Activities for Tutorials
01	Presentation on design of Bicycles for Indian children focusing on Aesthetic and Ergonomics by Explaining market analysis- user study – Problem identification – Product design and specification- Concept generation- Material and Manufacturing Processes- Final concept selection www.sastechjournal.com
02	Presentation on types of suspension springs used in Automobile vehicles by explaining leaf-spring, Coil spring , Torsion Spring, Air bags , Rubber Springs www.theengineerspost.com
03	Presentation on different types of Keys used in Transmission system and importance such as parallel key, Saddle key, Sunk Key , Gib headed key, Feather Key, Woorruff Key with Advantages and applications
04	Presentation on Antifriction Bearing by explaining rolling contact- journal ball bearing construction- Cylindrical bearing – Needle bearing – Foot step Bearing – Plumber Bearing

05	Presentation on Friction Clutches used in Automobiles by explaining parts- Single plate- Multi plate- Purpose –Application
06	The Role of Additive Manufacturing in the Era of Industry 4.0
07	Application of Additive Manufacturing in health care industry

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to **20**
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
				Total CIE Marks	60
	Semester End Examination (Practice)		180	100	40
				Total Marks	**100**

5. Format for CIE written Test

Course Name	**Production Design and Development**	Test	I/II/III	Sem	IV
Course Code	**20ME43P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels(R/U/A)	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

5 . (a) For CIE Skill Test -4 Duration: 240 Min

SL. No.	CO	Particulars/Dimension	Marks
1	02	One Question on Design of Shaft Subjected to Strength and Rigidity • Fixing the Diameter of Shaft after design ---30 Marks • Validate the Designed parameters of Shaft for Strength and Twisting using Ansys- 30 Marks	60
2	03	One question on Section of Solids (Prism/Pyramid/Cone/Cylinder) • Placing the Section plane and drawing the section – 20 Marks • Extracting the True shape of the Section – 10 Marks	30
3	01,02,03	Portfolio evaluation based on the average of all Practice Sessions (1-6 Weeks)	10
Total Marks			**100**

5 . (b)For CIE Skill Test -5 **Duration: 240 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	03,04	One Question on Design and Assembly drawing of Simple Machine parts like Muff Coupling/Flange Coupling/ Knuckle Joint • Design of Simple Machine part by using Data Hand Book --35 Marks • Preparation of Part Models for the Designed values by using CAD Software -- 35 Marks • Assembly of Part Models using CAD software With Bill of Materials --20 Marks	90
2	03,04	Portfolio evaluation based on the average of all Practice Sessions (7-12 Weeks)	10
Total Marks			**100**

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. 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

8. 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

9. SEE Scheme of Evaluation **Duration: 180 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	02,03	One Question on Design and Assembly of Simple Machine parts like Muff coupling/Flange Coupling/ Knuckle Joint • Design of Simple Machine part by using Data Hand Book -----35 Marks • Preparation of Part Models for the Designed valves By using CAD Software —25 Marks • Assembly of Part Models By using CAD Software With Bill of Materials---20 Marks	80
2	01,02,03,04	Viva voce	20
	Total Marks		**100**

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

Sl. No.	Particulars	Specification	Quantity
01	Latest version of CAD software	----------	20 user
02	Desk top computer	Latest configuration	20 no's
03	Laser printer	----------	02 no's
04	3-D Printing Machine		01 no

Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Mechanical Engineering	**Semester**	IV
Course Code	20ME44P	**Type of Course**	Programme Core
Course Name	**Elements of Industrial Automation**	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

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)**
			3 hours/week	1 hour/week	4 hours/week (2 hours/batch twice in a week)
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 technological 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**

- ***PO= Program Outcome as listed and defined in year 1 curriculum**
- **Course Co-Ordinator must prepare PO – CO mapping with strength (Low/Medium/High) before course planning**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl.No.	Suggestive Activities for Tutorials
01	Write a PLC Ladder Program to Switching on/off the Lamp whether they are at the bottom or the top of the staircase.
02	The production line may be powered off accidentally or turned off for noon break. The program is to control the counter to retain the counted number and resume counting after the power is turned ON again. When the daily production reaches 500, the target completed indicator will be ON to remind the operator for keeping a record. Press the Clear button to clear the history records. The counter will start counting from 0 again. Write a PLC Ladder Program to perform this operation.
03	Write a PLC Ladder Program Providing lubricant for the gear box before the lathe spindle starts to run which aims to ensure that the oil pump motor starts first and the main motor starts subsequently.
04	Write a PLC Ladder Program such that Once the photoelectric sensor detects 10 products, the robotic arm will begin to pack up. When the action is completed, the robotic arm and the counter will be reset.
05	Develop PLC Programming Examples on Industrial Automation according to the logic given below, • A Saw, Fan and oil pump all go ON when a start button is pressed. • If the saw has operated less than 20s, the oil pump should go off when the saw is turned off and the fan is to run for an additional 5s after the shutdown of the saw. • If the saw has operated for more than 20s, the fan should remain on until reset by a separate fan reset button and the oil pump should remain on for an additional 10 s after the saw is turned off.
06	Develop and Simulate a PLC Ladder Diagram for Bottle Filling Plant
07	Study and present a Report on home Automation
08	Study and present a Report on Embedded systems in Automation
09	Study and present a Report on Automation in Processing Industries

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	

6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
				Total CIE Marks	60
			Semester End Examination (Practice)	180	100	40
				Total Marks	**100**

5. Format for CIE written Test

Course Name	**Elements of Automation**	Test	I/II/III	Sem	IV
Course Code	**20ME44P**	Duration	80 Min	Marks	30
Note: Answer any one full question from each section. Each full question carries 10 marks.					

Section	Assessment Questions	Cognitive Levels(R/U/A)	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

5.(a)For CIE Skill Test -4 **Duration :240 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	02	Select a suitable Sensor / Switch for a given Process Variable and activate • Selection of Sensor/Transducer – 05Marks • Activation and Result – 15 Marks	20
2	02	Select a suitable motor for the given case and energize • Selection of the Motor – 10 Marks • Energize and Result – 20 Marks	30
3	03	Develop and Simulate a simple ladder diagram for a given Case • Writing Ladder Program – 20 Marks • Simulate and Troubleshoot - 20 Marks	40
4	01,02,03	Portfolio evaluation based on the average of all Practice Sessions (1 -6 Weeks)	10
Total Marks			**100**

5 . (b) For CIE Skill Test -5 **Duration: 240 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	03	Device and Simulate a ladder diagram for the given Case Study (PLC Based) • Writing Ladder Program – 40 Marks • Simulate and Troubleshoot - 20 Marks	60
2	04	Prepare a SCADA Block Diagram for the given Case	30
3	03,04	Portfolio evaluation based on the average of all Practice Sessions (7-12 Weeks)	10
Total Marks			**100**

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. 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

8. LIST OF SOFTWARE/LEARNING WEBSITES

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

9. SEE Scheme of Evaluation

Duration :180 Min

SL. No.	CO	Particulars/Dimension	Marks
1	02	Select a suitable Sensor / Switch for a given Process Variable and activate • Selection of Sensor/Transducer – 10 Marks • Activation and Result –20Marks **OR** Select a suitable motor for the given case and energize • Selection of the Motor – 10 Marks • Energize and Result – 20 Marks	30
3	03	Device and Simulate a ladder diagram for the given Case Study • Writing Ladder Program –30 Marks • Simulate and Troubleshoot –20 Marks	50
4	01,02, 03,04	Viva voce	20
	Total Marks		**100**

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

Sl. No.	Particulars	Specification	Quantity
01	PLC Trainer Kit with the following Modules		05 No

	• 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		05 No each
03	Sensors • Temperature Sensors • Position/Displacement Sensors • Strain Gauges • Pressure Sensors • Liquid level detectors • Fluid flow measurement • Smart Sensors • Proximity Sensors		05 No each
04	Induction Motor with DOL Starter	3 Phase Ac 50 Hz	01
05	Synchronise Motor with DOL Starter	3 Phase Ac 50 Hz	01
06	Stepper Motor	Standard size	01
07	Relays	Standard size	10
08	Counter and Timers	Standard size	10

Government of Karnataka
Department of Collegiate and Technical Education

Programme	Audit Course	**Semester**	IV
Course Code	20ME45T	**Type of Course**	Audit
Course Name	**Indian Constitution**	**Contact Hours**	2 hours/week 26 hours/semester
Teaching Scheme	L:T:P :: 2:0:0	**Credits**	2
CIE Marks	50	**SEE Marks**	Nil

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

CO-01	**CO1**	Understand Preamble, salient features and importance of Indian Constitution.
CO-02	**CO2**	Understand Fundamental rights, duties and Directive principles of state policy.
CO-03	**CO3**	Understand Parliamentary system of governance, Structure, Functions, Power of Central, state governments (Legislative, Executive) and Judiciary.
CO-04	**CO4**	Understand Panchayat Raj Institutions and Local self-governments, UPSC, KPSC, NHRC, Status of women, RTE etc.

2. Course Content

Week	CO	Detailed Course Content	Contact Hours
1	1	Introduction to constitution of India-Formation and Composition of the Constituent Assembly-Salient features of the Constitution-Preamble to the Indian Constitution	2
2	1,2	Fundamental Rights- Definition, The right to equality, The right to freedom, The right against exploitation, The right to freedom of religion.	2
3	1,2	Cultural and educational rights and The right to constitutional remedies. Fundamental Duties, Directive principles of state policy.	2
4	1,3	Parliamentary system of governance- Structure of Parliament- Lok Sabha and Rajya Sabha. Functions of parliament- Legislative, Executive, Financial Function Powers of Lok Sabha and Rajya Sabha.	2
5	1,3	Procedure followed in parliament in making law, Annual financial statement (Budget) – procedure in parliament with respect to estimates, Appropriation bill, Supplementary, additional grants, Vote on account, votes on credit and exception grant, special provisions, rules of procedure.	2
6	1,3	Structure of union executive, Power and position of President. Vice President, Prime minister and council of ministers.	2
7	1,3	Structure of the judiciary: Jurisdiction and functions of Supreme Court, high court, and subordinate courts.	2
8	1,3	Federalism in the Indian constitution- Division of Powers: Union list, State list and concurrent list. Structure of state legislation, Legislative assembly and Legislative council.	2
9	1,3	Functions of state legislature, Structure of state executive-Powers and positions of Governor, Speaker, Deputy Speaker, Chief Minister and council of minister.	2
10	4	Local self-government- meaning-Three tier system, Village Panchayat-Taluk panchayat Zilla panchayat, Local bodies-Municipalities and Corporations, Bruhath Mahanagara Palike, Functions of Election commission, UPSC, KPSC.	2

11	4	Amendment of the constitution, Human Rights-Definition-constitutional provisions-right to life and liberty-Human Rights of Women-Discrimination against women steps that are to be taken to eliminate discrimination against women in Education, employment, health care, Economic and social life,	2
12	4	Status of Women in India - Women in rural areas, Constitutional Safeguards - Dowry Prohibition act 1961- Domestic violence act 2005- Sexual harassment at work place bill 2006. Human Rights of Children- Who is a child- list the Rights of the Child- Right to education, Protection of Children from Sexual Offences Act (POCSO)-2012-	2
13	1,4	National Human Rights Commission Constitution- Powers and function of the Commission-Employee rights- Provisions made, Contractual-Non contractual employee rights-Whistle blowing-definition-Aspects-Intellectual Property Rights (IPR)–Meaning-Need for protection- Briefly description of concept of patents, Copy right, Trademark	2
Total in Hours			**26 Hrs**

REFERENCES

1. Introduction to the Constitution of India- Dr. Durga Das Basu
2. Empowerment of rural women in India-Hemalatha H.M and Rameshwari Varma, Hema Prakashana.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 MCQ	6	60	20	Average of two CIE = 20
5	CIE-5 Open Book Test	12	60	20	
Total CIE Marks					50
Semester End Examination (Practice)			-	-	-
Total Marks					**50**