SIXTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
6.1	Industrial Engineering	6	-	2	6	20	10	30	50	2 ½	20	3	70	100
6.2	Metrology and Measuring Instruments	5	-	4	7	20	10	30	50	2 ½	20	3	70	100
6.3	CNC Machines and Automation	4	-	4	5	20	10	30	50	2 ½	20	3	70	100
6.4	Automobile Maintenance, Servicing& Repair (for Automobile) Computer Aided Design (for CAD) Tool Engineering (for Production) Refrigeration Plant, Erection And Servicing (for RAC) Repairand Maintenance- II (for Repair & Maintenance)	5	-	-	6	20	-	20	50	2 ½	-	-	50	70
6.5	Project Work	-	-	12	4	-	40	40	-	-	60	3	60	100
#Student Centred Activities (SCA)		-	-	6	1	-	30	30	-	-	-	-	-	30
Total		20	-	28	29	80	100	180	200	-	120	-	320	500

Student Centred Activities will comprise of co-curricular activities like extension lectures, self study, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities, disaster management and safety etc.

6.1 INDUSTRIAL ENGINEERING

L	T	P
6	-	2

RATIONALE

A diploma holder in this course will have to conduct time and motion study to improve the methods/system. For this, knowledge and related skills in method study and work measurement are essential. Knowledge of industrial safety is also required. Hence this subject.

LEARNING OUTCOMES

After undergoing this course, the students will be able to:

- use industrial engineering concepts to improve productivity
- use resources optimally and economically.
- apply work study techniques for improving production
- explain various incentive plans
- maintain inventory optimally and classify different types of inventory
- take preventive measures to avoid accidents use of safety device.

DETAILED CONTENTS

1. Productivity (10 Periods)
   Introduction to productivity, factors affecting productivity, practical measurement of productivity, difference between production and productivity, causes of low productivity and methods to improve productivity, contribution of standardization in improving productivity.
2. Work Study (10 Periods)
   Definition and scope of work study; factors for selection of work study job, uses and limitations of work study, Inter-relation between method study and work measurement; Human aspects of work study; Role of work study in improving productivity.
3. Method Study (10 Periods)
   Definition, Objectives and procedure for Method study analysis; Information collection and recording techniques through various diagrams.
4. Motion Analysis (10 Periods)

Principles of Motion analysis; Therbligs and SIMO charts; Normal work area (Principle of motion economy), design and arrangement of work place. Ergonomics, design of tools and equipments.

5. Work Measurement (14 Periods)

Objectives; work measurement techniques, stop watch time study; principle, equipment used and procedure; systems of performance rating; standard elements of time, calculation of basic times; various allowances; guide for rest allowance in Indian conditions, calculation of standard time, work sampling, standard data and its usage. Work sampling.

6. Wages and Incentive Schemes (08 Periods)

Introduction to wages, Wage payment for direct and indirect labour, wage payment plans and incentives, various incentive plans, incentives for indirect labour.

7. Stores Management: (10 Periods)

Different Layout and structures of stores, Inventory control, calculation of EOQ, Bin cards and various forms required in stores for documentation. Purchase procedures.

8. Industrial Safety (10 Periods)

8.1 Accident- causes, types, results and control.

8.2 Mechanical and electrical hazards- types, causes and preventive steps/procedure.

8.3 Describe salient points of Factories Act 1948 for health and safety- wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels etc.

8.4 Safety colour codes.

8.5 Fire prevention and fire fighting, equipment and methods.

LIST OF PRACTICALS

1. Stop watch time study on any machine like lathe, drilling machine or milling machine
2. Method improvement - Assembly of bolt, nut and 3 washers
3. Determination of standard time for assembly of electrical switch
4. Preparation of flow process chart
5. Preparation of SIMO chart
6. Preparation of flow diagram
7. Preventive measure in case of electrocution
8. Preventive measures in case of snake/poisonous creature sitting
9. Use of first aid in case of minor accidents
10. Use of five extenuates/five drill

INSTRUCTIONAL STRATEGY

1. Teacher should use models and encourage students to develop some other suitable model.
2. The teacher should observe and redress the difficulties faced by students in performing the work while working on ergonomically good and poorly designed workstation.
3. The teacher should show them real forms to be filled from stores and record keeping.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Model/prototype making
- Preparation of different charts
- Viva-voce

RECOMMENDED BOOKS

1. Work Study and Ergonomics by S Dalela and Sourabh
2. Industrial Engineering and Management by O.P. Khanna, Dhanpat Rai and Sons, Delhi.
3. Industrial Engineering and Management by M. Mahajan; Dhanpat Rai and Sons, New Delhi.
4. Introduction to Work Study, ILO Publication
5. Production and costing by GBS Narang; Khanna Publishers, New Delhi.
6. E-books/e-tools/relevant software to be used as recommended by AICTE/UBTE/NITTTR, Chandigarh.

Websites for Reference:

http://swayam.gov.in

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	10	12
2	10	12
3	10	12
4	10	12
5	14	16
6	08	10
7	10	12
8	12	14
Total	**84**	**100**

6.2 METROLOGY AND MEASURING INSTRUMENTS

L	T	P
5	-	4

RATIONALE

Metrology is the science of measurement, Diploma holders in this course are responsible for ensuring process and quality control by making measurements and carrying out inspection of various parameters. For this purpose, knowledge and skills about various measuring instruments are required. The aim of this subject is to develop knowledge and skills regarding various measuring instruments amongst the students.

LEARNING OUTCOME

After undergoing the subject, students will be able to :

- use verniercalliper, micrometer, Height gauge for linear internal and external measurement.
- use bore gauge, radius gauge, taper gauge, plug gauge, ring gauge, snap gauge for measurements.
- use bevel protector, sine bar, slip gauge, dial indictor, angle deckor, poppy dial for angular measurements.
- measure spur gear characteristics using gear tooth vernier, outside diameter over dovel pins.
- use tool makers microscope
- measure surface roughness parameters.
- use profile projector, auto collimeter, angle deckor.
- select and measure variables using electrical and electronics comparators and measuring instrument, sensors, transducers.
- select and use non destructive testing methods.
- explain the use of coordinate measuring machine.
- use the concept of limits, fits and tolerance in assembly of components

DETAILED CONTENTS

1. Introduction (08 Periods)

   1.1 Definition of metrology
   1.2 Standard of measurement
   1.3 Types of Errors - Controllable and random errors

1.4 Precision, accuracy, sensitivity, hysteresis, response time, repeatability, calibration, uncertainty of measurement, interchangeability.

1.5 Standardization and standardizing organizations

2. Linear and Angular Measurement (20 Periods)

2.1 Construction features and use of instruments for non precision linear measurement: steel rule, callipers, surface plate, angle plate, V-block.

2.2 Construction features and use of instruments for precision measurements :verniercalipers, vernier height and depth gauges, micrometers.

2.3 Slip gauges, Indian standards of slip gauges, sets of slip gauges, use of slip gauges.

2.4 Cylinder bore gauges, feeler and wire gauges. Checking flatness, roundness and squareness

2.5 Comparators – Characteristics, uses, working principles of different types of comparators: mechanical, electrical, electronics and pneumatic .

2.6. Construction and use of instruments for angular measurements: bevel protector, sine bar, angle gauges, clinometer, angle dekker. Optical instruments for angular measurement, auto collimator.

3. Measurement of Surface Finish (12 Periods)

3.1 Terminology of surface roughness.

3.2 Concept of primary texture and secondary texture.

3.3 Factors affecting surface finish.

3.4 CLA, RMS and RA value.

3.5 Principle and operation of stylus probe instruments. Tomlinson surface meter and Taylor surface talysurf.

4. Limits, Fits and Tolerance (05 Period)

5. Measurements of Screw threads and Gauges (10 Periods)

5.1 Measurement of screw threads- Introduction, measurements of external and core diameters, checking of pitch and angle of threads with gauges.

5.2 Measurements of gears (spur) – Measurement of tooth thickness, pitch, Gear Ball tester, Lead and Profile Testers.

5.3 Profile projector, Coordinate Measuring Machine (CMM), Tool maker's microscope.

6. Instrumentation (15 Periods)

6.1 Various types of instruments used for mechanical quantities such as displacement, velocity, acceleration, speed and torque. Use of transducers and electronic counters, stroboscope, vibrating reeds and tachometers.

6.2 Strain gauge – use of strain gauge and load cells

6.3 Various types of temperature measuring instruments such as thermometers, Thermistor, Bimetallic strip, Pyrometers

Note: There should be a visit to established metrology lab to familiarize students with purpose and need of metrology.

LIST OF PRACTICALS

1. Internal and external measurements with verniercalliper and micrometer
2. Measurement of linear dimensions with height gauge and depth gauge.
3. Measurement of flatness, concentricity with dial indicator
4. Use of feeler gauge, wire gauge, radius gauge and fillet gauges for checking of standard parameters.
5. Use of plain plug and ring gauge, taper plug and ring gauge, thread plug and ring gauge and snap gauges.
6. Measurement of Angle using;
   - i) Cylindrical rollers and spherical balls and slip gauges
   - ii) Bevel protector
   - iii) Sine Bar/Sine Table , Slip Gauges, Height Gauge and dial indicator.
   - iv) Angle deckor.
7. Measurement of thread parameters by using tool maker's microscope.
8. Measurement of cylindrical bore using cylinder bore gauge for bore diameter, ovality and taper.
9. Measurement of surface roughness using surface roughness tester.
10. Measurement of a profile using profile projector.
11. Study and use of Auto-Collimator.
12. Determination of temperature of thermocouple, pyrometer, Infrared thermometer.

INSTRUCTIONAL STRATEGY

1. Demonstrate use of various measuring instruments while imparting theoretical instructions.
2. Stress should be laid on correct use of various instruments.

RECOMMENDED BOOKS

1. Engineering Metrology by RK Jain; Khanna Publishers, New Delhi.
2. A Text Book of Production Engineering by RC Sharma; S Chand and Company, New Delhi.

3. Metrology Laboratory Manual by M Adithan and R Bahl; NITTTR, Chandigarh.
4. Engineering Metrology by RK Rajput; SK Kataria and Sons, Ludhiana.
5. E-books/e-tools/relevant software to be used as recommended by AICTE/UBTE/NITTTR, Chandigarh.

Website for Reference:

http://swayam.gov.in

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	08	12
2	20	28
3	12	18
4	05	08
5	10	14
6	15	20
Total	**70**	**100**

6.3 CNC MACHINES AND AUTOMATION

L	T	P
4	-	4

RATIONALE

Diploma holders are required to supervise and handle specialized machines and equipment like CNC machines. For this purpose, knowledge and skills about NC machines, part programming in NC machines and tooling for CNC machines are required to be imparted for enabling them to perform above functions. This subject aims at development of knowledge and skills about CNC machines, tools, equipment and use of high tech machines for increased productivity and quality.

LEARNING OUTCOMES

After undergoing this course, the students will be able to :

- explain the construction and tooling of CNC machine.
- prepare simple part programme for different operations.
- operate a CNC lathe.
- operate a CNC milling machine.
- diagnose common problems in CNC machines.
- explain the trends in the field of automation.

DETAILED CONTENTS

1. Introduction (06 Periods)

   Introduction to NC, CNC & DNC, their advantages, disadvantages and applications, Machine Control Unit, input devices, serial communication and Ethernet techniques, selection of components to be machined on CNC machines, Problems with conventional NC, New developments in NC, Axis identification, PLC Control and its components.

2. Constructional details and Tooling (08 Periods)

   Design features, specification Chart of CNC machines, use of slideways, balls, rollers and coatings, motor and leadscrew, swarf removal, safety and guarding devices, various cutting tools for CNC machines, overview of tool holder, different pallet systems and automatic tool changer system, management of a tool room.

3. Part Programming (12 Periods)

   Part programming and basic concepts of part programming, NC words, part programming formats, simple programming for rational components, part programming using canned

cycles, subroutines and do loops, tool off sets, cutter radius compensation and wear compensation.

4. System Devices (08 Periods)

Actuators, Transducers and Sensors, Tachometer, LVDT, opto-interrupters, potentiometers for linear and angular position, encoder and decoder, axis drives, open loop system, close loop system.

5. Problems in CNC Machines (06 Periods)

Common problems in mechanical, electrical, pneumatic, electronic and PC components of NC machines, diagnostic study of common problems and remedies, use of on-time fault finding diagnosis tools in CNC machines.

6. Automation and NC system (06 Periods)

Role of computer in automation, emerging trends in automation, automatic assembly, manufacture of magnetic tape, manufacture of printed circuit boards, manufacture of integrated Circuits, Overview of FMS, Group technology, CAD/CAM and CIM.

7. CNC operations involved in Turning and Milling (10 Periods)

7.1 Introduction to operations involved in turning machines- Facing OD and ID Rough cut, Finish cut, Taper turning, Drilling, Threading, Grooving and cut-off (parting).

7.2 Introduction to operations involved in Milling-contouring, pocketing, Drilling, Facing, Circular tools paths.

7.3 Different terms like clearance, Retract, Feed plane, Depth of cut, lead in, lead out, overlap.

7.4 Simple programmes in Milling and Turning involving different operations.

LIST OF PRACTICALS

1 Study the constructional details of CNC lathe.

2. Study the constructional details of CNC milling machine.

3. Study the constructional details and working of:
   Automatic tool changer and tool setter
   - Multiple pallets
   - Swarf removal
   - Safety devices

4. Develop a part programme for following lathe operations and make the job on CNC lathe and CNC turning center.

- Plain turning and facing operations
- Taper turning operations
- Operation along contour using circular interpolation.

5. Develop a part programme for the following milling operations and make the job on CNC milling
   - Plain milling
   - Slot milling
   - Contouring
   - Pocket milling
6. Preparation of work instruction for machine operator
7. Preparation of preventive maintenance schedule for CNC machine.
8. Demonstration through industrial visit for awareness of actual working of FMS in production.
9. Use of software for turning operations on CNC turning center.
10. Use of software for milling operations on machine centres.

INSTRUCTIONAL STRATEGY

This is highly practice-based course. Efforts should be made to develop programming skills amongst the students. During practice work, it should be ensured that students get opportunity to individually perform practical tasks.

RECOMMENDED BOOKS

1. CNC Machines – Programming and Applications by M Adithan and BS Pabla; New Age International (P) Ltd., Delhi.
2. Computer Aided Manufacturing by Rao, Kundra and Tiwari; Tata McGraw Hill, New Delhi.
3. CNC Machine by Bharaj; Satya Publications, New Delhi.
4. e-books/e-tools/relevant software to be used as recommended by AICTE/UBTE,NITTTR, Chandigarh.

Website for Reference:

http://swayam.gov.in

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	06	10
2	08	14
3	12	22
4	08	14
5	06	10
6	06	10
7	10	20
Total	**56**	**100**

6.4 TOOL ENGINEERING
(only For Production)

L	T	P
5	-	-

RATIONALE

A diploma holder should have complete knowledge of basic tools, their materials and their optimal utilization. This subject imparts skill and awareness of quality production in minimum time by using jigs and fixtures.

LEARNING OUTCOMES

After completion of this course, the students will be able to :

- List various properties of cutting tools.
- Explain the geometry of cutting tools.
- Explain the principles of location.
- Describe the functions of various locating devices.
- Explain the working of various types of clamps.
- Explain the functioning of various types of drilling jigs.
- Discuss features of various types of fixtures

DETAILED CONTENTS

1 Cutting Tools (24 Periods)

Mechanical property and uses of high-speed steel, stellite, cemented carbide, ceramics diamond, study of commercially available cutting tools. Tool geometry of single point cutting tools, multipoint cutting tools, reamer, drill, milling cutter, throw-away inserts, chip breaker, tool and cutter maintenance, regrinding and lapping of tools.

2 Location and Clamping (16 Periods)

Principles of location, 3-2-1 principle, Location with previous machined hole, different locating devices, V-location, conical locations. Purpose of Clamping elements, types of clamps.

3 Jigs and Fixtures (30 Periods)

Need for jigs and fixtures, fundamental principles of jigs and fixtures design.
Types of bushes, advantages of bushings.
Types of drilling jigs- template jig, channel jig, latch jig, quick acting jig, indexing jig, box jig.
Types of fixtures-simple fixture, milling fixture, welding fixture, turning fixture, assembly fixture & inspection fixture.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Mid-term and end-term written tests

RECOMMENDED BOOKS

1 Production Engineering by P.C. Sharma; S. Chand & Company Ltd., Delhi.
2 Tool Design by Donaldson and Lecain; Tata McGraw Hill Company, New Delhi
3 Production Engineering & Design by Dr. Surender Kumar and Umesh Chandra
4 E-books/e-tools/relevant software to be used as recommended by AICTE/UBTE/NITTTR, Chandigarh.

Websites for Reference:
http://swayam.gov.in

SUGGESTED DISTRIBUTION OF MARKS

Sr. No.	Time Allotted (Periods)	Marks allotted (%)
1.	24	36
2.	16	22
3.	30	42
Total	70	100

6.5 PROJECT WORK

L	T	P
-	-	12

RATIONALE

Major Project Work aims at developing innovative skills in the students whereby they apply in totality the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. In addition, the project work is intended to place students for project oriented practical training in actual work situation for the stipulated period.

LEARNING OUTCOMES

After undergoing the project work, students will be able to:
Apply in totality the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. In addition, the project work is intended to place the learner for project oriented practical training in actual work situation for the stipulated period with a view to:

- Develop understanding regarding the size and scale of operations and nature of field-work in which students are going to play their role after completing the courses of study
- Develop understanding of subject based knowledge given in the classroom in the context of its application at work places.
- Develop firsthand experience and confidence amongst the students to enable them to use and apply polytechnic/institute based knowledge and skills to solve practical problems related to the world of work.
- Develop abilities like interpersonal skills, communication skills, positive attitudes and values etc.

General Guidelines

The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. The activity of problem identification should begin well in advance (say at the end of second year). Students should be allotted a problem of interest to him/her as a major project work. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments for their students. The project assignment can be individual assignment or a group assignment. There should not be more than 3 students if the project work is given to a group. The project work identified in collaboration with industry should be preferred.

This practical training cum project work **should not be considered** as merely conventional industrial training in which students are sent at work places with either minimal or no supervision. This experience is required to be planned in advance and supervised on regular basis by the polytechnic faculty. For the fulfillment of above objectives, polytechnics may establish

close linkage with 8-10 relevant organization for providing such an experience to students. It is necessary that each organization is visited well in advance and activities to be performed by students are well defined. The chosen activities should be such that it matches with the curricular interest to students and of professional value to industrial/ field organizations. Each teacher is expected to supervise and guide 5-6 students.

The projects given to students should be such for which someone is waiting for solution. Some of the suggested project activities are given below:

1. Projects connected with repair and maintenance of machines.
2. Estimating and costing projects.
3. Design of jigs / fixtures.
4. Projects related to quality control.
5. Project work related to increasing productivity.
6. Projects relating to installation, calibration and testing of machines.
7. Projects related to wastage reduction.
8. Project, related to fabrication.
9. Energy efficiency related projects.
10. Projects related to improving an existing system

NOTE: Each student has to take one project individually and one to be shared with a group of four-five students depending upon cost and time involved. There is no binding to take up the above projects as it is only a suggestive list of projects.

A suggestive criterion for assessing student performance by the external (person from industry) and internal (teacher) examiner is given in table below:

Sr. No.	Performance Criteria	Max.** Marks	Rating Scale				
			Excellent	Very Good	Good	Fair	Poor
1.	Selection of project assignment	10%	10	8	6	4	2
2.	Planning and execution of considerations	10%	10	8	6	4	2
3.	Quality of performance	20%	20	16	12	8	4
4.	Providing solution of the problems or production of final product	20%	20	16	12	8	4
5.	Sense of responsibility	10%	10	8	6	4	2
6.	Self expression/ communication skills	5%	5	4	3	2	1
7.	Interpersonal skills/human relations	5%	5	4	3	2	1
8.	Report writing skills	10%	10	8	6	4	2
9	Viva voce	10%	10	8	6	4	2
Total marks		**100**	**100**	**80**	**60**	**40**	**20**

The overall grading of the practical training shall be made as per following table.

In order to qualify for the diploma, students must get "Overall Good grade" failing which the students may be given one more chance to improve and re-evaluate before being disqualified and declared "not eligible to receive diploma ". It is also important to note that the students must get more than six "goods" or above "good" grade in different performance criteria items in order to get "Overall Good" grade.

	Range of maximum marks	**Overall grade**
i)	More than 80	**Excellent**
ii)	79 <> 65	Very good
iii)	64 <> 50	Good
iv)	49 <> 40	Fair
v)	Less than 40	Poor

Important Notes

1. **This criteria must be followed by the internal and external examiner and they should see the daily, weekly and monthly reports while awarding marks as per the above criteria.**

2. **The criteria for evaluation of the students have been worked out for 200 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.**

3. **The external examiner, preferably, a person from industry/organization, who has been associated with the project-oriented professional training of the students, should evaluate the students performance as per the above criteria.**

4. **It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific nearby industries are approached for instituting such awards.**

The teachers are free to evolve other criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work

10. RESOURCE REQUIREMENT

10.1 PHYSICAL RESOURCES

(A) Space requirement

Norms and standards laid down by All India Council for Technical Education (AICTE) are to be followed to work out space requirement in respect of class rooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

(B) Equipment requirement:

Following Laboratories are required for Diploma Programme in Mechanical Engineering:

- Communication Laboratory
- Applied Physics Laboratory
- Applied Chemistry Laboratory
- Engineering Drawing
- Applied Mechanics
- Basics of Information Technology/Computer Laboratory
- Carpentry Shop
- Painting and Polishing Shop
- Electrical Shop
- Smithy Shop
- Fitting and Plumbing Shop
- Sheet Metal Shop
- Welding Shop
- Foundry Shop
- Machine Shop
- Material and Metallurgy Laboratory
- Mechanical Engineering Drawing
- Strength of Material Laboratory
- Electrical and Electronics Engineering Laboratory
- Mechanical Workshop
- Hydraulic and Pneumatic Laboratory
- Thermal Engineering Laboratory
- Metrology Laboratory
- Refrigeration and Air Conditioning Laboratory
- Theory of Machine Laboratory
- Automobile Engineering Lab
- Maintenance Lab (fot Repair & Maintenance)
- Environment Engineering

- Energy Conservation Lab