NEP-2020 Aligned Curriculum for

Three year (Six Semester) Diploma Programme in

- MECHANICAL ENGINEERING (Production)

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(Effective from session 2025-26)

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PREFACE

An important issue generally debated among the planners and educator's world over is how technical education can contribute to sustainable development of the societies struggling hard to come in the same bracket as that of the developed nations. The rapid industrialization and globalization have created an environment for free flow of information and technology through fast and efficient means. This has led to the shrinking of the world, bringing people from different culture and environments together and giving rise to the concept of world turning into a global village. In India, a shift has taken place from the forgettable years of closed economy to knowledge based and open economy in the last few decades. To cope with the challenges of handling new technologies, materials and methods, we have to develop human resources having appropriate professional knowledge, skills and attitude. Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Now it is time to consolidate and infuse quality aspect through developing human resources in the delivery system. Polytechnics play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives being taken by Technical Education, UP to revise the existing curricula of diploma programme as per the needs of the industry and making them NEP-2020 compliant, are laudable.

In order to meet the requirements of future technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of diploma programme. The curricula for diploma programme have been revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of diploma programme.

The real success of the diploma programme depends upon its effective implementation. However best the curriculum document is designed, if that is not implemented properly, the output will not be as expected. In addition to acquisition of appropriate physical resources, the availability of motivated, competent and qualified faculty is essential for effective implementation of the curricula.

It is expected of the polytechnics to carry out job market research on a continuous basis to identify the new skill requirements, reduce or remove outdated and redundant courses, develop innovative methods of course offering and thereby infuse the much-needed dynamism in the system.

Director
Institute of Research Development &Training.
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5. Faculty/Subject Experts from U.P. Government polytechnics

6. All the participants from industry/field organizations, engineering colleges, polytechnics, and other technical institutions for their professional inputs during curriculum workshops.

Coordinator
Institute of Research Development & Training,
Kanpur, U.P.

1. SALIENT FEATURES

- Name of the Programme: Diploma in Mechanical Engineering (Production)
- Duration of the Programme: Three years (Six Semesters)
- Entry Qualification: Matriculation or as Prescribed by State BTE, UP
- Intake: As prescribed by the Board
- Pattern of the Programme: Semester Pattern
- Ratio between theory and Practical: 40 : 60 (Approx.)
- Practicum subjects are to be evaluated by theory or practical examinations as mentioned in the scheme.

2. Employment Opportunities

1. Entry-Level and Production Roles
Diploma Engineer Trainee/Junior Engineer (Manufacturing/Production)
Plant Operator roles in agro-processing industries

2. Supervisory and Quality/Design Roles
Mid-level roles such as Production Supervisor, Quality Engineer, Mechanical Design Engineer, CNC Programmer/Operator, and Draughtsman

3. Government & Public Sector Jobs
Diploma holders are eligible to apply for Junior Engineer positions in UP state departments, CPWD, Public Sector Units (e.g., Indian Railways, NTPC), and Defence PSUs (e.g., HAL, Ordnance Factories) .
Entry into railways via RRB JE, DMRC JE-ME, etc., is common and offers stable pay and benefits

4. Apprenticeships & Training
Apprenticeship programs through Polytechnic placements are common in manufacturing, electronics, and mechanical workshops. These often involve training in CNC operation, maintenance, design tools, etc., leading to permanent roles .

5. Career Advancement & Further Education
Many diploma grads later pursue Graduation to advance technical credibility
Skill/Certification courses: AutoCAD, SolidWorks, CNC, SAP, NDT

PROGRAM OUTCOMES (POs)

PO1: Basics and Discipline specific Knowledge

Assimilate knowledge of basic mathematics, science, engineering fundamentals, and electronics and communication engineering.

PO2: Problem's Analysis and solution

Identify, analyse and solve problems using standard methods and established techniques.

PO3: Design and Development

Design solutions for technical problems.

Assist in designing components, systems, or processes to meet specific requirements.

PO4: Engineering Tools, Experimentation, and Testing

Use modern engineering tools and appropriate techniques to conduct experiments as per BIS standard.

PO5: Socio/ Economic /Environmental impact assessment/remedy.

Apply relevant technologies while considering societal needs, environmental impact keeping in view sustainable and ethical responsibilities.

PO6: Project Management and Communication

Apply engineering management principles, work effectively as an individual or in a team, and communicate clearly on activities.

PO7: Lifelong Learning

Recognize the importance of continuous learning and actively pursue self-improvement to keep pace with technological developments.

Study Scheme
Diploma in Mechanical Engineering (Production) (Six Semester)
Semester: III

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External	End Semester Exam Type	#
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT							
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot			
1.	Thermal Engineering -I	4	0	0	3	40	-	40	60	3	-	-	60	100	**Theory**	
2.	Fluid Mechanics & Hydraulic Machinery	4	0	0	3	40	-	40	60	3	-	-	60	100	**Theory**	
3.	Fluid Mechanics & Hydraulic Machinery Lab	0	0	4	2	-	60	60	-	-	40	3	40	100	**Practical**	
4.	Workshop Practice	0	0	4	2	-	60	60	-	-	40	3	40	100	**Practical**	
5.	Measurements & Metrology	2	0	3	3	-	40	40	60	3	-	-	60	100	**Practicum**	
6.	Computer Aided Machine Drawing Practice	1	0	6	4	-	60	60	-	-	40	3	40	100	**Practicum**	
7.	Advance Skill Development OR	-	-	-	2	-	-	-	-	-	-	-	-	-	***Qualifying**	
	*Open Elective-I	2	-	-		50	-	50	-	-	-	-	-	-		
8.	Summer Internship-I (4 weeks) after IInd Sem	0	0	0	1	-	50	50	-	-	-	-	-	50	**Practical**	
#Student Centred Activities (SCA)		-	-	6	-	-	50	50	-	-	-	-	-	50	-	
Total		**13**	**0**	**23**	**20**	**80**	**320**	**400**	**180**	**-**	**120**	**-**	**300**	**700**		

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

*** Qualifying paper** must have to pass, but the marks will not be added in awarded division or total marks.

* **Practicum subjects** are to be evaluated by theory or practical examinations as mentioned in above scheme.

***Tata Tech. Based** Open Elective-I subject will be offered preferably at the centers established by Tata Tech.

The lecture alloted to SCA can also be utilized for the course completion of other subjects.

Note -

1) Each period will be 60 minutes duration.
2) Each session will be of 16 weeks.
3) Effective teaching will be at least 14 weeks.

Open Elective-I

SR. NO.	SUBJECT NAME
1.	Material Handling Systems (AICTE)
2.	Energy Conservation & Audit (AICTE)
3.	Industrial Robotics & Automation (AICTE)
4.	Any Course Of Minimum 02 Credit From (Advance Skill Development) • NPTEL • MOOCS THROUGH SWAYAM • AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES • C-DAC • CERTIFICATES CONDUCTED BY THE INSTITUTE OF NATIONAL IMPORTANCE (IIT, NIT, IIT ETC.) • ISRO E-LEARNING • COURSES OFFERED BY TATA TECHNOLOGY (Annexure-1) OR OTHER REPUTED ORGNISATION. o Advanced Welding & Painting using Simulator (Tata Tech) o Internet of Things (Tata Tech) o Product Verification & Analysis (Tata Tech)

Advance Skill Development:

To fulfill the requirements for Advanced Skill Development, a minimum of 20 hours of skill certification is necessary. This certification must be obtained from a recognized national or international agency or institute. The assessment and certification process will be conducted by the respective agency or institute. Students must present their certificate to earn 02 credits for this subject.

Study Scheme
Diploma in Mechanical Engineering (Production) (Six Semester)
Semester: IV

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External	Exam Type
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT						
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot		
1.	Strength of Materials	4	0	0	3	40	-	40	60	3	-	-	60	100	**Theory**
2.	Industrial Engineering & Management	4	0	0	3	40	-	40	60	3	-	-	60	100	**Theory**
3.	Strength of Materials Lab	0	0	6	3	-	60	60	-	-	40	3	40	100	**Practical**
4.	Manufacturing Engineering	2	0	3	3	-	40	40	60	3	-	-	60	100	**Practicum**
5.	Material Science & Engineering	1	0	4	3	-	60	60	-	-	40	3	40	100	**Practicum**
6.	Thermal Engineering-II	1	0	4	3	-	60	60	-	-	40	3	40	100	**Practicum**
7.	Advance Skill Development OR	-	-	-	2	-	-	-	-	-	-	-	-	-	***Qualifying**
	*Open Elective-II	2	-	-		50	-	50	-	-	-	-	-	-	
8.	*Essence of Indian Knowledge and Tradition (Q)	2	0	0	-	50	-	50	-	-	-	-	-	-	***Qualifying**
#Student Centred Activities (SCA)		-	-	3	-	-	50	50	-	-	-	-	-	50	-
Total		**16**	**0**	**20**	**20**	**80**	**270**	**350**	**180**	**-**	**120**	**-**	**300**	**650**	-

Industrial training of 4-6 weeks duration to be organized after 4th semester exam and will be evaluated in 5th sem.

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

*** Qualifying paper** must have to pass, but the marks will not be added in awarded division or total marks.

* **Practicum subjects** are to be evaluated by theory or practical examinations as mentioned in above scheme.

***Tata Tech. Based open elective-II** subject will be offered preferably at the centers established by Tata Tech.

The lecture alloted to SCA can also be utilized for the course completion of other subjects.

Note -

1) Each period will be 60 minutes duration.
2) Each session will be of 16 weeks.
3) Effective teaching will be at least 14 weeks.

Open Elective-II

SR. NO.	SUBJECT NAME
1.	Refrigeration & Air-conditioning
2.	Power Plant Engineering
3.	Disaster Management
4.	Any Course Of Minimum 02 Credit From (Advance Skill Development) • NPTEL • MOOCS THROUGH SWAYAM • AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES • C-DAC • CERTIFICATES CONDUCTED BY THE INSTITUTE OF NATIONAL IMPORTANCE (IIT, NIT, IIT ETC.) • ISRO E-LEARNING • COURSES OFFERED BY TATA TECHNOLOGY (Annexure-1) OR OTHER REPUTED ORGNISATION. o Inspection & Quality Control (Tata Tech) o Advanced Automobile (Tata Tech)

Advance Skill Development:

To fulfill the requirements for Advanced Skill Development, a minimum of 20 hours of skill certification is necessary. This certification must be obtained from a recognized national or international agency or institute. The assessment and certification process will be conducted by the respective agency or institute. Students must present their certificate to earn 02 credits for this subject.

4. GUIDELINES FOR ASSESSMENT OF STUDENT CENTRED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 50 as itinvolves a lot of subjectivity in the evaluation. The marks may be distributed as follows:

i. 10 Marks for general behaviour and discipline
(by HODs in consultation with all the teachers of the department)

ii. 10 Marks for attendance as per following:
(by HODs in consultation with all the teachers of the department)

a) 75 - 80% 8 Marks
b) 80 - 85% 9 Marks
c) Above 85% 10 Marks

iii. 30 Marks maximum for Sports/ NCC/ Cultural/ Co-curricular/ NSS activities as per following:
(by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) 30 - State/National Level participation
b) 25 - Participation in two of above activities
c) 15 - Inter-Polytechnic level participation

3.1	Thermal Engineering-I	L	T	P	C
Theory		4	0	0	3

RATIONALE

Thermal Engineering is a fundamental subject for diploma holders in Mechanical, Automobile, and related engineering fields. It provides essential knowledge about thermodynamics, heat transfer, and energy systems, which form the backbone of various industrial and engineering applications.

As industries increasingly focus on energy efficiency, environmental impact, and sustainable technologies, a strong understanding of thermal principles is crucial. This subject enables diploma students to analyze, operate, and maintain thermal systems such as boilers, turbines, steam generators, sources of energy.

LEARNING OUTCOMES

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

- Understand the Fundamentals of Thermodynamics.
- Apply Thermodynamic Principles to Practical Systems.
- Understand and Apply Heat Transfer Principles.
- Understand Steam Properties and Steam Boilers.
- Analyze Steam Turbines and Steam Nozzles.

DETAILED CONTENT

UNIT-I: Fundamental Concepts: Role of Thermodynamics in Engineering .Thermodynamic state and system, boundary, surrounding, universe, thermodynamic systems – closed, open, isolated, adiabatic, homogeneous and heterogeneous, properties of system, thermodynamic equilibrium, quasi – static process, reversible and irreversible processes, Zeroth law of thermodynamics,

Unit-II: Thermodynamic Processes on Gases and Laws of thermodynamics : Explanation of perfect gas laws – Boyle's law, Charle's law, Gay-Lussac's law, Universal gas constant, Characteristic gas constants, simple problems on gas equation, Laws of conservation of energy, first law of thermodynamics (Joule's experiment), Application of first law of thermodynamics ,Steady flow energy equation, Application of steady flow energy equation, statement of second laws of thermodynamics: Kelvin Planck's statement, Clausius statement, Perpetual motion Machine of first kind, second kind, Carnot cycle, Carnot engine, Introduction of third law of thermodynamics.

UNIT-III: Properties of Steam: Formation and Industrial uses of Steam; Basic definitions: saturated liquid line, saturated vapour line, liquid region, vapour region,wet region, superheat region, critical point, saturated liquid, saturated vapour, saturation temperature, sensible heat, latent heat, wet steam, dryness fraction, wetness fraction,saturated steam, superheated steam, degree of superheat; Determination of enthalpy,internal energy, latent heat, of wet, dry and superheated steam at a given pressure using steam tables and simple direct problems on the above using table.

UNIT-IV: Steam generators: Introduction and classification of boilers with example, Boiler mountings and accessories, Brief explanation with line sketches of Cochran, Babcock and Wilcox

Boilers Locomotive boiler; Brief explanation with line sketches of High Pressure Boiler, Draught systems (Natural, forced & induced).

Unit-V : Steam Turbines and Steam Nozzles: Classification of steam turbines with examples . Difference between Impulse & Reaction turbines. Working Principle of a simple De-lavel turbine & Parson's Reaction turbine with line diagrams-Velocity diagrams; Basic concept used for calculation of work done, axial thrust, tangential thrust, blade and diagram efficiency, stage efficiency, nozzle efficiency.
Governing of steam turbines: Throttle, By-pass & Nozzle control governing

Flow of steam through nozzle; Discharge of steam through nozzles; Critical pressure ratio; Effect of friction in nozzles and Super saturated flow in nozzles.

INSTRUCTIONAL STRATEGY
While imparting instructions, teacher should explain various sources of energy to the students and facilitate discussions where students evaluate pros and cons of different energy sources. It's recommended that teachers take action to grab students' interest and increase their confidence in their ability to learn. The demonstration might spark interest in the subject and encourage a scientific perspective. Every topic should have planned student activities. To make sure that learning is outcome and employability based, a theory – demonstrate practice - activity approach may be used throughout the course. If available, demonstrate small-scale models of steam boilers in the lab or use virtual labs to simulate their operation.

MEANS OF ASSESSMENT
- Assignments and quiz/class tests.
- Sessional test.
- Model making, Mini-Projects.
- Small projects.

REFERENCE BOOKS/ ONLINE RESOURCES
1. Engineering Thermodynamics by PK Nag; Tata McGraw Hill, Delhi.
2. Basic Engineering Thermodynamics by Roy Chaudhary; Tata McGraw Hill, Delhi.
3. Engineering Thermodynamics by CP Arora; Tata McGraw Hill, Delhi.
4. R. K. Rajput, Thermal Engineering ,Laxmi Publications Pvt Ltd , New Delhi.
5. R.S. Khurmi, J. K. Gupta, A Textbook of Thermal Engineering, S. Chand Publications.
6. E-books/e-tools/relevant software to be used as recommended by AICTE/BTE,Lucknow.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	10	12
2	10	12
3	12	12
4	12	12
5	12	12
Total	**56**	**60**

3.2	Fluid Mechanics & Hydraulic Machinery	L	T	P	C
THEORY		4	0	0	3

RATIONALE

Diploma holders in this course are required to deal with problems of fluid and use of hydraulics in power generation. For this purpose, knowledge and skills about fluid mechanics and machinery, hydraulics systems are required to be imparted for enabling them to perform above functions.

LEARNING OUTCOMES

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

- Explain fluid properties, their units and conversion.
- Measure different types of pressures.
- Calculate flow and discharge of various liquids.
- Apply Bernoulli's theorem for calculating pipe diameter and height of pipe from ground.
- Calculate pipe friction and losses in pipelines.
- Specify hydraulic machines for different applications.
- Apply Pascal's law in practical applications.

DETAILED CONTENT

UNIT-I: Properties of Fluid: Definition of fluid, Density, Specific gravity, Specific Weight, Specific Volume, Dynamic Viscosity, Kinematic Viscosity, Surface tension, Capillarity, Vapour Pressure, Compressibility. Different types of fluids: Ideal fluid, Real fluid, Ideal plastic fluid, Plastic fluid, Newtonian and non Newtonian fluid. Simple numerical problems.

Fluid Pressure: Fluid pressure, Pressure head, Conversion of Pressure head, Pressure Intensity, Statement of Pascal law and its applications.

Concept of vacuum and gauge pressures, atmospheric pressure, absolute pressure. Simple numerical problem.

UNIT-II: Pressure Measurement: Barometer, Simple manometer, differential manometers and sensitive Manometers, Bourdan pressure gauge.

Concept of Total pressure on immersed bodies, Center of pressure, Simple problems on Manometers.

UNIT-III: Fluid Flow: Types of fluid flows, Path line, Streamline and streak lines, Continuity equation, Bernoulli's theorem, Principle of operation of Venturi meter and Orifice meter, Principle of operation of Pitot tube and rotameter. Concept and relation of Cd, Cv and Cc. Simple numerical problem.

Flow Through Pipes: Laminar and turbulent flows; Reynold's number and its effect on pipe friction; critical velocity, siphon, Water hammer. Darcy's equation and Chezy's equation for frictional losses, Minor losses in pipes. Hydraulic gradient, Simple numerical problem.

UNIT-IV: Hydraulic Turbines: Classification of hydraulic turbines, Selection of turbine on the basis of head and discharge available, Construction and working principle of Pelton wheel, Francis

and Kaplan turbines, Draft tubes – types and construction, Concept of cavitation in turbines, Cavitation causes, effects and remedies.
Centrifugal Pumps: Principle of working and applications, Types of casings and impellers, Concept of multistage, Priming and its methods.
Reciprocating Pumps: Construction, working principle and applications of single and double acting reciprocating pumps, Concept of Slip, Negative slip, Cavitation and separation.

UNIT-V: Hydraulic System: Description, operation and application of hydraulic systems – hydraulic ram, hydraulic jack, hydraulic brake, hydraulic accumulator, hydraulic door closer, hydraulic press.
Hydro Power plant: Introduction, type of hydro-power plant, tidal and wave energy.

INSTRUCTIONAL STRATEGY

- Use computer-based learning aids for effective teaching-learning Expose students to real life problems
- Plan assignments so as to promote problem solving abilities and develop continued learning skills.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Sessional test
- Actual Practical Performance
- Small projects
- Viva-voice

REFERENCE BOOKS/ ONLINE RESOURCES:

1. Fluid Mechanics by KL Kumar; S Chand and Co Ltd., Ram Nagar, New Delhi.
2. Hydraulics and Fluid Mechanics Machine by RS Khurmi; S. Chand& Co. Ltd., New Delhi.
3. Fluid Mechanics through Problems by RJ Garde; Wiley Eastern Ltd., New Delhi.
4. Fluid Mechanics by Dr AK Jain, Khanna Publishers, New Delhi.
5. Hydraulic and Pneumatic Control by K Shammuga Sundaram, S. Chand & Co. Ltd., New Delhi
6. Hydraulics and Hydraulic Machinery by Dr. Jagadish Lal; Metropolitan Book Company Ltd., Delhi.
7. Hydraulic and Pneumatic Power and Control Design, Performance and Application by Yeaple, McGraw Hill, New York..
8. Pneumatic Controls by Festo Didactic; Bangalore.
9. Pneumatics Control: An Introduction to the Principles by Werner Deppert and Kurt Stoll; Vogel – Verlag.
10. e-books/e-tools/relevant software to be used as recommended by AICTE/NITTTR, Chandigarh.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	10	12
2	08	12
3	14	12
4	16	12
5	08	12
Total	**56**	**60**

3.3	Fluid Mechanics & Hydraulic Machinery Lab	L	T	P	C
PRACTICAL		0	0	4	2

LIST OF PRACTICALS

1. Measurement of pressure head by employing.
   i) Piezometer tube ii) Single and double column manometer.
2. To verify Archimedes' Principle.
3. To find out the value of coefficient of discharge for a venturi meter. Measurement of flow by using venturi meter.
4. To find out the value of coefficient of discharge for an orifice meter. Measurement of flow by using orifice meter.
5. To find out the value of coefficient of discharge for V- notch.
6. Verification of Bernoulli's theorem.
7. To find coefficient of friction for a pipe (Darcy's friction).
8. To study hydraulic circuit of an automobile brake.
9. To study hydraulic circuit of a hydraulic ram.
10. To study the working of a Pelton wheel Turbine.
11. To study the working of a Francis turbine.
12. To study a single stage centrifugal pump for constructional details and its operation to find out its normal head and discharge.

3.4	Workshop Practice	L	T	P	C
PRACTICAL		0	0	4	2

RATIONALE: The subject workshop practice forms a crucial foundation in the education of mechanical engineering diploma students. It introduces them to the fundamental manufacturing processes, tools, equipment's, and basic fitting, machining, and fabrication techniques used in industry. This hands on exposure bridges the gap between theoretical knowledge and practical application fostering skill development, accuracy, safety consciousness and confidence in working with machines and material.

COURSE OBJECTIVES - The course aims to provide hands-on experience and practical skills in various essential workshops including Smithy Shop, Advance Welding Shop, Advance Fitting Shop and this curriculum is primarily divided into three parts. This practical knowledge will equip students with the necessary skills to handle real-world tasks efficiently, fostering a deeper understanding of the techniques and safety measures required in each shop.

1 SMITHY SHOP

1. General Shop Talk

1.1 Purpose of Smithy shop

1.2 Different types of Hearths used in Smithy shop

1.3 Purpose, specifications, uses, care and maintenance of various tools and equipments used in hand forging by segregating as cutting tools, supporting tools, holding tools, measuring tools etc.

1.4 Types of fuel used and maximum temperature obtained

1.5 Types of raw materials used in Smithy shop

1.6 Uses of Fire Bricks & Clays in Forging workshop.

2. Practice

2.1 Practice of firing of hearth/Furnace, Cleaning of Clinkers and Temperature Control of Fire.

2.2 Practice on different basic Smithy/Forging operations such as Cutting, Upsetting. Drawing down, Setting down, Necking, Bending, Fullering, Swaging, Punching and Drifting.

a) Demonstration - Making cube, hexagonal cube, hexagonal bar from round bar

2.3 Practice of Simple Heat treatment processes like Tempering, Normalizing, Hardening etc

3. Job Practice : Job Preparation

3.1 Job I - Making a cold/hot, hexagonal/octagonal flat chisel including tempering of edges.

3.2 Job II - Production of utility goods e.g. hexagonal bolt/square shank boring tool, fan hook (long S-type) [Two jobs are to be done by the students]

3.3 Job III - To prepare a cube from a M.S. round by forging method

2 ADVANCE WELDING SHOP

1. General Shop Talk

1.1 Basic introduction of all types of Welding Techniques and Equipment Familiarization Overview of advanced welding equipment's.

1.2 Overview of Advanced Welding Processes Brief review of foundational welding processes (e.g., SMAW, GMAW, GTAW, TIG, Plasma Arc, Submerged Arc) with explanation of their applications in industries like aerospace, automotive, oil and gas or manufacturing.

1.3 Safety Protocols and Hazard Awareness Personal Protective Equipment (PPE)- Importance of welding helmets with appropriate shade levels, gloves, flame-resistant jackets, safety boots and respiratory protection.

1.4 Discuss about proper storage of gas cylinders and handling of welding consumables and awareness of fire and explosion risks from flammable materials or gases.

1.5 Weld Imperfections and Quality Standards Common weld imperfections (e.g., porosity, cracks, lack of fusion) and their causes.

2. Practice

2.1 Preparation of key components (e.g., power sources, torches, wire feeders, shielding gas regulators)

2.2 Maintenance tips to prevent equipment malfunctions (e.g., cleaning nozzles, checking cables).

2.3 Complete awareness of workstation setup, calibration and shutdown procedures.

2.4 Importance of selecting appropriate filler metals, shielding gases and welding parameters for specific materials.

2.5 Practicing flame generation is an essential step in gas welding and cutting, especially using oxy- acetylene equipment. Discuss the classification of all types of flames.

3. Job Practice : Job Preparation

3.1 Job 1. Preparing gas welding joint in vertical/Horizontal position joining M.S. Plates

3.2 Job 2. Exercise on gas cutting of mild steel plate with oxyacetylene gas torch.

3.3 Job 3. Exercise on gas welding of cast iron and brass part or component.

3.4 Job 4. Exercise on preparation of T Joint by arc welding

3.5 Job 5. Exercise on spot welding/seam welding

3.6 Job 6. Exercise on MIG and TIG welding

3.7 Job 7. Exercise on arc welding pipe joint MS.

3 ADVANCE FITTING SHOP

1. General Shop Talk

1.0 Introduction of application of all types of tools used in fitting shop.

1.1 Basic knowledge of limits, fits and tolerances which is necessary for precision fitting work.

1.2 Familiarization with Interchangeable parts fitting.

1.3 Introduction to jigs and fixtures that improve efficiency and accuracy.

1.4 Understanding of Advanced shop safety, proper handling of tools and materials.

2. Practice

2.1 Precision use of tools like scrapers, micrometers, Venier calipers and gauges, Hack sawing, drilling, reaming, and tapping with precision.

2.2 Use of taps and dies for internal and external threading.

2.3 Accurate chisel and file work to meet tight tolerances.

3. Job Practice : Job Preparation

3.1 Job 1. Exercise on drilling, reaming, counter boring, counter sinking and taping.

3.2 Job 2. Dovetail fitting in mild steel.

3.3 Job 3. Radius fitting in mild steel.

3.4 Job 4. Pipe threading with die.

Text and Reference books:

1. Elements of workshop Technology Volume I & II– Hajra Chowdry & Bhattacharaya- IIth Edition-Media Promoters & Publishers Pvt. Ltd.,

2. A Textbook of workshop Technology- R.S.Khurmi & J.K.Gupta- 2nd Edition, S.Chand & Co., Ram Nagar, New Delhi– 2018.

3. Manufacturing process– Begeman- 5th Edition-McGraw Hill, New Delhi 2011.

4. Workshop Technology- WAJ Chapman- Volume I, II, & III– Vima Books Pvt. Ltd., 4262/3, Ansari Road, Daryaganj, New Delhi 110 002.

5. Production Technology– HMT- Edn. 18- published by Tata McGraw Hill publishing Co. Ltd., 7 West Patel nagar, New Delhi 110 008.– 20181

3.5	Measurements & Metrology	L	T	P	C
PRACTICUM		2	0	3	3

RATIONALE

The progress in metrology and measurements is highly necessary and has led to improvements in product quality, enhanced scientific research capabilities, and increased efficiency in diverse industries including manufacturing, automobile, aerospace, and quality control. It encompasses various disciplines and techniques used to ensure the accuracy, precision, and reliability of measurements. Therefore, the study of metrology and measurements is essential for maintaining uniformity and excellence across various fields, including manufacturing and scientific research.

Learning Outcomes

On successful completion of this course, the student will be able to:

- Classify the measuring instruments based on their applications.
- Select appropriate instrument for linear dimensions.
- Select appropriate instrument for angular dimensions.
- Explain various instruments used in measuring screw threads and gears.
- Discuss about the applications of CMM and LASER technology in metrology.

UNIT I: LINEAR MEASUREMENTS AND COMPARATORS

Basics of Metrology: Scope of Metrology, basic units, important terminology, Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; international standardization, the bureau of Indian standards, important elements of measurements, methods of measurements. Precision, accuracy, factors affecting the accuracy of the measuring system, general rules for accurate measurements, precautions for use of instruments so as to avoid in accuracy in measurements, reliability, Measurement uncertainty, Compare systematic error and random error, Selection of measuring instruments, Calibration of measuring instruments.

Linear Measurements: Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, bore gauge, Gauge blocks – Use and precautions, slip gauges.

Comparator : Comparators – Working and advantages, Types - Mechanical and Pneumatic Comparators.

Practical Exercises:

Ex. No	Name of the Experiment	Hours
1	VERNIER CALIPER i) Measure the dimensions of ground MS flat/Cylindrical bush using Vernier Caliper. ii) Compare the results with Digital Vernier Caliper.	5
2	OUTSIDE MICROMETER i) Measure the diameter of a wire using micrometer ii) Compare the results with a digital Outside micrometer.	5
3	INSIDE MICROMETER i) Measure the inside diameter of the bore of a bush cylindrical component using Inside micrometer ii) Compare the results with digital inside micrometer.	4
4	SLIP GAUGES Measure the thickness of ground MS plates using slip gauges.	4
5	VERNIER HEIGHT GAUGE Measure the height of gauge blocks or parallel bars using vernier height gauge.	4
6	MECHANICAL COMPARATOR Find out the measurement of a given component and Compare with a standard component using a mechanical comparator and slip gauge.	4

UNIT II: ANGULAR MEASUREMENTS, CMM, SURFACE & ADVANCED METROLOGY

Angular Measurements: Angular measuring instruments, Bevel protractor, Angle gauges, Precision level, Sine bar, Autocollimator. Opto-mechanical measurements using a measuring microscope and Profile projector. Measurement of Screw threads – Single element measurements, Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose, Analytical measurement ,Runout, Pitch variation, Tooth profile, Tooth thickness, Lead.
Coordinating measuring Machine: Basic concept of CMM, Types of CMM, Constructional features Probes, Accessories, Software, Applications.
Advanced Metrology: Basic concepts of lasers, types of lasers, Laser and LED based distance measuring instruments.

Practical Exercises:

Ex. No.	Name of the Experiment	Hours
7	UNIVERSAL BEVEL PROTRACTOR Measure the angle of a V-block/Taper Shank of Drill/ Dovetail using universal bevel protractor.	4
8	SINE BAR Measure the angle of the machined surface using sine bar with slip gauges.	4
9	SCREW THREAD MICROMETER Measure the geometrical dimensions of V-Thread using screw thread micrometer.	4
10	PROFILE PROJECTOR Measurement of a profile using profile projector.	4

Suggested List of Student Activity

1. Each student writes and submits the assignment on the topic of Methods of measurements, Precautions to avoid inaccuracy in measurements, Selection and Calibration of measuring instruments.
2. Four students can be grouped as a batch to measure the various dimensions of taper shank drill bit and spur gear and submit the activity report. The activity report should have the diagram and various dimensions of the taper shank drill bit and spur gear.
3. Visit Industry to study the working of the CMM. Prepare a report.
4. Visit Industry to study the working of the Profile Projector. Prepare a report.
5. Study the various types of Comparator. Prepare a report.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Sessional test
- Actual Practical Performance
- Small projects

Viva-voice

Text and Reference books:

1. R. K. Jain, Engineering Metrology, 22 nd Edition, Khanna Publishers, 2022.
2. N. V. Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press India, 2013.
3. R. K. Rajput, Engineering Metrology and Instrumentation, S.K. Kataria & Sons, 2nd Edition, 2013.
4. Samir Mekid, Metrology and Instrumentation: Practical Applications for Engineering and Manufacturing, John Wiley & Sons, Inc., 2021.
5. Anand K. Bewoor & Vinay A. Kulkarni, Metrology & measurement, Tata McGraw-Hill, 2009.
6. Rega Rajendra, Principles of Engineering Metrology, Jaico Publishing House, 2008.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	14	30
2	14	30
Total	**28**	**60**

3.6	Computer Aided Machine Drawing Practice	L	T	P	C
PRACTICUM		1	0	6	4

Syllabus contents

SECTIONAL VIEWS Sectioning, sectional views, representation of sectional plane, hatching, inclination, spacing, hatching large areas, hatching adjacent parts, full section/half section – types of half sections, conventional representation of materials in section. **GEOMETRIC DIMENSIONING AND TOLERANCES.** Importance of GD&T, Tolerance specification and interpretation, Tolerance symbols, Features, Datum plane and Axis, Shaft basis and hole basis system. Material Condition Modifiers. Maximum Material Condition (MMC), Least Material Condition (LMC), Feature Control Frames	24

Manual Drawing Practice	
Detailed drawings of the following machine components will be given to students to draw the assembled views. Only the assembled Front view (Without section / Full Section / Half Section) and Top view or Side view (Without section / Full Section / Half Section) with dimensions and Bill of materials in the Drawing Sheet. Note: All the exercises drawing sheet should be submitted for the model and end semester examination as a record of work done.	24
COMPUTER AIDED DRAFTING (CAD) PRACTICES	
PART A - Drafting Practices: 2D Drafting Practices - Draw the front view of the assembled drawing of the components with dimensions.	24
PART B - Solid modeling Practices: Detailed drawings of the machine components will be given to students to create the solid modeling and assemble using any CAD software in the computer and take the printout. Machine Components for the Practical Exercises 1. Sleeve and Cotter Joint. 2. Plummer Block. 3. Flange Coupling. 4. Bushed Bearing.	26
Total	98

Text and Reference Books:

1. A beginner's guide to 3D modeling by Cameron Coward
2. Solidworks 2022 step by step guide by Amit Bhatt and Mark Wiley

Web-based/Online Resources:

- https://www.autodesk.in/campaigns/autocad-tytorials
- https://www.mycadsite.com/tutorials.html
- NPTEL Lecturers

3.7.1	Material Handling Systems (Open Elective I)	L	T	P	C
QUALIFYING		2	-	-	2

RATIONALE

In the field of engineering and technology, the term materials handling system is used with reference to industrial activity. In any industry, be it big or small, involving manufacturing or construction type work, materials must be handled as raw materials, intermediate goods or finished products form the point of receipt and storage of raw materials, through production processes and up to finished good storage and dispatch point. Lot of development has taken place in the field of materials handling system. So, it is necessary to teach them various types of material handling system and their different parts and selection process

Learning outcomes

At the end of the course, the student will be able to:

- Understand constructional & operational features of various materials handling systems.
- Identify, compare & select proper material handling equipment for specified applications.
- Know the controls & safety measures incorporated on material handling equipment.
- Appreciate the role of material handling devices in mechanization & automation of industrial process.
- Understand & appreciate safety instrumentation for equipment.

DETAILED CONTENT

UNIT-I: Introduction to Material Handling System

Main types of Material handling equipment's & their applications; Types of load to be handled; Types of Movements; Methods of stacking, loading & unloading systems; Principles of Material Handling Systems; Modern trends in Materials handling.

UNIT-II: Hoisting Machinery & Equipment's

Construction, Working & Maintenance of different types of hoists such as Lever operated hoist, Portable hand chain hoist, Differential hoists, Worm geared and Spur geared hoists, Electric & Pneumatic hoists, Jumper; Construction, Working & Maintenance of different types of cranes such as Rotary cranes, Trackless cranes, Mobile cranes, Bridge cranes, Cable cranes, Floating cranes & Cranes traveling on guide rails; Construction, Working & Maintenance of Elevating equipments such as Stackers, Industrial lifts, Freight elevators, Passenger lifts, and Mast type's elevators, Vertical skip hoist elevators.

UNIT-III: Conveying Machinery

Construction, Working & Maintenance of Traction type conveyors such as Belt conveyors, Chain conveyors, Bucket elevators, Escalators; Construction, Working & Maintenance of Traction less type conveyors such as Gravity type conveyors, Vibrating & Oscillating conveyors, Screw conveyors, Pneumatic & Hydraulic conveyors, Hoppers gates & Feeders.

Surface Transportation Equipment
Construction, Function, Working of Trackless equipment such as Hand operated trucks, Powered trucks, Tractors, Automatic Guided vehicle, Industrial Trailers; Construction, Function, Working of Cross handling equipment such as Winches, Capstans, Turntables, Transfer tables, Monorail conveyors.

UNIT-IV: Components of Material Handling Systems
Flexible hoisting appliances such as Welded load chains, Roller chains, Hemp ropes, Steel wire ropes, Fastening methods of wire & chains, Eye-bolts, Lifting tackles, Lifting & Rigging practices; Load handling attachments: a) Various types of hooks-Forged, Triangular eye hooks, Appliances for suspending hooks b) Crane grab for unit & piece loads c) Electric lifting magnet, vacuum lifter. d) Grabbing attachment for loose materials e) Crane attachment for handling liquids/molten metals; Construction & Working of Arresting gear & Brakes; Construction & use of electromagnetic shoe brakes, Thruster operated shoe brakes, Control brakes.

UNIT-V: Mechanism used in Material Handling Equipment
Steady state motion; Starting & stopping of motion in following mechanisms: Hoisting mechanism, Lifting Mechanism, Traveling Mechanism, Slewing Mechanism, Rope & chain operated Cross-Traverse Mechanism.
Selection of Material Handling Equipment
Factors affecting choice of material handling equipment such as Type of loads, Hourly capacity of the unit, Direction & length of travel, Methods of stocking at initial, final & intermediate points, Nature of production process involved, Specific load conditions & Economics of material handling system.

REFERENCE BOOKS/ ONLINE RESOURCES
1. Material handling (Principles & Practice) – Allegri T. H., CBS Publisher, New Delhi.
2. Plant Layout & Materials Handling – Apple J. M., JohnWiley Publishers.
3. Material Handling Equipment – N. Rundenko, Peace Publisher, Moscow.
4. Material Handling Equipment – M. P. Alexandrov, MIR Publisher, Moscow.
5. Material Handling Equipment – Y. I. Oberman, MIR Publisher, Moscow.

3.7.2	Energy Conservation & Audit	L	T	P	C
QUALIFYING	(Open Elective I)	2	-	-	2

RATIONALE:

This subject aims to develop awareness among students about the importance of conserving energy reducing waste and promoting Eco-friendly technologies. It introduces them to tools, techniques and methodologies used for conducting energy audits in industrial, commercial and domestic setups.

Learning Outcomes:

Students will be able-

- To Identify demand supply gaps in present scenario.
- To understand conversations approaches to an industry.
- To draw the energy flow diagram of an industry.
- To identify energy wastage and suggest alternative methods.
- To understand the concepts energy audit.

Course Content:

UNIT-I: Introduction: General energy problem, Sector wise Energy consumption, demand supply gap, Scope for energy conservation and its benefits; Energy Efficiency Principle – Maximum energy efficiency, Maximum cost effectiveness; Mandatory provisions of EC act; Features of EC act-Standards and labeling, designated consumers, Energy Conservation Building Codes (ECBC);

Unit-II: Energy Conservation Approaches In Industries: Methods and techniques of energy conservation in ventilation and air conditioners- compressors pumps, fans and blowers - Area Sealing, Insulating the Heating / cooling fluid pipes, automatic door closing- Air curtain, Thermostat / Control; Energy conservation in electric furnaces, ovens and boilers.

Unit-III: Energy Conservation Option: New equipment, technology, staffing, training; Calculation and costing of energy conservation project; Depreciation cost, sinking fund method. Cost evaluation by Return On Investment(ROI) and pay back method etc.

Unit-IV: Performance improvement of existing power plant: cogeneration, small hydro, DG Set; Demand side management; Load response programme; Types of tariff and restructuring of electric

tariff Technical measures to optimize T and D losses.

Unit-V: Energy Audit: Energy audit and its benefits; Energy flow diagram; Preliminary, Detailed energy audit; Methodology of -preliminary energy audit and Detailed energy audit – Phase I, Pre audit, Phase II- Audit and Phase III- Post audit; Energy audit report; Electrical Measuring Instruments - Power Analyzer.

Reference Books:

1. Electric Energy Generation, Utilisation and Conservation Sivaganaraju, S Pearson, New Delhi, 2012
2. Project Management, Prasanna Chandra, Tata Mcgraw Hill, New Delhi
3. O.P. Jakhar, Energy Conservations in Buildings, Khanna Publishing House, New Delhi
4. Financial Management, Prasanna Chandra Tata Mcgraw Hill, New Delhi.
5. Energy management Handbook, Prasanna Chandra, Tata Mcgraw Hill, New Delhi.
6. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi (ed. 2018)

3.7.3	Advanced Welding & Painting using Simulator (Tata Tech.) (Open ELECTIVE I)	L	T	P	C
QUALIFYING		-	-	4	2

Rationale: The course on Advanced Welding & Painting using Simulator is designed to impart both theoretical understanding and practical skills in industrial welding and painting processes using modern simulation technologies. With increased industrial demand for precision, safety, and quality assurance, this course aims to bridge the skill gap by integrating XR-based simulation platforms to train students in a risk-free, industry-aligned environment. The curriculum also includes essential safety practices, equipment handling, defect inspection, and quality control for welding and painting, preparing students for real-time industrial challenges.

Learning Outcomes:
After successful completion of this course, students will be able to:
1. Demonstrate industrial safety practices including proper handling of fire extinguishers, tools, and PPE in welding and painting operations.
2. Identify and classify different welding processes, equipment, filler materials, and welding joints, along with their industrial applications.
3. Interpret welding symbols and drawings and apply standard inspection techniques to identify welding defects.
4. Operate and troubleshoot welding equipment and XR simulators, adhering to SOPs and safety protocols.
5. Explain the importance and application of industrial painting, including surface preparation, paint types, and coating technologies.
6. Use painting equipment like spray guns, booths, and compressors, and apply modern techniques like powder coating with safety and accuracy.
7. Ensure quality control and compliance in both welding and painting tasks by adhering to industry standards and documentation practices.
8. Integrate theory with XR simulator-based practicals to enhance precision, productivity, and confidence in welding and painting jobs.

Sr No	Course contents
1	**Introduction to Industrial Safety Practices** • Fire Extinguishers & its Types, • Safely handling Tools & Equipment, • Use of proper Tools & Equipment & its maintenance, • OSH & practices to be observed as a precaution

2	**Introduction to Welding** • Introduction and importance of welding in Industry. • Types of welding and its selection criteria. • Types of filler material and its selection criteria • Application of welding, • Advantages and disadvantages of welding joints. • Welding techniques and its application • Safety precautions, • Selection of welding equipment, • Types of welding joints its application & symbolic representation on drawing. (Welding drawing reading and symbols used for welding) • Defects in welding and its inspection technique. • Concept of welding skill and its impact on product quality. • Selection of welding technique
3	**Introduction to different components of welding equipment & XR station** • Power Source (Single Phase, Three Phase, Transformer, Inverter etc.) • Welding electrode, electrode holder and its types • Welding torch and its types and selection criteria • High-pressure cylinder and regulator used for welding work, • Types of cylinder & regulators, • Types of welding joints & its application, • Working functions and safety precautions. • Introduction to XR station simulator basic settings and user interface • Application and benefit of XR Station simulator. • Standard operating procedure for XR station and safety guidelines. • Basic troubleshooting and maintenance • Industrial case studies for selection of welding equipment's and XR Station.
,4	**Introduction to Industrial Painting** • Introduction to industrial Paintings and its importance. • paint and its manufacturing knowledge, • Paint preparation or mixing as per required shade of color. • Different types of paints, coatings, and its selection criteria. • Technology of painting, adhesives, • Safety precautions and use of equipment. • Paint storing guidelines and its standard procedure. • Quality assurance in painting and concept of life span for paint. • Advancement in painting technology • Compliance and Regulations in industrial painting.

5	**Different components of Painting booth, painting materials & Technology** • Equipment knowledge of paint booth • Powder coating spray gun • Oven and spray gun, compressor, etc., • Industry application of spray painting, • Advantages and disadvantages of different types of spray-painting technique, • Types of spray-painting components, Functional working & settings of painting guns, • Safety tips for handling spray painting guns, • Metal Surface painting – corrosion, effects, • Types of emery papers & protection.

COURSE PRACTICALS

Conduct practicals as per lesson plan.

1. Prepare a list for safety equipments used in workplace.
2. Prepare a list of different types of welding, selection of welding criteria and its applications.
3. Prepare a check list as per industrial welding drawing.
4. Prepare a chart for welding symbols.
5. Prepare a list of welding defects.
6. Draw a sketch of welding set up and list the important parts and its function.
7. Perform settings for welding machine by using XR station.
8. Use welding torches for different stroke adjustment, speed, travel angle & work angle for different types of welding.
9. Guided welding practice on simple horizontal and vertical Plate/Pipe Joints.
10. Advance unguided welding practice on simple horizontal and vertical surfaces.
11. Guided welding practice on complex Job Positions.
12. Advance unguided welding practice on complex Job Positions.
13. Perform practice for various welding joint on Simulator.
14. Identify and apply welding on complex surfaces & positions.
15. Spray painting using spray gun by using paint booth.
16. Powder Coating and its application usage using available instruments.

17. Assembly & Connection of spray-painting device Perform settings for spray painting by using XR station & gun holding techniques.
18. Guided spraying practice on complex surface like as edges, corner, square, round & curved area to understanding Coverage level, Dry areas, Defect areas, Drips Areas, Travel Lines etc.
19. Case studies
20. Mini project

3.7.4	Industrial Robotics & Automation (Open Elective-I)	L	T	P	C
QUALIFYING		2	-	-	2

RATIONALE

Industrial Robotics & Automation is essential for mechanical engineering diploma students as it prepares them for the automation-driven industries of today. It equips them with practical skills to operate and maintain robotic systems, improving their employability in sectors like manufacturing and automotive. By understanding automation, students can contribute to optimizing production processes, enhancing efficiency and precision. Additionally, the subject provides a foundation for future studies in advanced fields like robotics and mechatronics, ensuring they stay competitive in a rapidly evolving technological landscape.

Learning Outcomes:

After successful completion of this course, students will be able to-

- Explain the robot anatomy, classification, characteristics of robot, advantages and disadvantages.
- Explain the various robotic actuators on hydraulic, pneumatic and electrical drives.
- Explain about various types of sensors and concepts on robot vision system.
- Explain the concepts of robot programming languages and various methods of robot programming.
- Explain the various applications of robots.

DETAILED CONTENT

UNIT-I: Fundamentals of Robotics: Introduction; Definition; Robot anatomy (parts) and its working; Robot Components: Manipulator, End effectors; Construction of links, Types of joints; Classification of robots; Cartesian, Cylindrical, Spherical, Scara, Vertical articulated; Structural Characteristics of robots; Mechanical rigidity; Effects of structure on control work envelope and work Volume; Robot work Volumes, comparison; Advantages and disadvantages of robots.

Unit-II: Robotic Drive System and Controller: Actuators; Hydraulic, Pneumatic and Electrical drives; Linear actuator; Rotary drives; AC servo motor; DC servo motors and Stepper motors; Conversion between linear and rotary motion; Feedback devices; Potentiometers; Optical encoders; DC tachometers; Robot controller; Level of Controller; Open loop and Closed loop controller; Robot path control: Point to point, Continuous path control and Sensor based path control;

Unit-III: Sensors: Requirements of a sensor; Principles and Applications of the following types of sensors: Position sensors (Encoders, Resolvers, Piezo Electric); Range sensors (Triangulation Principle, Structured lighting approach); Proximity sensing; Force and torque sensing. Introduction to Machine Vision: Robot vision system (scanning and digitizing image data); Image processing and analysis; Cameras (Acquisition of images); Vidicon camera (Working principle & construction); Applications of Robot vision system: Inspection, Identification, Navigation & serving.

Unit-IV: Robot kinematics and Robot Programming: Forward Kinematics; Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two Degrees of

Freedom (In 2 Dimensional); Robot programming Languages; VAL Programming; Motion Commands; Sensor Commands; End effector commands; and Simple programs

Unit-V: Automation: Basic elements of automated system, advanced automation functions, levels of automation. Industrial Applications: Application of robots in machining; welding; assembly and material handling.

REFERENCE BOOKS/ ONLINE RESOURCES

1. Introduction to Robotics: Analysis, Systems, Applications – Saeed B. Niku, Pearson Education Inc. New Delhi 2006.
2. Industrial Robotics: Technology, Programming and Applications – M.P. Groover, Tata McGraw Hill Co, 2001.
3. Robotics Control, Sensing, Vision and Intelligence – Fu.K.S. Gonzalz.R.C and Lee C.S.G, McGraw Hill Book Co, 1987.
4. Robotics for Engineers – Yoram Koren, McGraw Hill Book Co, 1992.
5. A Text book on Industrial Robotics – Ganesh S. Hedge, Laxmi Publications Pvt. Ltd., New Delhi, 2008.
6. Robotics Technology and Flexible Automation – S.R. Deb & Sankha Deb, Tata McGraw-Hill, 2010.
7. Elements of Robotics Process Automation, Mukherjee, Khanna Publishing House, Delhi, 2018

3.7.5	Internet of Things (Tata Tech) (Open Elective-I)	L	T	P	C
QUALIFYING		2	-	-	2

Rationale:
This course is designed to develop skills on Internet of things (IOT) using latest software & Hardware. The course helps students to build IOT applications and devices using controller, sensors, actuators, and other electronic components. It also helps candidates to develop competency on latest technologies using IOT in various sectors such as home automation, smart city, agriculture, automotive, manufacturing etc. This course also provides opportunities for starting their own start up by developing novel IoT applications.

Sr No	Course contents
1	**Introduction to Industrial Safety Practices** • Fire Extinguishers & its Types • Safely handling Tools & Equipment • Use of proper Tools & Equipment & its maintenance • OSH & practices to be observed as a precaution
2	**Fundamentals of Internet of Things** • Introduction of Internet of Things • Basics of electricals & electronics components used in IoT • History of IoT • Applications, Benefits and Limitations of IoT • Important components of IoT – Micro Controller, Sensors, actuators, communication protocol, cloud etc • IoT Architecture – Physical layer, Network layer, Data processing layer, Application layer.
3	**IoT Micro-controllers and Single board computer** • Introduction to micro-controller • Different types of micro-controllers, Arduino, Raspberry pi • Introduction to input, output and PWM, interface of camera to raspberry pi, interface of various sensors to raspberry pi, IOT protocol (HTTP, MQTT, HTTPS) for RPI, Study connection of raspberry pi to cloud • Important features of micro-controller • Specification of micro-controller • Selection of micro-controller based on IoT application. • Basic programming of micro-controller • Advanced programming of micro controller • Debugging of program, Testing of program

4	**IoT Sensors** • Introduction of Sensors • Various types of Sensors and their applications • Specifications of sensors • Working principle of important sensors • Comparison of sensors and relative advantages and limitations • Selection of sensor based on IOT application. • Interfacing of sensors with micro-controller to develop IOT application. • Testing of sensors for IOT application
5	**Use of Actuators for IoT applications** • Introduction to actuators • Various types of actuators • Working principle of actuator • Applications of actuators • Comparison of various actuators and relative advantages and limitations • Selection of actuator based on IOT application
6	**IoT Network Connectivity** • Introduction to IoT network technologies • Various options for IoT connectivity • Comparison of various options for IoT connectivity • Selection of IoT connectivity based on application parameter like Range, Data size, Rate of data transfer, Type of data, Number of devices to be connected etc.
7	**Cloud and Application of IoT** • Various options available to store IOT Data • Comparison of storage options • Storage on premises and Cloud • IOT Database • Selection of database • Interfacing Database with IOT application • Requirements for IoT applications • Selection of sensors and actuators as per IoT application • IoT dashboard building • Authentication • IoT application building as per real world application related to Smart City, Healthcare, Automotive, Manufacturing. • IoT based mobile application development • Use of API in IoT application Building • Basics of Machine Learning and AI • Use of Machine Learning and Artificial Intelligence in IoT • Industrial Use cases

COURSE PRACTICALS

Please conduct the practicals as per lesson plan.

1. Writing and understanding basic code syntax and setting configuration of IDE.
2. Adding external libraries and boards in IDE.
3. Implementing basic Programs like LED Blink, LED fading etc.
4. Interfacing of digital sensor to microcontroller.
5. Interfacing of analog sensor to microcontroller.
6. Uploading and monitoring digital and analog sensor data to cloud.
7. Interfacing of actuator to microcontroller
8. Interfacing of wireless module to microcontroller.
9. Controlling actuators remotely using IoT.
10. Implementing Monitoring and alert data system using IoT.
11. Interfacing led to raspberry pi and performing blinking and fading operations on led with raspberry pi.
12. Interfacing Camera to raspberry pi and performing picture and video operations.
13. Implementation sensors to raspberry pi.
14. Sending data from raspberry pi to cloud and receiving data from cloud
15. Write code for IOT application.
16. Develop IOT application based on specific need.
17. Develop IoT application for Agriculture application.
18. Develop IoT application for Home Automation
19. Develop IoT application for Smart City
20. Develop IoT application for manufacturing
21. Develop IoT application for Automotive
22. Develop IoT application for Industrial automation
23. Develop IoT application for Warehouse management
24. Testing of IOT application
25. Case studies

3.7.6	Product Verification & Analysis (TataTech) (Open Elective-I)	L	T	P	C
QUALIFYING		2	-	-	2

RATIONALE : This course provides basic concept of design, modeling, FEA concepts and real time simulation methods. Further it gives hands on working experience on important areas in Product Verification & Analysis using analytical software. It includes Basics of Product design & development, 3D modelling, FEA basics, Meshing, Meshing Quality criteria, Material Properties, defining boundary conditions, Post Processing, Interpretation of results, countermeasure planning, optimization of results. It also includes various case studies such as Structural, modal Analysis, Buckling & other types of analysis.

TABLE OF CONTENTS

Sr No	Course contents
1	**Introduction to Industrial Safety Practices** • Fire Extinguishers & its Types • Safely handling Tools & Equipment • Use of proper Tools & Equipment & its maintenance • OSH & practices to be observed as a precaution
2	**Overview of Product Design and Development** • Various Phases of Product Design and Development • Concept Design, Detail Design • Product Verification and Validation • User interface, basic settings & customization for creation of geometry. • 2D sketching, 3D Modelling • Concept creation, Modelling, Assembly • Design Modifications • Engineering Drawing • Bill of Material • Basic Understanding of Regulatory Requirements and testing.
3	**FEA & Meshing** • Basics of FEA and Meshing • Basics of strength of materials • Introduction to FEA, FEA Steps • Types of Analysis • FEA software user interface • Importing Geometry

	• Geometry cleanup & editing • Mid Surface Extraction • Basics of Discretization (Meshing) • Understanding of basic of Meshing such as nodes, elements etc. • Selection of type of the mesh / element based on the structure • Mesh Parameters • Checking of Mesh Quality • Refining of Mesh
4	**Material, Meshing and Boundary conditions** • Applying Material Properties • Basics of Types of Loads • Applying Load • Define Boundary Condition • Rigidity Check of FEA Model • Solving • Post Processing • Interpretation of Results • Countermeasure planning • Optimization of Results.
5	**Structural and nodal analysis** • Concept of structural and modal analysis • Interactive design exploration for static structural • Structural condition -support constraints • Force & pressure condition • Remote load condition, • Nodal analysis-frequency calculation, • Real time topology optimization • Post-processing - Contour Plot Viewing • Post-processing - Report Generator • Simulation report reading • Industrial case study
6	**Buckling Analysis and other types of Analysis** • Basic Buckling Analysis • Basic Thermal Analysis • Thermal Analysis • Thermo-Mechanical Analysis • Simple Nonlinear Analysis, Other advanced Types of Analysis • Interpretation of Results • Countermeasure & Recommendations • Industrial case studies

4 COURSE PRACTICALS

Please conduct practicals as per lesson plan

1. List the industrial safety procedures.
2. Create a sketch, 3d model and assembly
3. Create a drawing and Bill of Materials
4. Import the computer aided design model
5. Modify the imported computer aided design model.
6. Cleaning of 3D Model
7. Extract Mid surface of given model
8. Create 1D element using computer aided design software
9. Create 2D element using computer aided design software
10. Create 3D Element for a given problem | Generate the 3d meshing for given problem
11. Generate the meshing by tetrahedral, hexahedral, polyhedral, pyramid, or wedge cells (or a combination of these) in 3D.
12. Apply material properties as per given specifications
13. Apply the boundary condition like pressure, force, remote force, fixed support, etc.
14. Interpret Finite Element Analysis Results
15. Structural analysis of simply supported beam.
16. Structural analysis of truss structure
17. Topology optimization of design using structural analysis.
18. Modal analysis for natural frequencies.
19. Modal analysis for vibration analysis.
20. Generate and export simulation report for structural and modal analysis.
21. Steady state thermal analysis of simple metal plate
22. Steady state thermal analysis of heat sink.
23. Free-vibration analysis and Buckling analysis using FEA software
24. Thermal Analysis using FEA software.
25. Advanced Finite Element Analysis.
26. Optimize the design
27. Preparation of FEA report

Advance Skill Development

To fulfill the requirements for Advanced Skill Development, a minimum of 20 hours of skill certification is necessary. This certification must be obtained from a recognized national or international agency or institute. The assessment and certification process will be conducted by the respective agency or institute. Students must present their certificate to earn 02 credits for this subject.

3.8	Summer Internship-I (4 weeks) after IInd Sem	L	T	P	C
		0	0	0	1

RATIONALE

It is needless to emphasize further the importance of Industrial/summer Training of students during their 3 years of studies at Polytechnics. It is industrial training, which provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice. Polytechnics have been arranging industrial training of students of various durations to meet the above objectives.

DETAILED CONTENT

This document includes guided and supervised industrial/summer training of 4 weeks duration to be organised during the semester break starting after first year i.e. after 2nd semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

An Internal assessment of 50 marks has been provided in the study and evaluation scheme of 3th Semester. Evaluation of summer training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engauge in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations.

Teachers and students are requested to see the footnote below the study and evaluation scheme of 2nd semester for further details.

The teacher along with field supervisors will conduct performance assessment of students. The components of evaluation will include the following:

a)	Punctuality and regularity	15%
b)	Initiative in learning new things	15%
c)	Presentation and Viva	15%
d)	Industrial training report	55%

4.1	Strength of Materials	L	T	P	C
THEORY		4	0	0	3

RATIONALE

This subject provides a crucial foundation for designing safe and efficient mechanical components. It equips students with the ability to analyse material behaviour under various loads, ensuring proper material selection and failure prevention. SoM also enhances problem-solving skills, helping students calculate stress, deformation, and stability in structures. Additionally, it prepares students for advanced courses and real-world applications in industries ensuring career readiness in technical roles.

Learning Outcomes:

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

- Compute stress and strain values and find the changes in axial, lateral and volumetric dimensions of bodies of uniform section and of composite section under the influence of normal forces.
- Calculate thermal stresses, in bodies of uniform section and composite sections.
- Define resilience, proof – resilience and modulus of resilience and obtain expressions for instantaneous stress developed in bodies subjected to different loads.
- Compute shear force and bending moment at any section of beam and draw the S.F. & B.M diagrams of for UDL and Point loads.
- Calculate the safe load, safe span and dimensions of cross section.
- Compare strength and weight of solid and hollow shafts of the same length and material and compute the stress and deflection of the closed coil helical spring.

DETAILED CONTENT

UNIT-I: Stresses and Strains:

Stress, Strain and their nature; Mechanical properties of common engineering materials; Significance of various points on stress – strain diagram for M.S. and C.I. specimens; Significance of factor of safety; Relation between elastic constants; Stress and strain values in bodies of uniform section and of composite section under the influence of normal forces; Thermal stresses in bodies of uniform section and composite sections; Related numerical problems on the above topics.

Unit-II: Strain Energy:

Strain energy or resilience, proof resilience and modulus of resilience; Derivation of strain energy for the following cases: i) Gradually applied load, ii) Suddenly applied load, iii) Impact/ shock load; Related numerical problems.

Principal stresses

Concept of principal stresses, Principal Planes and maximum shear stresses for the bodies subjected to direct and shear stresses, determination by mohr's circle method.

Thin Cylindrical Shells:

Explanation of longitudinal and hoop stresses in the light of circumferential and longitudinal failure of shell.

Unit-III: Shear Force & Bending Moment in beams:
Introduction of Beams, Types of Beams, Types of Loads – Point load, UDL and UVL; Definition, explanation and relation of shear force and bending moment; Calculation of shear force and bending moment and drawing the S.F and B.M. diagrams by the analytical method only for the following cases: a) Cantilever with point loads, b) Cantilever with uniformly distributed load, c) Simply supported beam with point loads, d) Simply supported beam with UDL, e) Combination of point and UDL for the above; Related numerical problems.

Unit-IV: Theory of Simple Bending and Deflection of Beams:
Explanation of terms: Neutral layer, Neutral Axis, Modulus of Section, Moment of Resistance, Bending stress, Radius of curvature; Assumptions in theory of simple bending; Bending Equation $M/I = \sigma/Y = E/R$ with derivation; Problems involving calculations of bending stress, modulus of section and moment of resistance; Calculation of safe loads and safe span and dimensions of cross- section; Definition and explanation of deflection as applied to beams; Deflection formulae without proof for cantilever and simply supported beams with point load and UDL only (Standard cases only); Related numerical problems.

Unit-V: Torsion in Shafts and Springs:
Definition and function of shaft; Calculation of polar M.I. for solid and hollow shafts; Assumptions in simple torsion; Derivation of the equation $T/J=fs/R=G\theta/L$; Problems on design of shaft based on strength and rigidity; Numerical Problems related to comparison of strength and weight of solid and hollow shafts; Classification of springs; Nomenclature of closed coil helical spring; Deflection formula for closed coil helical spring (without derivation); stiffness of spring; Numerical problems on closed coil helical spring to find safe load, deflection, size of coil and number of coils.

INSTRUCTIONAL STRATEGY
- Use lectures to introduce fundamental concepts (stress, strain, elasticity, material properties). Visual aids such as diagrams, charts, and animations can help students understand key principles.
- Provide real-life engineering problems where students need to calculate stresses, bending moments, and deflections in beams, rods, or structures. This encourages analytical thinking and application of theoretical knowledge

MEANS OF ASSESSMENT
- Assignments and quiz/class tests
- Sessional test
- Actual Practical Performance
- Small projects
- Viva-voice

REFERENCE BOOKS/ ONLINE RESOURCES
1. Strength of Materials – D.S. Bedi, Khanna Book Publishing Co. (P) Ltd., Delhi, 2017
2. Strength of Materials – B.C.Punmia, Ashok Kumar Jain & Arun Kumar Jain, Laxmi Publications, New Delhi, 2013

3. Strength of Materials – S. Ramamrutham, Dhanpat Rai & Publication New Delhi
4. Strength of Materials – R.S. Khurmi, S.Chand Company Ltd. Delhi
5. A Text Book strength of Material– R.K. Bansal, Laxmi Publication New Delhi.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	10	12
2	12	12
3	12	12
4	12	12
5	10	12
Total	**56**	**60**

4.2	INDUSTRIAL ENGINEERING & MANAGEMENT	L	T	P	C
THEORY		4	0	0	3

RATIONALE

The rationale for teaching Industrial Engineering and Management to diploma students lies in its comprehensive approach to optimizing complex systems and processes. These subject combines engineering principles with management practices to improve efficiency, productivity, and quality in manufacturing and service industries. By studying this subject, students gain skills in areas such as operations research, production planning, quality control, and supply chain management. This knowledge equips them to design, analyze, and manage industrial systems effectively.

Learning Outcomes:

After successful completion of this course, students will be able-

- To understand the different types of layouts and plant maintenance with safety.
- Explain the production facilitating techniques of work and method studies.
- To understand production planning and controls for desired product quality.
- Define the principles of personal management and organizational behavior.
- List and explain the various financial and material managements.

DETAILED CONTENT

UNIT-I:

Plant Engineering:

Plant; Selection of site of industry; Plant layout; Principles of a good layout; Types; Process; Product and Fixed position; Techniques to improve Layout; Principles of Material handling equipment; Plant maintenance; Importance; Break down maintenance; Preventive maintenance and Scheduled maintenance.

Plant Safety:

Importance; Accident: Causes and Cost of an Accident, Accident Proneness, Prevention of Accidents; Industrial disputes; Settlement of Industrial disputes; Collective bargaining; Conciliation; Mediation; Arbitration; Indian Factories Act 1948 and its provisions related to health, welfare and safety.

UNIT-II:

Work Study:

Productivity; Standard of living; Method of improving Productivity; Objectives; Importance of good working conditions.

Method Study:

Definition; Objectives; Selection of a job for method study; Basic procedure for conduct of Method study; Tools used; Operation process chart; Flow process chart; Two handed process chart; Man Machine chart; String diagram and flow diagram.

Work Measurement:

Definition; Basic procedure in making a time study; Employees rating factor; Basic concept of production study; Techniques of Work Measurement; Ratio delay study; Synthesis from standard data; Analytical estimating and Pre determined Motion Time System (PMTS).

UNIT-III:

Production Planning and Control:

Introduction; Major functions of Production Planning and Control; Routing and Scheduling; Dispatching and Controlling; Concept of Critical Path Method (CPM); Types of Production: Mass Production, Batch Production and Job Order Production; Characteristics; Economic Batch Quantity (EBQ); Principles of Product and Process Planning;

Quality Control:

Definition; Objectives; Types of Inspection: First piece, Floor and Centralized Inspection; Advantages and Disadvantages; Statistical Quality Control; Types of Measurements; Method of Variables; Method of Attributes; Uses of X, R, p and c charts; Operating Characteristics curve(O.C curve); Sampling Inspection; Single and Double Sampling plan; Concept of ISO 9001:2008 Quality Management System Registration/Certification procedure; Benefits of ISO to the organization.

UNIT-IV:

Principles of Management:

Definition of Management; Administration; Organization; F.W. Taylor's and Henry Fayol's Principles of Management; Functions of Manager; Types of Organization: Line, Staff, Taylor's Pure functional types; Line and staff and committee type; Directing; Leadership; Styles of Leadership; Qualities of a good leader; Motivation; Positive and Negative Motivation; Modern Management Techniques; Just In Time; Total Quality Management (TQM); Quality circle; Zero defect concept; 5S Concept; Management Information Systems.

Personnel Management:

Responsibility of Human Resource Management; Selection Procedure; Training of Workers; Apprentice Training; On the Job training and Vestibule School Training; Job Evaluation and Merit Rating; Objectives and Importance; Wages and Salary Administration; Components of Wages; Wage Fixation; Type of Wage Payment: Halsey's 50% Plan, Rowan's Plan and Emerson' sufficiency plan; Numerical Problems.

UNIT-V:

Financial Management:

Fixed and Working Capital; Resources of Capital; Shares Preference and Equity Shares; Debentures; Type of debentures; Public Deposits; Factory Costing: Direct Cost; Indirect Cost; Factory Overhead; Selling Price of a product; Profit; Numerical Problems; Depreciation; Causes; Methods: Straight line, sinking fund and percentage on Diminishing Value Method; Numerical Problems.

Material Management:

Objectives of good stock control system; ABC analysis of Inventory; Procurement and Consumption cycle; Minimum Stock, Lead Time, Reorder Level-Economic Order Quantity problems; Supply Chain.

INSTRUCTIONAL STRATEGY

To teach Industrial Engineering and Management to diploma students effectively, integrate a variety of instructional strategies. Utilize active learning through group projects, hands-on activities, and case studies to engauge students practically. Blend traditional teaching with online resources, including multimedia content and discussion forums, to enhance
understanding.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Sessional test
- Viva-voice

REFERENCE BOOKS/ ONLINE RESOURCES

1. Industrial Engineering & Management, S.C. Sharma, Khanan Book Publishing Co (P) Ltd., New Delhi
2. Industrial Engineering and Management, O.P. Khanna, Revised Edition, Dhanpat Rai Publications (P) Ltd., New Delhi – 110002.
3. Management, A global perspective, Heinz Weihrich, Harold Koontz, 10th Edition, McGraw Hill International Edition 1994.
4. Essentials of Management, 4th Edition, Joseph L.Massie, Prentice-Hall of India, New Delhi 2004.
5. Principles and Practices of Management, Premvir Kapoor, Khanna Publishing House, N. Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	10	12
2	12	12
3	12	12
4	12	12
5	10	12
Total	**56**	**60**

4.3	Strength of Materials Lab	L	T	P	C
PRACTICAL		0	0	6	3

LIST OF PRACTICALS

1. Study and understand the use and components of universal Testing Machine (UTM).
2. Perform tension test on mild steel specimen using UTM.
3. Conduct compression test on sample test piece using compression testing machine.
4. Conduct Izod impact test on any metal e.g. mild steel/ brass/ aluminum/ copper/ cast iron.
5. Conduct charpy impact test on any metal e.g. mild steel/ brass/ aluminum/ copper/ cast iron.
6. Determination of Rockwell's Hardness number for various materials like mild steel, high carbon steel, brass, copper, aluminum.
7. Determination of Brinell's Hardness number for various materials like mild steel, high carbon steel, brass, copper, aluminum.
8. To find the value of 'E' for a steel beam by method of deflection for different loads.
9. Determination of modulus of rigidity, strain energy, shear stress and stiffness by load deflection method. (Open and closed coil spring)
10. Plot shear force diagram for cantilever, simply support beams subjected to point load only.
11. Plot bending moment diagram for cantilever, simply support beams subjected to point load only.

4.4	Manufacturing Engineering	L	T	P	C
PRACTICUM		2	0	3	3

RATIONALE :

Manufacturing engineering is a crucial subject for diploma students as it provides a comprehensive understanding of the processes, tools, and technologies used in the production of goods. It lays the groundwork for understanding how products are designed, developed, and manufactured, which is essential for any career in engineering and production.

Learning Outcomes:
After successful completion of this course, students will be able to-

- Explain the functions of Jigs and Fixtures.
- Describe the advancements in the area of manufacturing and production processes.
- Familiarized with working principles and operations performed on non-traditional machines, machining center, SPM, and maintenance of machine tools.

Course Content:

UNIT-I :

Cutting Fluids & Lubricants: Introduction -Types of cutting Fluids, Fluids and coolants required in turning, drilling, shaping, sawing & broaching; Selection of cutting fluids ,methods of application of cutting fluid; Classification of lubricants (solid, liquid, gaseous) Properties and applications of lubricants.

Lathe Operations: Types of lathes, CNC lathe, Specifications, Basic parts and their functions, Operations and tools – Turning, parting off, Knurling, facing, Boring, drilling, threading, step turning, taper turning.

Shaping and Planing -Working principle of shaper and planer, Type of shapers, Type of planers, Quick return mechanism applied to shaper and planer machine, Work holding devices used on shaper and planer, Specification of shaper and planer, Speeds and feeds in above processes.

Milling: Introduction; Types of milling machines: plain, Universal, vertical; constructional details – specifications; Milling operations: simple, compound and differential indexing; Milling cutters – types; Nomenclature of teeth; Teeth materials; Tool signature of milling cutter; Tool & work holding devices.

UNIT -II :

Drilling and Broaching: Classification of drilling machines; Basic parts and their functions; Radial drilling machine; Types of operations, Specifications of drilling machine, Types of drills and reamers. Introduction to broaching; Types of broaching machines –Elements of broach tool, broach teeth details, Nomenclature, Tool materials.

Grinding and finishing processes: Principles of metal Grinding, Abrasives-Bonds and binding processes, Factors affecting the selection of grind wheels, Grinding wheel specification. Grinding wheel wear - attritions wear, fracture wear, Dressing and Truing, Grinding machines classification: Cylindrical, Surface, Tool & Cutter grinding machines, Construction details, Principle of centreless grinding, Advantages & limitations of centre less grinding;

Super finishing Processes: Basic principles of Honing, Lapping, Buffing, Polishing, Burnishing etc.

UNIT -III:

Rolling and Forging: Definition and complete classification of Rolling and Forging process.

Extrusion and Drawing: Type of Extrusion- Hot & Cold and Direct & Indirect, Pipe Drawing, Tube Drawing; Wire Drawing.

Brazing and soldering: Types, Principles and Applications.

Jig and Fixture : Definition , Application and Basic Difference between a Jig and a Fixture
Press working: Types of Presses and Specifications, Press working operations - Cutting, bending, drawing, punching, blanking, notching, lancing.

UNIT -IV:

Pattern Making : Definition and Application of Patterns in casting, Classification of Patterns types (Single piece, Split pattern, match plate etc.) Materials used for patterns (wood, metal, plastic, etc.) Pattern Allowances (shrinkage, machining, draft, and distortion) and Purpose and importance of Different types of Measuring and Marking using tools, Cutting, shaping and assembling wooden or metallic patterns, Pattern layout and planning, Surface finishing and polishing of patterns.
Casting and Moulding: Properties and various types of moulding sand, Types of moulds, All important steps of mould making, moulding boxes, hand tools used for mould making, Moulding processes,

Casting processes – Charging of furnace, melting, pouring, Cleaning of castings, Principle, Working and application of Die casting, Investment casting, Centrifugal casting, Gating and Riser System, Casting defects and Testing of casting defects.

Practical Course Content

Pattern Making Shop :

Job 1. Preparation of solid/single piece pattern.
Job 2. Preparation of two piece/split pattern
Job 3. Preparation of a pattern on wooden lathe

Job 4. Preparation of a self cored pattern
Job 5. Preparation of a core box.

Moulding/Foundry Shop:

Job 1. Preparation of mould with solid pattern on floor.
Job 2. Preparation of floor mould of solid pattern using cope.
Job 3. Preparation of floor mould of split pattern in cope and drag of moulding box.
Job 4. Moulding and casting of a solid pattern of aluminum
Job 5. A visit to cast iron foundry should be arranged to have firsthand knowledge of cast irc melting pouring and casting.

Machine Shop : (Two Practicals are given in each group, any one is to be performed)

Job 1- Prepare a V-Block up to 0.5 mm accuracy on shaper machine.
Or
Exercise on key way cutting and spline cutting on shaper machine.
Job 2- Produce a rectangular block by facing on a slotting machine.
Or
Produce a rectangular slot on one face with a slotting cutter.
Job 3- Produce a rectangular block using a milling machine with a side and face cutter.
Or
Prepare a slot on one face using milling machine.
Job 4- Exercises on internal turning on lathe machine.
Or
Exercises on extemal turning on lathe machine.
Job 5- Exercises on internal threading on lathe machine.
Or
Resharpening of single point cutting tool with given geometry.
Job 6- Job on grinding machine using a surface grinder.
Or
Exercise of boring with the help of boring bar.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Sessional test
- Viva-voice

Text and Reference books:

1. Elements of workshop Technology Volume I & II– Hajra Chowdry & Bhattacharaya- IIth Edition-Media Promoters & Publishers Pvt. Ltd.,
2. A Textbook of workshop Technology- R.S.Khurmi & J.K.Gupta- 2nd Edition, S.Chand & Co., Ram Nagar, New Delhi– 2018.
3. Manufacturing process– Begeman- 5th Edition-McGraw Hill, New Delhi 2011.
4. Workshop Technology- WAJ Chapman- Volume I, II, & III– Vima Books Pvt. Ltd., 4262/3, Ansari Road, Daryaganj, New Delhi 110 002.

5. Production Technology– HMT- Edn. 18- published by Tata McGraw Hill publishing Co. Ltd., 7 West Patel nagar, New Delhi 110 008.– 20181

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	7	15
2	7	15
3	7	15
4	7	15
Total	**28**	**60**

4.5	Material Science & Engineering	L	T	P	C
PRACTICUM		1	0	4	3

RATIONALE

Lot of development has taken place in the field of materials. New materials are being developed, and it has become possible to change the properties of materials to suit the requirements. Diploma holders on this course are required to make use of different materials for various applications. For this purpose, it is necessary to teach them the basics of metal structure, properties, usage and testing of various ferrous and non-ferrous materials and various heat treatment processes. This subject aims to develop knowledge about the characteristics, testing and usage of various types of materials used in industries.

LEARNING OUTCOMES

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

1. Distinguish between metals and non-metals and ferrous and non-ferrous materials.
2. Explain the arrangement of atoms in various crystals.
3. Carryout various heat treatment processes.
4. Analyze microstructure and changes in microstructure due to heat treatment.
5. Explain properties and applications of composites, ceramics and smart materials, plastics and rubber.
6. Perform destructive and non-destructive testing of materials.

COURSE CONTENT

UNIT-1: Introduction & Structure of Metals

Overview of different engineering materials and applications, Classification of materials, Thermal, Chemical, Electrical, Mechanical properties of various materials Crystallography Fundamentals: Crystal, Unit Cell, Space Lattice, Arrangement of atoms in Simple Cubic Crystals, BCC, FCC and HCP Crystals,. Deformation and Defects.

Metals And Alloys

Ferrous Materials: Raw materials in production of iron and steel, Basic process of iron-making and steel-making, Classification of iron and steel. Cast Iron: Different types of Cast Iron, manufacture and their use. Classification of cast iron and Steels: Steels and alloy steel, Classification of plain carbon steels, Properties and usage of different types of Plain Carbon Steels, Non Ferrous Materials: Properties and uses of Aluminum, Copper and Zinc and their alloys.

LIST OF PRACTICALS

EX NO.	NAME OF EXPERIMENT	HOURS
1	Finding Young's Modulus of Elasticity, yield points, percentage elongation and percentage reduction in area, stress strain diagram plotting, tests on mild steel.	6
2	Prepare a specimen and examine the microstructure of the Ferrous and Non- ferrous metals using the Metallurgical Microscope.	6
3	Study and sketches of Blast furnace, Cupola Furnace	6
4	To detect defects and Deformation in any metals	4
5	Torsion test on mild steel – relation between torque and angle of twist determination of shear modulus and shear stress.	5
6	Determination of modulus of rigidity, strain energy, shear stress and stiffness by load deflection method (Open & Closed coil spring)	5

UNIT-2: Heat Treatment and Testing of Metals

Purpose of heat treatment, Transformation – Simplified Transformation Cooling Curves. Various heat treatment processes- hardening, tempering, annealing, normalizing, Casehardening and surface hardening, Harden ability of steels, Selection of case carburizing and induction hardening steels.
Destructive testing: Stress testing, Hardness testing, Impact testing Non-destructive testing: Eddy-current, Magnetic-particle, Liquid penetration, radiographic, Ultrasounic and visual testing Materials for bearing metals, Materials for Nuclear Energy, Refractory materials.

LIST OF PRACTICALS

EX NO.	NAME OF EXPERIMENT	HOURS
1	Identification of metal by giving mini projects.	4
2	Detect the cracks in the specimen using (i) Visual inspection and ring test (ii) Die penetration test (iii)	4

	Magnetic particle test.	
3	Determination of Rockwell's Hardness Number for various materials like mild steel, high carbon steel, brass, copper and Aluminium.	6
4	Single or double Shear test on M.S. bar to finding the resistance of material to shear load	4
5	Finding the resistance of materials to impact loads by Izod test and Charpy test.	6

Reference Books:

1. A Text Book of Material Science & Metallurgy – O.P. Khanna, Dhanpath Rai and Sons, New Delhi.
2. Material Science & Engineering – R.K. Rajput, S.K. Kataria & Sons, New Delhi, 2004.
3. Material Science – R.S. Khurmi, S. Chand & Co. Ltd., New Delhi, 2005.

4.6	Thermal Engineering -II	L	T	P	C
PRACTICUM		1	0	4	3

Introduction

The purpose of this subject is to give conceptual and principles involving thermal science, especially focusing on Internal combustion engine, Refrigerator, and compressors. Through experiments and simulations conducted in the lab, students can validate theoretical concepts, optimize system performance, testing of various oil properties for using as a fuel and lubricant in thermal systems and develop innovative solutions for real-world applications. This practical knowledge enhances their problem-solving skills and prepares them for the challenges they will face in their careers.

Learning Outcomes:

After successful completion of this course, students will be able-

- To understand the fundamental concepts involved in thermal systems.
- To analyse the various performance parameters of internal combustion (IC) engines.
- To analyse the performance of refrigeration cycle/ components.
- To analyse the performance of the compressor and its volumetric efficiency.
- To study the properties, complete combustion of fuels and its products.

Detailed Content

Unit I : AIR CYCLES, IC ENGINES AND FUEL

Air-standard Brayton cycle; Description with p-v and T-S diagrams; Gas turbines Classification: open cycle gas turbines and closed cycle gas turbines;

IC Engines : Introduction, Working principle of two stroke and four stroke cycle, SI engines and CI engines, Otto cycle, diesel cycle and dual cycle,

Testing of IC Engines: Engine power - indicated and brake power, Efficiency - mechanical, thermal. relative and volumetric, Methods of finding indicated and brake power, Morse test for petrol engine, Heat balance sheet.

Classifications of fuels: Requirements of a good fuel – stoichiometric air required for complete combustion of fuels –products of combustion – analysis of exhaust gases - calorific value of fuels – higher and lower calorific values ,Specific fuel consumption.

Practical Exercises:

Ex. No.	Name of Experiment	Hours
1	Determine the flash and fire point of the lubricating oil by using Open cup apparatus and Closed cup apparatus and compare the value for the given sample	5
2	Draw the valve timing diagram of single cylinder four stroke	5

	petrol and diesel engines	
3	Draw the port timing diagram of a single cylinder two stroke Petrol Engine	5
4	Load test (Performance test) on Four Stroke Diesel Engine or Four Stroke Petrol Engine	5
5	Morse test on multi-cylinder petrol engine	5
6	Heat balance test on Four Stroke Diesel or Petrol Engine	5
7	Find the Percentage of CO, CO2, O2, and amount of HC, NOx using Exhaust gas analyser.	5

Unit II AIR COMPRESSOR ,REFRIGERATION AND POWER PLANTS

Air Compressor and its functions, Single stage & Multi stage reciprocating air Compressor. Introduction to Refrigeration, Refrigeration Effects . COP, TON of Refrigeration. Reversed Carnot cycle, Air-standard Brayton cycle, Functions and classification of Refrigerants, selection of Refrigerant. Component and Line diagram of thermal power plant , nuclear power plant and hydro-power plant .

Practical Exercises:

Ex. No.	Name of Experiment	Hours
8	Volumetric efficiency of Air Compressor.	5
9	Demonstration of various refrigeration tools and equipment.	5
10	Study of various parts of power plants.	5
11	Study and sketch of various mountings and accessories of boilers.	6

Textbook for reference

1. R. K. Rajput, Thermal Engineering, 11th Edition, Laxmi publications Pvt Ltd , New Delhi, 2020.
2. R.S. Khurmi, J. K. Gupta, A Textbook of Thermal Engineering, S. Chand Publishing, 2019.
3. R. K. Rajput , A Text Book of Automobile Engineering, Laxmi publications Pvt Ltd, New Delhi, 2012.
4. P. K. Nag, Basic And Applied Thermodynamics 2/E, McGraw-Hill Education (India) Pvt Limited, 2010.

Website links for reference

- NPTEL (Website): https://archive.nptel.ac.in/courses/112/103/112103316/
- NPTEL (Website): https://archive.nptel.ac.in/courses/112/103/112103262/

4.7.1	REFRIGERATION AND AIR CONDITIONING (Open Elective-II)	L	T	P	C
QUALIFYING		2	-	-	2

RATIONALE

The diploma holders in Mechanical Engineering are responsible for supervising and maintenance of RAC system. For this purpose, the knowledge and skill covering basic principles of refrigeration and air conditioning is required to be imparted to the students. Moreover, RAC industry is expanding and employment opportunities in this field are good.

LEARNING OUTCOMES

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

- Explain the working and construction features of refrigeration and air conditioning systems
- Draw and interpret various refrigeration cycles.
- Make basic calculation of psychometric properties and processes.
- Calculate heating and cooling load requirements of a room.
- Explain latest developments in the field of refrigeration and air conditioning.
- Calculate the properties of air by using psychometric chart.
- Detect faults in an air-conditioner/refrigerator.
- Carry out charging of air conditioner.

DETAILED CONTENT

Unit- 1 Fundamentals of Refrigeration

Introduction to refrigeration, Meaning of refrigerating effect, units of refrigeration, COP, Methods of refrigeration- Ice, Dry ice, Steam jet, Throttling, Liquid Nitrogen refrigeration. Reversed carnot cycle and its representation on P-V and T-S diagram.

Air Refrigeration System

Bell – Coleman cycle, Boot strap system, calculation of mass flow rate, work done and COP; Advantages and Disadvantages of air-refrigeration system.

Unit- 2 Vapour Compression System

Introduction, principle, function, parts and necessity of vapour compression system, T- S and p– h charts, dry, wet and superheated compression. Effect of sub cooling, super heating, Refrigerating effect and COP. advantages and disadvantages of vapour compression system over air-refrigeration system.

Vapour Absorption System

Introduction, principle and working of simple absorption system and Domestic Electrolux refrigeration systems. Solar power refrigeration system, advantages and disadvantages of solar power refrigeration system over vapour compression system.

Unit- 3 Refrigerants

Functions, classification of refrigerants, Nomenclature of refrigerant, Desirable properties of refrigerant, selection of refrigerant.

Refrigeration Equipment

Compressors- Function, various types of compressors. Condensers - Function, various types of condensers. Evaporators- Function, types of evaporators. Expansion Valves - Function, various types such as capillary tube, thermostatic expansion valve, low side and high side float valves, application of various expansion valves Safety Devices-Thermostat, overload protector LP, HP cut out switch.

Unit-4 Psychrometry

ASHRAE Nomenclature, Specific Humidity, Relative Humidity, Degree of Saturation, DBT, WBT, DPT, Sensible Heat, latent Heat, Total enthalpy of air.; Air Water vapour mixture; Psychrometric processes- Sensible Heating and Cooling, Adiabatic Cooling, Humidification and Dehumidification, Cooling and Humidification, Cooling and Dehumidification, Heating and Humidification, Heating and Dehumidification, By Pass Factor; Psychrometric Chart.

Air Conditioning Systems

Classification of air conditioning systems; Thermal Comfort; Mathematical analysis of Air-Conditioning Systems; Cooling and Heating Load Estimation.

Unit- 5 Other Refrigeration Systems

Steam Jet Refrigeration System; Vortex tube refrigeration; Thermoelectric refrigeration system; Magnetic refrigeration.

Latest development in refrigeration and air conditioning

Inverter technology, auto-defrosting, blast cooling, star rating, Ionocaloric cooling, Thermo Acoustic Refrigeration.

REFERENCE BOOKS/ ONLINE RESOURCES

1. Refrigeration and Air Conditioning by Domkundwar; Dhanpat Rai and Sons, Delhi.
2. Refrigeration and Air Conditioning by CP Arora; Tata McGraw Hill, New Delhi.
3. Refrigeration and Air Conditioning by R.S Khurmi and J.K. Gupta; S Chand and Company Limited, New Delhi.
4. Refrigeration and Air Conditioning by Dr.Harjeev Khanna; Dhanpat Rai and Sons, Delhi.
5. Refrigeration and Air Conditioning by Dr. R.K Rajput; S.K. Kataria and Sons, Ludhiana.
6. http://swayam.gov.in

4.7.2	Power Plant Engineering (Open Elective-II)	L	T	P	C
QUALIFYING		2	0	0	2

RATIONALE

Power Plant Engineering equips mechanical engineering diploma students with critical skills and knowledge needed to operate and maintain energy production systems, preparing them for careers in the power and energy industries.

LEARNING OUTCOME

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

- Explain the principles of operation for different power plants and their economics.
- Describe the control methods of major pollutants emitted from fossil-fuel power plants.
- Distinguish the major types of hydro-power and wind-power turbines and estimate power generation potential.
- Calculate the performance of gas turbines with reheat and regeneration, and discuss the performance of combined cycle power plants.
- Assess the environmental impact of electric power product.

DETAILED CONTENT

UNIT I- Power plants – types and classification based on energy sources.
Coal based Thermal Power Plants: Basic Rankine cycle and its modifications; Layout of modern coal power plant; Super critical boilers, FBC boilers; Turbines, condensers, steam and heating rates; Subsystems of thermal power plants; Fuel and ash handling; Draught system; Feed water treatment; Binary cycles and cogeneration systems.

UNIT II- Gas Turbine and Combined Cycle Power Plants: Brayton cycle analysis and optimization; Components of gas turbine power plants; Combined cycle power plants; Integrated Gasifier based Combined Cycle (IGCC) systems.

UNIT III- Nuclear Power Plants: Basics of nuclear energy conversion; Layout and subsystems of nuclear power plants; Boiling Water Reactor (BWR); Pressurized Water Reactor (PWR); CANDU Reactor; Pressurized Heavy Water Reactor (PHWR); Fast Breeder Reactors (FBR); Gas cooled and liquid metal cooled reactors; Safety measures for nuclear power plants.

UNIT IV- Hydroelectric Power Plants: Classification; Typical layout and components. Renewable Power Systems: Principles of wind, tidal, solar photo-voltaic, solar thermal, geothermal, biogas and fuel cell power systems.

UNIT V- Energy Economics and Environment: Economic and environmental issues; Power tariffs; Load distribution parameters; Load curve; Capital and operating cost of different power plants; Pollution control technologies including waste disposal options for coal and nuclear plants.

REFERENCE BOOKS/ ONLINE RESOURCES

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.
4. https://onlinecourses.nptel.ac.in/noc22_me73/preview

4.7.3	Disaster Management (Open Elective-II)	L	T	P	C
QUALIFYING		2	0	0	2

RATIONALE: The subject of disaster management helps diploma mechanical engineering students become responsible professionals who can anticipate, respond to and help recover from emergency in industrial and societal contexts it supports the development of safer work places and communities by preparing students to be key players in sustainable engineering practices

Learning Outcomes:
After successful completion of this course, students will be able-
• To learn about various types of natural and man-made disasters.
• To know pre- and post-disaster management for some of the disasters.
• To know about various information and organizations in disaster management in India.
• To get exposed to technological tools and their role in disaster management.

Course Content:

Unit – I: Understanding Disaster
Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management.

Unit – II: Types, Trends, Causes, Consequences and Control of Disasters
Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

Unit- III: Disaster Management Cycle and Framework
Disaster Management Cycle – Paradigm Shift in Disaster Management. Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness. During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Stretegy, Hyogo Framework of Action.

Unit– IV: Disaster Management in India
Disaster Profile of India – Mega Disasters of India and Lessons Learnt. Disaster Management Act 2005 – Institutional and Financial Mechanism, National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter Governmental Agencies.

Unit– V: Applications of Science and Technology for Disaster Management

Geo-informatics in Disaster Management (RS, GIS, GPS and RS). Disaster Communication System (Early Warning and Its Dissemination). Land Use Planning and Development Regulations, Disaster Safe Designs and Constructions, Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India.

References

1. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management
2. Bhandani, R. K., An overview on natural & man-made disasters and their reduction, CSIR, New Delhi
3. Srivastava, H. N., and Gupta G. D., Management of Natural Disasters in developing countries, Daya Publishers, Delhi
4. Alexander, David, Natural Disasters, Kluwer Academic London
5. Ghosh, G. K., Disaster Management, A P H Publishing Corporation
6. Murthy, D. B. N., Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.

4.7.4	Inspection & Quality Control (Tata Tech) (Open Elective-II)	L	T	P	C
QUALIFYING		2	-	-	2

Rationale

This course is designed for individuals in the quality and manufacturing sectors, aiming to enhance their skills in inspection and quality control through the use of various measurement instruments. It offers a comprehensive, entry-level introduction and practical exposure to the measurement tools frequently used in inspections, with a special emphasis on hand-held devices.

Upon successful completion of the course students will qualify as Quality Control Inspectors or Quality Assurance Technicians. They will have job opportunities in inspection and quality control roles across diverse industries, including automotive, defence, aerospace, locomotive, construction, consumer goods, and more.

TABLE OF CONTENTS:

Sr No	Course contents
1.	**Introduction to Industrial Safety Practices** • Safely handling Tools & Equipment • Fire Extinguishers & its Types • Use of proper Tools & Equipment & its maintenance • OSH & practices to be observed as a precaution.
2.	**Introduction to Inspection and Quality** • Different Stages of Quality Control in the production process • Quality Assurance vs quality control • Importance of Quality control in minimizing defect and optimizing production **Types of Inspection** • Visual Inspection • Dimensional Inspection • Functional Inspection • Destructive Vs Non-Destructive Testing **Quality Standards** • Internation Quality Standards • Six Sigma • Lean Manufacturing • Total Quality Management
3.	**Engineering Drawing and Its importance in Inspection** • Drawing symbols • Types of Dimensions (Linear, Angular, Geometric dimensions (GD&T)

	• Inspection based on Engineering Drawing • Inspect parts and assemblies based on Engineering Drawing • Use of Drawing for Quality in Manufacturing **Geometric Dimensioning and Tolerancing (GD&T) and its role in manufacturing and Inspection** • GD&T Symbols • Types of Tolerances • Interpreting GD&T on Engineering Drawing • Case studies
4.	**Importance of Metrology in Quality Control** • Importance of Quality Control in engineering sector • Basic principles of measurement • Units of Measurements • Measurement Terminology • Precision, Accuracy, Tolerances and error analysis. • Types and classifications of handheld measuring instruments **Vernier Calipers (Digital, Dial and Vernier Scale)** • Measuring the depth, diameter, depth and thickness. • Measurement of external and internal diameters. • Measuring thickness and small components with high precision • Dial, Digital, and Vernier Calipers: Structure, reading techniques, applications, and calibration • Differences between dial, digital, and vernier calipers • Common errors and troubleshooting in caliper measurements **Micrometers and Gauges** • Outside and Digital Micrometers: Structure, working principles, applications, and calibration • Inside and Tubular Inside Micrometers: Measurement techniques, accuracy, and calibration • Specialized Micrometers: Digital Disc, Gear Tooth, Blade, and Analog 3 Pin Micrometers - specific uses, advantages, and limitations • Bore Gauges: Types, measurement techniques, applications, and calibration • Depth Gauges: Structure, reading techniques, applications, and calibration
5.	**Height Gauges, Profile Projector, Protractors and Gauges** • Height Gauges: Structure, reading techniques, applications, and calibration • Types of Height Gauges, Use of Height Gauges

	• Profile Projector components, working of Profile Projectors • Importance of profile projector in inspecting surface profile, contours and shapes. • Protractors and Gauges: Universal Bevel Protractor, Thickness, Radius, and Thread Pitch Gauges - specific uses, advantages, and limitations • Digital and Dial Indicators: Structure, digital vs. analog readouts, applications, and calibration • Dial Test Indicator: Measuring small deviations, applications, and calibration • Common errors and troubleshooting in indicator measurements
6.	**Measurement Data Wireless Communication System and Statistical Process Control (SPC)** • Overview of Measurement Data Wireless Communication systems and their applications in measurement • Connection units, comparator stands, magnetic stands, and micrometer stands - structure, usage, and applications • Integration of Measurement Data Wireless Communication systems with other measuring instruments • Statistical Process Control (SPC) Software: Applications in statistical process control, IoT integration, and data analysis • Calibration of measuring Instruments • Real World Applications of Inspection and Quality Control • Maintenance of Measuring Instruments

LIST OF PRACTICALS

Please conduct practical as per lesson plan.

1. Make a list of available safety equipment and its application.
2. Read industrial manufacturing drawings and prepare an inspection process plan.
3. Draw a block diagram of a Micrometer and identify various components, explaining their functions.
4. Perform calibration of outside Micrometer (0-25mm and 25-50mm).
5. Measure various objects using outside Micrometer (0-25mm and 25-50mm) and record the measurements.
6. Perform calibration of Digital Micrometer (IP65, range: 0-25mm).
7. Measure internal dimensions using tubular inside Micrometer and record the measurements.
8. Basic troubleshooting and maintenance of Micrometer.
9. Write a report on the accuracy and precision of measurements taken with Micrometer.
10. Import measurement data into quality control software and analyze the results.

11. Make a quality report and inspect the workpiece according to the engineering drawing using Micrometer.
12. Measure the diameter of a cylindrical component. Record the measurements using an outside Micrometer (0-25mm).
13. Calibrate an outside Micrometer (25-50mm) and measure the thickness of a metal plate.
14. Use a Digital Micrometer (IP65, range: 0-25mm) to measure the thickness of a turbine blade. Record the measurements and integrate the data with SPC software.
15. Perform a series of measurements on precision gears using a digital gear tooth Micrometer. Analyze the data for consistency.
16. Measure the internal diameter of a bearing using a dial caliper (range: 0-300mm). Record the measurements and compare them with the specified tolerances.
17. Use a Digital caliper (range: 0-150mm) to measure the depth of a drilled hole in a metal component. Record the measurements and verify against the design specifications.
18. Measure the internal diameter of a cylinder bore using a bore gauge (range: 50-150mm). Record the measurements and assess the wear of the cylinder.
19. Calibrate a bore gauge and measure the internal diameter of a hydraulic cylinder.
20. Measure the height of a machined part using a Digital height gauge (range: 0-200mm). Record the measurements and verify against the engineering drawing.
21. Use a vernier height gauge (range: 0-12") to measure the height of a component. Record the measurements and compare with the design specifications.
22. Measure the depth of a slot in a metal part using a Digital depth gauge (range: 0-150mm). Record the measurements and ensure they meet the specified tolerances.
23. Calibrate a vernier depth gauge (range: 0-150mm) and measure the depth of a groove in a component.
24. Measure the angle of a machined part using a universal bevel protractor (blade length: 150mm). Record the measurements and verify against the design specifications.
25. Use a thickness gauge (range: 0.05-1mm) to measure the thickness of a sheet metal part. Record the measurements and compare with the specified tolerances.
26. Measure the thread pitch of a screw using a metric screw pitch gauge (range: 0.4-7mm). Record the measurements and ensure they match the specified thread standards.
27. Perform measurement using profile projector.
28. Perform measurement using Measurlink (SPC, IoT Software).

4.7.5	Advanced Automobile (Tata Tech) (Open Elective-II)	L	T	P	C
QUALIFYING		2	-	-	2

This course is designed to acquire adequate knowledge and practical experience of various systems and sub systems of automobile. It includes automotive body engineering, chassis, Powertrain, auto electrical & auto electronics, automobile Regulatory requirements, and advancements in Automobile such as electric vehicle, connected car and autonomous car etc.
It also includes automotive materials, manufacturing process etc. This course provides opportunities for students to build their career in automotive industry. It also provides opportunity to start up their own business.

Table Of Contents

Sr No	Course contents
1	**Introduction to Industrial Safety Practices** • Fire Extinguishers & its Types • Safely handling Tools & Equipment • Use of proper Tools & Equipment & its maintenance • OSH & practices to be observed as a precaution
2	**Introduction to Automobile** • Introduction to Advanced automobile. • Evolution of Automobile & Automotive Industry • Key Automobile Companies and their Products • Product Segments (Criteria for Vehicle Types, Variants and Versions, Markets: India, EU, and US) • Vehicle Architecture, Classification & specifications of automobile (systems and subsystems: powertrain, chassis, electrical & electronics, body engineering, vehicle integration etc.) • Automotive materials (steels, Al alloys, magnesium alloys, plastics, composite, hybrid materials etc.) • Manufacturing processes: (forming, forging, plastic, assembly Processes, joining processes, welding etc.)

3	**Introduction to Chassis system** • Introduction to chassis & chassis system architecture • Difference between Ladder chassis and small commercial vehicles chassis • Different Long members (C type channels) and cross members (I channels) used in chassis • Chassis structure: Functions of chassis structure, types of chassis structures, ladder frame, backbone chassis, Space Frame, monocoque, etc • Introduction to chassis subsystems: wheels and tyres, suspension system, steering system, brake system, etc • Design considerations for chassis structures: types of loads acting on chassis • Materials and manufacturing processes used for chassis, Review of chassis frame FEA report • Regulations and standards for chassis system, future trends in chassis structures
4	**Introduction to Body Engineering** • Introduction to vehicle body engineering and its importance. • Overview of Body Structure, Exterior, Interior, Seating System, Safety System, Closures etc. • Body engineering terminology. • Identification and importance of components in car body assembly. (A-Pillar, B-Pillar, Fender, Hood, Door beam, frame rail, roof panel etc.) • Identification and importance of car underbody assemblies. (Engine support, suspension housing, mounting brackets, floor pan etc). • Concept of reinforcement in automotive body construction. • Sub assembly and construction of body shell (Bonnet panel assembly, boot lid assembly, shroud & Dash panel assembly, etc) • Design and safety Considerations: Morphology of Vehicle Body (Structural) Design, Material selection, vision importance, braking system, seat belt, air bag, child lock etc. • overview of paint and sealing.
5	**Introduction to Powertrain system** • Introduction to powertrain system and its components. • Engine and its development history (BSVI). • Internal combustion engines and external combustion engines • Working principle of gasoline and diesel engine • Electric motors in electric and hybrid vehicles. • Transmission system and its components • Types of Gears and a clutch or torque converter

	• Types of transmission system: Manual and automatic • Drivetrain and its components. (In conventional vehicle: Driveshaft, differentials, and axles & in electric vehicles: electric motors, power electronics, and a battery pack • Alternative fuels, and fuel efficiency • Working principal of exhaust system and emission norms • Advancements in powertrain technology and its impact on industry.
6	**Automotive Electrical** • Auto Electrical Architecture & Power Supply: Architecture, Layout, Nomenclature of Auto Electrical Components, Power Supply (Starting Charging System): Battery and its types (Battery Monitoring System), Starter Motor, Alternator • Instrumentation: Instrument Cluster, Gauges, Meters and Tell-Tales, Horn, Power Socket, Clock, Flasher, Beeper, DC-DC Converter • Lighting System: Exterior: Head Lamp Assembly, Front Fog Lamp, Side Repeater, Tail Lamp Assembly, Rear Fog Lamp etc., Interior: Roof Lamp, Glove Box Lamp, Door Ajar Lamp, Mood Lighting • Switches: Combination Switch, Steering Lock cum Ignition Switch, Mechanical Switches, Fascia Switches, Pressure, Float etc. Switches • Electrical Distribution system: Power Distribution, Circuit Schematic Design: Wire, Fuse, Relay etc. selection process, Voltage, Drop Analysis, Grounding and Splicing Strategy, Wiring Harness Design: Harness Topology, Typical Layout, Harness Components • AC (HVAC, FATC), Wash & Wiper, Radiator and Condenser Fan, Heated Rear Window
7	**Automotive Electronics & other systems** • Introduction to automotive electronics and its application (safety, comfort, and convenience) • Engine Control Units (ECUs) • Infotainment Systems and its connectivity. (Touchscreen displays, audio systems, Bluetooth connectivity, GPS navigation, and smartphone integration). • Advanced Driver Assistance Systems (ADAS): (Sensors, cameras, adaptive cruise control, lane departure warning, blind-spot monitoring, and automatic emergency braking.) • Telematics Systems: (Vehicle tracking, remote diagnostics, emergency services, and connectivity with mobile devices). • Electric Power Steering (EPS): (Electronic sensors and motors) • Components and working principle of Anti-lock Braking Systems (ABS)

	• Importance of Electronic Stability Control (ESC) and Body Control Modules (BCMs) (Lighting, power windows, door locks, climate control, and security systems. • Electronics in electric vehicle (EV) systems, connected and autonomous vehicles.
	Repair of Vehicle and Maintenance • Repair and Servicing of Vehicles • Break down, Schedule Maintenance • Trouble Shooting • Common automobile issues, causes and how to solve them • Preventive Maintenance of Vehicle • Predictive Maintenance • Advancements and repair and maintenance
8	**Automotive regulatory requirements and latest trends** • Testing requirements: Necessity of testing, Types of testing. • Overview of Design Considerations for Crash Energy Management and Occupant Protection. Different Types of Air Bags, Overview of Vehicle Testing (Frontal Crash, Side Impact, Roof Crush, Pedestrian Safety.). • Overview of various loads acting on the Body. Durability and NVH Requirements. • Automotive Regulations and other requirements (AIS, FMVSS, CMVSS, ECE/EEC, JIS, ENCAP, US NCAP IIHS etc.). • Certification and Homologation: Worldwide agencies, component level approval, type approval, E marks etc. • Latest trends in Automobile – Introduction to Electric Vehicles, Advanced Drive Assistance System (ADAS), Autonomous Car, Connected Car, Internet of things, etc.

COURSE PRACTICALS

Please conduct practical as per lesson plan

1. Prepare a table for classification of vehicle (Draw sketches as applicable).
2. Draw a sketch of vehicle architecture.
3. Draw a sketch or photos of vehicle and label the important components with its function.
4. Identify and prepare a list of safety tools and equipment's in automotive workplace.
5. Prepare a table with sketches or photos of interiors and exterior components of vehicle and list the function of important part.
6. Identify and prepare a list of manufacturing process involved during vehicle manufacturing like welding, drilling, machining on vehicle cut section.

7. Prepare a list of chassis components with its function.
8. Prepare a table to compare chassis of two vehicles.
9. Identify and make a list of body structure components,
10. Prepare a table with sketches or photos of the automotive exterior, interior, seating system, safety system, closures etc. with their function.
11. Study of vehicle suspension system and working of its sub-systems.
12. Prepare a list of suspension components with its functional importance.
13. Prepare a table for automotive materials & manufacturing processes with examples.
14. Identify important components of powertrain.
15. Identify different components of engine and engine cooling system, types of sensors used in automotive.
16. Study the function of cooling system demo kit and list all its components.
17. Draw a schematic diagram of HVAC system and list the function of each component.
18. Demonstrate working of HVAC system.
19. Demonstrate the function of transmission, gearbox and list the important components with its function. Study the basic calculations used in transmission.
20. Demonstrate the function of rear axle and make a list of all its components with its functional importance.
21. Study exhaust system & identify components of exhaust system with its materials used and applications.
22. Identify important components of electrical & electronics parts in vehicles etc.
23. Study of automotive battery charging system.
24. Study of engine starting system with use of starter motor.
25. Identify all components of fuel systems, use a schematic circuit diagram & list the key sub-systems, components & their working principle.
26. Identify main components of wiring harness system & study of electrical components.
27. Study the brake system and prepare a report by drawing a simple sketch of brake system and label the important components and list the function of each part.
28. Demonstrate usage and working of HMI, ECUs & Sensors etc used in automotive subsystems.
29. Identify seat belt, air bag systems and other safety feature.
30. List important types of vehicles tests conducted for passenger car.
31. Prepare a list of all EV components with its function.

32. Trouble Shooting and repair of lighting system
33. Repair of given automotive system
34. Preventive Maintenance of vehicle
35. Predictive Maintenance of Vehicle.
36. Compare various standard for autonomous levels used in Autonomous Car.
37. Case Studies
38. Mini Project

4.8	Essence of Indian Knowledge and Tradition	L	T	P	C
QUALIFYING		2	0	0	-

RATIONALE

It is essential for students to understand the fundamental aspects of the Indian Knowledge System, its integration with modern science, principles of Yoga and holistic healthcare, and practical applications in contemporary contexts.

LEARNING OUTCOMES

Upon completion of the course, the student will be able to demonstrate knowledge of the following topics:

- Overview, importance, and relevance of the Indian Knowledge System, including Vedas, Upavedas, Vedangas, and Upangas.
- Relevance of science and spirituality, and contributions of ancient Indian science and technology.
- Basic principles of Yoga, benefits of holistic healthcare, and integration with modern healthcare.
- Practical applications and case studies of the Indian Knowledge System's relevance today.

DETAILED CONTENT

Unit 1: Introduction to Indian Knowledge System

Overview of Indian Knowledge System

- Importance and relevance
  - Introduction to the Vedas
  - Upavedas
  - Vedangas
  - Upangas

Unit 2: Modern Science and Indian Knowledge System

- Relevance of Science and Spirituality,
- Science and Technology in Ancient India,

Unit 3: Yoga and Holistic Healthcare

- Basic principles of Yoga
- Benefits of holistic healthcare practices
- Integration with modern healthcare

Unit 4: Case Studies / Assignment

- Practical Applications / Case studies demonstrating the relevance of Indian Knowledge System in modern times

REFERENCE BOOKS/ ONLINE RESOURCES

1. Essence of Indian Traditions by Dr. Om Prakash Mishra, Khanna Publishers.
2. Indian Knowledge Systems by Kapil Kapoor and Avadhesh Kumar Singh
3. The Vedas: An Introduction to Hinduism's Sacred Texts by Roshen Dalal
4. Yoga and Ayurveda: Self-Healing and Self-Realization by David Frawley
5. Ancient Indian Science and Technology by Bal Ram Singh

	Summer Internship-II (4-6 weeks) after IVth Sem	L	T	P	C
		0	0	0	2

RATIONALE

It is needless to emphasize further the importance of Industrial/summer Training of students during their 3 years of studies at Polytechnics. It is industrial training, which provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice. Polytechnics have been arranging industrial training of students of various durations to meet the above objectives.

DETAILED CONTENT

This document includes guided and supervised industrial/summer training of 4-6 weeks duration to be organised during the semester break starting after first year i.e. after 4th semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

An Internal & External assessment of 60 & 40 marks has been provided in the study and evaluation scheme of 5th Semester. Evaluation of summer training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engauge in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations.

Teachers and students are requested to see the footnote below the study and evaluation scheme of 4th semester for further details.

The teacher along with field supervisors will conduct performance assessment of students. The components of evaluation will include the following:

a) Punctuality and regularity 15%
b) Initiative in learning new things 15%
c) Presentation and Viva 15%
d) Industrial training report 55%

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/ Mechanical Engineering (Automobile)/Mechanical Engineering (CAD)/ Mechanical Engineering (Production)/ Mechanical Engineering (R.A.C) / Mechanical Engineering (Repair & Maintenance)

- Communication Laboratory/Language Lab
- Applied Physics Laboratory
- Applied Chemistry Laboratory
- Engineering Graphics Laboratory
- CAD Lab.
- Engineering Mechanics Laboratory
- IT Systems /Computer Laboratory
- Workshop-
    - Carpentry Shop
    - Painting and Polishing Shop
    - Smithy Shop
    - Fitting and Plumbing Shop
    - Sheet Metal Shop
    - Welding Shop
    - Foundry Shop
    - Machine Shop
- Fluid Mechanics & Hydraulic Machinery Laboratory
- Measurement and Metrology Laboratory
- Strength of Material Laboratory
- Material Science Laboratory
- Thermal Engineering Laboratory
- Automobile Engineering Lab (for Automobile specialization)
- Refrigeration and Air Conditioning Laboratory (for RAC specialization)
- Maintenance Lab (for Repair & Maintenance specialization)

EQUIPMENT REQUIRED

Sr. No.	Description	Qty	Total Price (Rs)
COMMUNICATION LABORATORY/Language Lab (As per the DTE Specification)			
1.	Computer Server	01	1,28,000
2.	Headphone With Mic	01	
3.	Webcam: HD	01	
4.	Server OS; Windows/Linux	01	
5.	Monitor	01	
6.	Computer system (i7 processor,16 GB 512 SSD latest configuration)	40	3000000
7.	UPS 5KVA Online (At Least 60 Min. backup)	02	350000
8.	Computer Chair and Table	40	400000
9.	AC	02	100000
10.	Laser Printer with ADF scanner	01	50000
11.	LAN Setup	LS	20,000
12.	Language lab Software License/ Open Source	01	1,00,000
13.	Misc. Items	LS	10,000

APPLIED PHYSICS LABORATORY			
1.	Vernier calipers Working length 160 mm, Internal and external dia with locking arrangement	12	2,000
2.	Screw Gauges Working length 15 mm, pitch 0.5 mm, least count .005 mm	12	2,000
3.	Spherometers Distance between legs 2.5 mm, pitch 0.5 mm, least count .005 mm.	12	2,000
4.	Mirrors (convex, concave)	5 Each	1,500
5.	Pendulum Setup	02	4,000
6.	Gravesand's Apparatus	02	3,000
7.	Inclined Plane Setup	02	2,000
8.	Flywheel Setup	02	4,000
9.	Prism	05	1,500
10.	Spectrometer	02	25,000
11.	DC Ammeters Moving coil weston-type ammeter with ebonite stand	10	3,500
12.	DC Miliammeters	2	1,000
13.	DC Microammeters	2	700
14.	DC voltmeters	10	700
15.	DC Millivoltmeters	10	2,000
16.	Sensitivity Galvanometer	2	800
17	Student Galvanometers	10	4,000
18.	Demonstration type DC Ammeters Range; 0 to 1 Amp.	2	1,000
19.	D type DC Voltmeter Range : 0 to 1 Volt	2	1,000
20.	D type Galvanometers Sensitivity : 20 microamperes per scale division,	8	8,000
21.	Resistance boxes (dial type) assorted	8	8,000
22.	Rheostats	10	4.000
23.	Miscellaneous items (Spring, Pan, Glycerine, Optic fibre, Ferromagnetic material)	LS	2,000
24.	Fortin's Barometer (Wall type)	2	20,000
25.	Stoke's Apparatus	2	10,000
26.	Gumther's Apparatus	2	16,000
27.	Resonance Tube Apparatus with accessories and	2	14,000

	Tuning fork set		
28.	Sodium Lamp setup with Biprism	2	10,000
29.	Ohmic resistance coil	10	5,00
30.	Slide wire bridge	2	8,000
31.	PN Junction diode Apparatus	2	10,000
32.	Laser (as per requirement)	1	1,00,000
33.	Numerical aperture setup	1	25,000
34.	Miscellaneous	LS	3,000

APPLIED CHEMISTRY LABORATORY			
1.	Digital Balance	1	80,000
2.	Burette 50ml	30	3,000
3.	Pipette 25ml	60	4,000
4.	Beakers 100ml	60	4,000
5.	Burette stand	30	30,000
6.	Glazed tile	30	1,000
7.	Conical flask 50ml (Titration flask)	60	4,000
8.	Standard (Measuring) flask (to prepare standard solution) 250ml/100ml	30	6,000
9.	Able's Flash Point apparatus	2	10,000
10.	(1/10)°C thermometer	06	6,000
11.	Candles	20	100
12.	Crucible with lid	06	2,000
13.	Muffle furnace	1	18,000
14.	Decicators	06	8,000
15.	Pair of tongue (small and big)	24 (small) 2 (big)	2,000
16.	Chemicals - EDTA-1 kg - Eriochrome Black-T(solochrome black T)-200g - Buffer solution (NH_3 - 2.5 ltr, NH_4Cl – 1 kg) - Zinc sulphate- 500g - H_2SO_4- 2.5 ltr - Phenolphthalein indicator (as per requirement) - Methyl orange indicator (as per requirement) - Charcoal (as per requirement) - Kerosene- 1 ltr	LS	20,000
17.	Miscellaneous	LS	2,000

ENGINEERING GRAPHICS LABORATORY			
1.	Drawing Boards (700 x 500mm)	75	40000
2.	Draughtsman Tables	75	220000
3.	Draughtsman Stools	75	60000
4.	Model of different wooder joints	1	1,000
5.	Model of different screw threads	1	1,000
6.	Model of various locking devices	1	1,000
7.	Model of various joints	1	1,000
8.	Cut section Model of various couplings	1	5,000
9.	Miscellaneous	LS	5,000

CAD LAB.			
1.	Computer system (i7 processor,16 GB 512 SSD latest configuration)	40	3000000
2.	Online UPS 5kVA with at least 60 min. backup	02	350000
2.	Computer Aided Drawing (CAD) Software	40 User	7,00,000
3.	Computer Table with Chair	40	400000
4.	Internet facilities	LS	150000
5.	Printer (Laser) with ADF scanner	1	50000
6.	Miscellaneous	LS	10,000

ENGINEERING MECHANICS LABORATORY			
1.	Polygon law of forces apparatus	1	2,000
2.	Jib crane apparatus	1	4,000
3.	Apparatus for reaction at supports	1	5,000
4.	Inclined plane and friction apparatus	1	2,500
5.	Screw jack	1	1,000
6.	Worm and worm wheel	1	3,500
7.	Force table apparatus	1	4,000
8.	Miscellaneous	LS	1,000

IT SYSTEMS LABORATORY/COMPUTER LABORATORY

1.	Computer System with latest configuration	30	8,00,000
2	Printer (MFP)	1	25,000
3	Printer (Laser)	1	35,000
4.	Plotter	1	75,000
5.	Digitiser	1	50,000
6.	Antivirus Software	LS	10,000
7.	Internet Facility on Computers	LS	2,00,000
8.	AutoCAD/Solid Works/Unigraphics/Pro-C (any one software)	30 user	5,00, 000
9.	LCD Projector	1	35,000
10.	UPS	60	1,20,000
11.	Software (latest windows, latest MS Office)	1	1,00,000
12.	Scanner	1	10,000
13.	Miscellaneous	LS	5,000

WORKSHOP			
CARPENTRY SHOP			
1	Work benches fitted with carpenter vices	5	20,000
2.	Circular saw grinder	1	6,000
3.	Wood cutting band saw-vertical	1	10,000
4.	Bench grinder	1	10,000
5.	Drilling machine	1	8,000
6.	Wood turning lathe	1	40,000
7.	Wood Planner	1	20,000
8.	Tool accessories measuring and marking Instruments	30	30,000
9.	Band saw blade brazing unit	1	10,000
10.	Miscellaneous	LS	1,500

PAINTING AND POLISHING SHOP			
1.	Spray gun with hose pipe	1	1,000
2.	Paint brushes	20	2,000
3.	Paint/Varnish	LS	2,000
4.	Air Compressor with 2 hp motor	1 set	10,000
5.	Miscellaneous	LS	2,000

SMITHY SHOP			
1.	Black smithy forge (with open hearths, accessories to match the forge)	20	40,000
2.	Wrought iron anvils	20	20,000
3.	Swage blocks	4	8,000
4.	Blower with accessories, motor switch etc	1	6,000
5.	Work benches with vices	2	6,000
6.	Power hammer	1	20,000
7.	Tools and accessories – hammers, swages, tongs, pokers, pullers etc	20	10,000
8.	Miscellaneous	LS	1,500

FITTING AND PLUMBING SHOP			
1.	Work benches with vices (4 vices on each bench)	5	30,000
2.	Marking tables with scribers	4	24,000
3.	Surface plates	5	20,000
4.	Accessories like calipers, V blocks, height, gauges steel rules and scribers	25	50,000
5.	Tool kits – taps, dies, drills	25	40,000
6.	Tool kits – chiesels, hammers, files, hacksaw	25	25,000
7.	Drilling machine	2	16,000

8.	Pipe vice	4	1,000
9.	Chain wrenches	5	1800
10.	Ring spanner set	5	600
11.	Pipe die set 2”	2 set	1,000
12.	Pipe bending device	1	5,000
13.	Various plumbing fittings	LS	2,000
14.	Miscellaneous	LS	1,500

SHEET METAL			
1.	Hammers as per requirement	8	3,000
2.	Mallets (Hard & Soft)	5	2,000
3.	Sheet and wire Ganges	LS	8,00
4.	Shearing Machine	1	20,000
5.	Bar folding Machine	1	20,000
6.	Burring machine	1	10,000
7.	Various sheet (black plain, galvanized iron, corrugated, Aluminium)	1 Each	1,000
8.	Hand Shears/Snippers	4	2,000
9.	Nuts, Bolts, Rivets, Screw	LS	5,00
10.	Miscellaneous	LS	1,000

WELDING SHOP			
1.	Electrical welding transformer set with accessories	3	30,000
2.	Gas Cutting Unit	1	10,000
3.	Work benches with vices	3	30,000
4.	Welding generator set	1	10,000
5.	Oxy acetylene welding set with accessories	1	10,000
6.	Acetylene generating set	1	15,000
7.	Electric welder tool kit	10	10,000

8.	Projection welding machine	1	50,000
9.	Brazing equipment with accessories	1	20,000
10.	Soldering irons	3	1,000
11.	Pedestal grinder	1	10,000
12.	Metal spraying gun	1	10,000
13.	Spot welder	1	40,000
14.	TIG welding set	1	1,00,000
15.	MIG welding set	1	1,00,000
16.	Welding Partition Screen	5	2,500
17.	Miscellaneous	LS	3,000

FOUNDRY SHOP			
1.	Moulding boxes	40	8,000
2.	Ladles	5	2,000
3.	Tool Kits	10 set	5,000
4.	Quenching tanks	2	5,000
5.	Portable grinder	1	3,000
6.	Pit furnace with blower	1	10,000
7.	Miscellaneous	LS	1,000

MACHINE SHOP			
1.	Centre Lathe (4 feet)	5	2000000
2.	Lathe with copy turning attachment and other attachments	1	1,70,000
3.	Universal milling machine	1	1,25,000
4.	Vertical milling machine	1	2,85,000
5.	Shaper machine	1	150000
6.	Planner Machine	1	6,00,000
7.	Radial drilling machine	1	1,00,000
8.	Upright drilling machine	1	50,000
9.	Gear Shaper	1	1,00,000
10.	Centreless grinder	1	1,50,000
11.	Universal cylindrical grinder	1	1,20,000
12.	Hydraulic surface grinder	1	1,00,000
13.	Tool and Cutter grinder	1	90,000
14.	Power hacksaw	1	150000
15.	Pedestal grinder	1	9,000
16.	Work bench	3	30,000
17.	Precision instruments	1	10,000
18.	Surface plates	2	15,000
19.	Hand tools and accessories	2	6,000
20.	CNC trainer lathe	1	3,00,000
21.	CNC trainer milling machine	1	4,00,000
22.	Computer based NC Programming Software	1	1,50,000
23.	CNC Simulation software	1	1,00,000
24.	CNC Milling machine accessories and holding devices	LS	1,00,000

FLUID MECHANICS AND HYDRAULICS MACHINERY LABORATORY			
1.	Piezometer tube	2	2500 each
2.	U tube differential manometer	2	5000
3.	Venturimeter apparatus with differential manometer	1	40000
4.	Orificemeter appratus	1	45000
5.	V- notch apparatus	1	50000
6.	Bernoulli's apparatus	1	60000
7.	Pipe friction apparatus	1	65000
8.	Working Model of Pelton Wheel Turbine	1	170000
9.	Working Model of Francis Turbine	1	150000
10.	Working Model of Centrifugal pump	1	50000
11.	Hydraulic Brake appratus	1	50000
12.	Hydraulic Ram appratus	1	25000

MEASUREMENT AND METROLOGY LABORATORY			
1.	Digital vernier calliper	2	15000 each
2.	Vernier calliper	2	8000
3.	Digital micrometer	2	12000 each
4.	Micrometer	2	4000 each
5.	Height gauge	2	5000 each
6.	Depth gauge	2	1,000
7.	Combination set	1	1,000
8.	Bevel protractor	1	1,000
9.	Sine bar	1	1,000
10.	Precision balls and rollers	1	500
11.	Surface plate	2	15,000
12.	Slip gauges set	1	10,000
13.	Comparator – Mechanical , Pneumatic	2	40,000

14.	Gear tooth vernier	1	2,000
15.	Snap and ring gauges, Plug gauge, Thread gauge	2 each	1,500
16.	Feeler gauge, radius gauge	1	1,000
17.	Angle plate	1	1,000
18.	Tool makers microscope	1	40,000
19.	Optical Profile projector	1	75,000
20.	Tomlinson Surface roughness tester	1	60,000
21.	Dial Bore Gauge with Accessories	1	10,000

Thermal Engineering Lab			
1.	Throttling Calorimeter	2	10000
2.	Real Engine cut section of 4-stroke single cylinder Petrol and Diesel engine	1	30,000
3.	Gravimetric Analysis	1 each	20,000 each
4.	Model of Various Boiler Mounting and Accessories -Steam Stop Valve, Safety Valves, Blow off Cock, Water Level Indicator, Low Water High Pressure Safety Valve, Pressure Gauge, Economiser, Pre Heater (Air), Super Heater Model only.	1 each	10,000
5.	Single Stage Reciprocating Air Compressor	1	50,000
6.	Rotary Compressor, Air Compressor	1	25,000
7.	Flash Point Apparatus	1	10,000
8.	Pyrometer, Infrared, Thermocouple	2	5,000 each
9.	Lancashire boiler model, Nestler Boiler Model	1 each	10,000
10.	Model of impulse turbine	1	5,000
11.	Model of reaction turbine	1	5,000
12.	Model of surface condenser	1	5,000
13.	Bab Cox & Wilcox Boiler Model	1	10,000
14.	Heat Transfer apparatus for conduction , convection and Radiation	1 set	45,000
15.	Model of 2 stroke	01 set	6000

16.	Steam Separating & Throttling calorimeter fully instrumented to determine, quality of steam of 10-15 kg/cm2 . Pressure with steam condensing arrangement	01	30,000
17.	Single cylinder 2 stroke petrol engine test rig	1	45,000
18.	Single cylinder 4 stroke petrol engine test rig	1	50,000
19.	Multicylinder petrol engine test rig (Morse test rig)	1	2,00,000
20.	Open cup apparatus	1 No.	5,000
21.	Closed cup apparatus	1 No.	9,000
22.	Four stroke petrol engine cut section model for valve timing diagram.	1 No.	55,000
23.	Four stroke diesel engine cut section model for valve timing diagram.	1 No.	50,000
24.	Two stroke petrol cut section model for port timing diagram.	1 No.	35,000
25.	Four Stroke Petrol Engine or Diesel Engine Test rig.	1 No.	20,000
26.	Multi- Cylinder Petrol or Diesel Engine Test rig.	1 No.	20,000
27.	Air Compressor Test rig.	1 No.	60,000
28.	Exhaust Gas Analyzer.	1 No.	1,20,000
29.	Reciprocating and Rotary Air compressor for dismantling and assembling	1 No.	50,000

STRENGTH OF MATERIALS LAB			
Sr. No.	**Description**	**Qty**	**Total Price (Rs)**
1.	Brinell and Rockwell hardness Tester	1	80,000 each
2.	Impact Testing machine (Izod and charpy)	1	50,000
3.	Microprocessor based Universal Testing Machine	1	4,00,000
4.	Spring Stiffness Tester	1	50,000
5.	Torsion test apparatus	1	50,000

6.	SFD & BMD apparatus (Simple supported and Cantilever Beam)	2	5,000
7.	Young's Modulus (Deflection of Beam apparatus)	1	5,000
8.	Digital Vernier Caliper 12 inch	2	5,000
9.	Misc. items	-	5,000

MATERIAL SCIENCE LABORATORY

Sr. No.	Description	Qty	Total Price (Rs)
1.	Forced circulation tempering furnace	1	50,000
2.	Quenching tank	2	10,000
3.	Models of- Simple Cubic , BCC, FCC and HCP	1 each	10,000
4.	Pedestal Grinder	1	8,000
5.	Specimen Kit (Ferrous and Non-ferrous Metals	1	10,000
6.	Metallurgical microscope	2	60,000 each
7.	Specimen Polishing Machine (Double Disk type)	1	50,000
8.	Set of Specimen of different alloys	1	5,000
9.	Misc. items	LS	5000

AUTOMOBILE ENGINEERING LAB (for Automobile Specialization)				
S.NO.	**EQUIPMENT NAME / ITEM NAME**	**SPECIFICATIONS**	**QTY**	**price**

1	Battery Charger 0-12 V, 0-6 Amp.	Output voltage in power supply mode: 12 Volt. Output voltage in charger mode: 13.2 – 14.4 Volt. Input 90-265VAC. Output current: 10Amp	1	3500
2	Batteries 6 V & 12 V	Lead-Acid Storage Batteries for Motor Vehicles with Light weight and High Cranking Performance conforming to IS:14257/1995,nominal voltage-12V,dimensions- as per IS specifications,maxim=um rated capacity-35AH.	1	5000
3	Hydrometer	With rubber bulb and tube, Range:1.100-1.300g/ml Division :5 Graduted at 20C	1	2000
4	Cell Tester	Measurement time 100 ms,Response time Approx. 1.6 sec.,Temperature: 0°C to 40°C (32°F to 104°F),Size AA alkaline battery (LR6) × 8	1	2000
5	Working Model of Battery Ignition System,And Magneto Ignition System Fitted on board	working Model for demonstration purpose for bith ignition system	1	5000
6	Fuel Injection Pump	maximum flow rate-30 to248 Bar,pressure range-2 to 4.5 bar,material-stainless steel ,working temprature—30 to +120 degree.	1	20000
7	Calibration Machine with Fuel Injection Pump & Coupling	diesel injector tester,Voltage: 110V 220V, 220V or 110V,Power: Electronic,Applicable Models: Diesel Auto,Single package size: 40X20X20 cm,Single gross weight: 6.000 kg	1	35000

8	Electrical Testing Bench	length 300*150,Width 150 mm,Height500 mm.material wooden top	1	2500
9	Condemned petrol engine of light petrol vehicle	any engine of light petrol vehicle for demonstration	1	7000
10	Condemned Diesel engine of medium and heavy vehicles	any engine of medium and heavy vehicle for demonstration	1	7000
11	Tyre inflator with twin hose assembly and small hose assembly	HOSE LENGTH (m):0.85,TYRE VALVE CONNECTIONEuro Clip-on,CALIBRATION 10-210 psi / 0.7-15 bar	1	3500
12	Spark plug cleaning machine and Testing machine	Weight-12 to 14kg,working pressure-5 to 12 kgf/ sq cm.,supply voltage-220V,spark plug used-M10,M12,M14,M18,electronic vibrator voltage 220V	1	6500
13	Condemned chassis frame of any light motor vehicle	Model for demonstration purpose	1	8000
14	Sectioned working model of a single cylinder two stroke petrol engine	Model for demonstration purpose	1	1500
15	Sectioned working model of single cylinder two stroke diesel engine	Model for demonstration purpose	1	1500
16	Sectioned working model of a single cylinder four stroke diesel engine	Model for demonstration purpose	1	1500
17	Sectioned working model of a single cylinder four stroke petrol engine fitted with ignition system Hand Operated Motor Operated	Model for demonstration purpose	1+1	5000+6000
18	Work bench	length 3000*1200,Width 700 mm,Height850 mm.material wooden top	2	3000
19	Mechanical Jack	Model for demonstration purpose	2	3500

20	Tool Kit (Spanner, socket set, screw driver, plier, file, wrench, drill, tap set, hammer etc.)	LS	4 SETS	3000
21	Models of rear axle and differential	Model for demonstration purpose	1	15000

REFRIGERATION AND AIRCONDITIONING LAB (for RAC Specialization)			
1	**Refrigeration Cycle Demonstration** Unit-With Condenser & Evaperator Made of toughened glass & Instrumented to measure Temperature & Pressurse, Refrigerant flow at All Suitable Locations. Arangement for Using Different Expansion Devices.	2	@75000 =15000
2	Experimental Air Conditioner Window Type-1 Ton Capacity With Proper Instrumentation For Studying its performance.	2	@45000 =90000
3	PSYCHROMETERS		
	Sling Psychrometer. Aspiratior Psychrometer. Hygrometer Dry & Wet bulb wall hygrometer. Dial type hygrometer Fortin's barometer Manometers	2 2	LS. Rs.24000 LS. Rs.12000
4	Anemometer Hand Hold	2	4000
5	Misc.	Ls	20000

MAINTENANCE LAB (for Repair & Maintenance Specialization)			
1	Benchwise 10cm jaw	4 @1000	Rs.4000
2	Centre Punch	4 @100	Rs. 400
3	Pin Punch	4 @100	400
4	Callipers Inside (spring)	10 @200	2000
5	Callipers outside (spring)	10 @200	2000
6	V. Callipers 30 Cm.	2 @600	1200
7	Micrometer 0-25 Cm.	2@250	500
	25-50 Cm.	2@250	500
8	V.Depth gauge	2@700	1400
9	Feeler gauge 15 Blades	2@100	200
10	Radious gauge	2@150	300

11	Angle Gauge	2@150	300
12	Thread Gauge	2@150	300
13	Tap set	2 @3000	6000
14	Allen Key Set	2@700	1400
15	Adjustable Wrench	2 @2500	5000
16	Double Spanners		
	i. Size (6x7,8x9,...18x19,20x22 24x27,30x32mm)	4 @500	2000
	ii. Size (32x36, 36x41, 41x46, 46x50, 50x55mm)	2 @500	1000
17	Misc. Files, Scrapers, Dieset Hexaframe as per need	LS	5000
18	Pipe Vice 5cm	2 @500	1000
19	Chain Rinch	2 @500	1000
20	Ring Spanner Set	2 @250	500
21	Ball Peen Hammer	6 @100	600
22	Claw Hammer	2 @100	200
23	Battery Charger 0-12v,6 Amp.Call Tester Hydrometer Lead Acid Battery 12V,6V	2 @7000	14000
24	T-socket wrench Set	2 @1000	2000
25	Off socket wrench Set	2 @1000	2000
26	Old Jacks Hydraulic mechanical	2 Each @ LS 5000	10000
27	Automobile Gear Box Old	2 @5000	10000
28	Refrigerator Old	2	LS 8000
29	Airconditioner (Window Type)old	2 @7000	Ls. 14000
30	Water cooler (old)	2 @5000	Ls. 10000

31	Digital Multimeter Portable 4-5 digits, 0.5 LCD Auto zeroing and Auto polarity DC Voltage 10MV-1000V DC Currient 0.1MA-10A Ac Voltage 10MV-750V AC Current 0.1MA-10A Batter Operated with connection Leads	2 @2000	4000
32	Clipon ammeter/Voltmeter Measuring rang 0-12A, 0-500V Opening 40mm for round conductors Set of spare fuses and connecting Leads.	2 @2000	4000
33	Pulley Pullers 2 2000 4000 (One two legged, One three Legged)	4 @2000	8000
34	Bearing Assorted	Ls.	4000
35	Couplings Assorted	Ls.	8000
36	Air compressor (old unit)	Ls.	
37	Portable tools - Pneumatic & Electrical (For Servicing & Repairing Work - Old).	2 @4000	8000
38	Old lathe Machine/Grinding Machine.	2 @20000	40000
39	Miscellaneous Needs and for the items ommited hear if any	Ls	35000
40	Apparatus for checking of slip of belt	1	Ls. 25000
41	Toolkit for dismantling of sub assembly for example pullers , pneumatic wrenches	1	LS.10,000

NOTE:-

If the items other then tools and instruments mentioned above are available in the institute, they should be used for the purpose alternatively they should be procured from other institutions from where they may be made available for the purpose . For the facilities which cannot be made available in the institution visits of repair and maintenance shops in the vicinity be arranged according to need.

The approximate cost is mentioned for eacg equipment listed above.

Note:

1. Above items are for 2 batches of 30 students each.

Note:

1. The specifications and price of equipment mentioned above used as broad guidelines for purchase of equipment.
2. Any other items not mentioned in the lit of equipment can be purchased as provision has been made for purchase under the item miscellaneous for each lab/shop.
3. Any additional equipment, already available in the institute, may be used for demonstration to the students, and for experiments / practical's of other Lab's / Shops

NOTE:

In addition to the above, laboratories in respect of physics, chemistry, Computer Centre etc will be required for effective implementation of the course. Provision for photocopiers, PC facilities along with LCD Projection System etc. has also to be made.

(C) Furniture Requirement

Norms and standards laid down by AICTE be followed for working out furniture requirement for this course.

10.2 Human Resources Development:

Weekly work schedule, annual work schedule, student teacher ratio for various group and class size, staffing pattern, work load norms, qualifications, experience and job description of teaching staff workshop staff and other administrative and supporting staff be worked out as per norms and standards laid down by the AICTE.

11. EVALUATION STRATEGY

11.1 INTRODUCTION

Evaluation plays an important role in the teaching-learning process. The major objective of any teaching-learning endeavor is to ensure the quality of the product which can be assessed through learner's evaluation.

The purpose of student evaluation is to determine the extent to which the general and the specific objectives of curriculum have been achieved. Student evaluation is also important from the point of view of ascertaining the quality of instructional processes and to get feedback for curriculum improvement. It helps the teachers in determining the level of appropriateness of teaching experiences provided to learners to meet their individual and professional needs. Evaluation also helps in diagnosing learning difficulties of the students. Evaluation is of two types: Formative and Summative (Internal and External Evaluation)

Formative Evaluation

It is an on-going evaluation process. Its purpose is to provide continuous and comprehensive feedback to students and teachers concerning teaching-learning process. It provides corrective steps to be taken to account for curricular as well as co-curricular aspects.

Summative Evaluation

It is carried out at the end of a unit of instruction like topic, subject, semester or year. The main purpose of summative evaluation is to measure achievement for assigning course grades, certification of students and ascertaining accountability of instructional process. The student evaluation has to be done in a comprehensive and systematic manner since any mistake or lacuna is likely to affect the future of students.

In the present educational scenario in India, where summative evaluation plays an important role in educational process, there is a need to improve the standard of summative evaluation with a view to bring validity and reliability in the end-term examination system for achieving objectivity and efficiency in evaluation.

11.2 STUDENTS' EVALUATION AREAS

The student evaluation is carried out for the following areas:

- Theory
- Practical Work (Laboratory, Workshop, Field Exercises)
- Project Work
- Professional Industrial Training

A. Theory

Evaluation in theory aims at assessing students' understanding of concepts, principles and procedures related to a course/subject, and their ability to apply learnt principles and solve problems. The formative evaluation for theory subjects may be caused through sessional /class-tests, home-assignments, tutorial-work, seminars, and group discussions etc. For end-term evaluation of theory, the question paper may comprise of three sections.

Section-I

It should contain objective type items e.g. multiple choice, matching and completion type. Total weightage to Section-1 should be of the order of 20 percent of the total marks and no choice should be given in this section. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.

Section-II

It should contain short answer/completion items. The weightage to this section should be of the order of 40 percent of the total marks. Again, no choice should be given in section-II

Section-III

It may contain two to three essay type questions. Total weightage to this section should be of the order of 40 percent of the total marks. Some built-in, internal choice of about 50 percent of the questions set, can be given in this section

Table II : Suggested Weightage to be given to different ability levels

Abilities	Weightage to be assigned
Knowledge	10-30 percent
Comprehension	40-60 percent
Application	20-30 percent
Higher than application i.e. Analysis, Synthesis and Evaluation	Upto 10 percent

B. Practical Work

Evaluation of students performance in practical work (Laboratory experiments, Workshop practicals/field exercises) aims at assessing students ability to apply or practice learnt concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behaviour and it should be followed by viva-voce.

C. Project Work

The purpose of evaluation of project work is to assess students ability to apply, in an integrated manner, learnt knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The formative and summative evaluation may comprise of weightage to nature of project, quality of product, quality of report and quality of presentation followed by viva-voce.

D. Professional Industrial Training

Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of materials, industrial processes, practices in the industry/field and their ability to engauge in activities related to problem-solving in industrial setting as well as understanding of application of learnt knowledge and skills in real life situation. The formative and summative evaluation may comprise of weightages to performance in testing, general behaviour, quality of report and presentation during viva-voce.

12. RECOMMENDATIONS FOR EFFECTIVE CURRICULUM IMPLEMENTATION

This curriculum document is a Plan of Action and has been prepared based on exhaustive exercise of curriculum planning and design. The representative sample comprising selected senior personnel (lecturers and HODs) from various institutions and experts from industry/field have been involved in curriculum design process.

The document so prepared is now ready for its implementation. It is the faculty of polytechnics who have to play a vital role in planning instructional experiences for the courses in four different environments viz. class-room, laboratory, library and field and execute them in right perspective. It is emphasized that a proper mix of different teaching methods in all these places of instruction only can bring the changes in stipulated students behaviour as in the curriculum document. It is important for the teachers to understand curriculum document holistically and further be aware of intricacies of teaching-learning process (T-L) for achieving curriculum objectives. Given below are certain suggestions which may help the teachers in planning and designing learning experiences effectively. These are indicative in nature and teachers using their creativity can further develop/refine them. The designers of the programme suggest every teacher to read them carefully, comprehend and start using them.

(A) Broad Suggestions:

1. Curriculum implementation takes place at programme, course and class-room level respectively and synchronization among them is required for its success. The first step towards achieving synchronization is to read curriculum document holistically and understand its rationale and philosophy.

2. An academic plan needs to be prepared and made available to all polytechnics well in advance. The Principals have a great role to play in its dissemination and, percolation upto grass-root level. Polytechnics, in turn are supposed to prepare institutional academic plan.

3. HOD of every Programme Department along with HODs and incharges of other departments are required to prepare academic plan at department level referring to institutional academic plan.

4. All lecturers/Senior lecturers are required to prepare course level and class level lesson plans referring departmental academic plan.

(B) Course Level Suggestions

Teachers are educational managers at class room level and their success in achieving course level objectives lies in using course plan and their judicious execution which is very important for the success of programme by achieving its objectives.

Polytechnic teachers are required to plan various instructional experiences viz. theory lecture, expert lectures, lab/workshop practicals, guided library exercises, field visits, study tours, camps etc. In addition, they have to carry out progressive assessment of theory, assignments, library, practicals and field experiences. Teachers are also required to do all these activities within a stipulated period of time. It is essential for them to use the given time judiciously by planning all above activities properly and ensure execution of the plan effectively.

Following is the gist of suggestions for subject teachers to carry out T-L process effectively:

1. Teachers are required to prepare a course plan, taking into account departmental academic plan, number of weeks available and courses to be taught.

2. Teachers are required to prepare lesson plan for every theory class. This plan may comprise of contents to be covered, learning material for execution of a lesson plan. They may follow steps for preparing lesson plan e.g. drawing attention, state instructional objectives, help in recalling pre-requisite knowledge, deliver planned subject content, check desired learning outcomes and reinforce learning etc.

3. Teachers are required to plan for expert lectures from field/industry. Necessary steps are to plan in advance, identify field experts, make correspondence to invite them, take necessary budgetary approval etc.

4. Teachers are required to plan for guided library exercises by identification of course specific experience requirement, setting time, assessment, etc. The assignments and seminars can be thought of as terminal outcome of library experiences.

5. Concept and content based field visits may be planned and executed for such content of course which is abstract in nature and no other requisite resources are readily available in institute to impart them effectively.

6. There is a dire need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem based learning/activity learning/ experiential learning approach effectively. The development of lab instruction sheets for the course is a good beginning to provide lab experiences effectively.

7. Planning of progressive assessment encompasses periodical assessment in a semester, preparation of proper quality question paper, assessment of answer sheets immediately and giving constructive feed back to every student

8. The student centred activities may be used to develop generic skills like task management, problem solving, managing self, collaborating with others etc.

9. Where ever possible, it is essential to use activity based learning rather than relying on delivery based conventional teaching all the time.

10. Teachers may take initiative in establishing liaison with industries and field organizations for imparting field experiences to their students.

11. Students be made aware about issues related to ecology and environment, safety, concern for wastage of energy and other resources etc.

12. Students may be given relevant and well thought out project assignments, which are purposeful and develop practical skills. This will help students in developing creativity and confidence for their gainful employment.

13. A Project bank may be developed by the concerned department of the polytechnics in consultation with related Industry, research institutes and other relevant field organizations in the state.

13. LIST OF PARTICIPANTS

The following experts participated in the workshops for Finalizing Curriculum Contents of 2nd year subjects of diploma course in Mechanical Engineering (Auto/Production/RAC/Repair & Maintenance/CAD) for UP State on organized by IRDT, Kanpur:

1. Tajammul Afzal, Joint Director, Technical Education Department, East Zone, Varanasi.
2. Pradeep Kumar, Head of Department Mechanical Engineering, Government Polytechnic Lucknow
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5. Atul Rai Head of Department Mechanical Engineering, Government Polytechnic Bighapur.
6. Pankaj Singh, Head of Department Mechanical Engineering, Government Polytechnic Hamirpur.
7. Saqib Ali Lecturer, Head of Department Mechanical Engineering, Government Polytechnic Fatehpur.
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11. Anshita Awasthi, Lecturer Mechanical Engineering, Government Polytechnic Deeh Unnao
12. Dr. Ram Sajeevan, Lecturer Mechanical Engineering, MMIT Kannauj
13. Anupriya Saxena, Lecturer Mechanical Engineering, Government Polytechnic Soron Kasganj
14. Ashish Kumar Mishra, Lecturer Mechanical Engineering, Government Polytechnic Hamirpur
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16. Kapildev Agarwal Lecturer Mechanical Engineering, Government Polytechnic Bachhrawa Raebareli
17. Prince Tyagi Lecturer Mechanical Engineering, Government Polytechnic Jansath Muzaffar Nagar
18. Puneet Pandey, Lecturer Mechanical Engineering, Government Polytechnic Azamgarh
19. Raja Ram, Lecturer Mechanical Engineering, Government Polytechnic Sitapur
20. Harshit Bajpai, Lecturer Mechanical Engineering, Manyavar Kanshi Ram Government Polytechnic Kannauj
21. Krishna Kumar, Workshop Superintendent, Government Polytechnic Manikpur Chitrakoot.

22. PAmit Ranjan, Lecturer Mechanical Engineering, Government Polytechnic Mohammadpur, Bahraich
23. Shazia Tabassum, Workshop Superintendent, Government Polytechnic Bargarh Chitrakoot
24. Puneet Pandey Workshop Superintendent, Government Polytechnic Gonda
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Annexure: 1

Proposed Courses by TATA Technology (Advance Skill Certification)

S. No.	Course Name
1	Fundamentals of Innovation and Design Thinking
2	Product Design and Development
3	Product Verification and Analysis
4	Advanced Automobile
5	Electric Vehicle
6	Internet of Things
7	Advanced Manufacturing
8	Advanced Welding & Painting using Simulator
9	Industrial Automation and MES
10	Industrial Robotics
11	Inspection and Quality Control
12	Advanced Plumbing
13	AI and ML