NEP-2020 Aligned Curriculum for

Three year (Six Semester) Diploma Programme in

- MECHANICAL ENGINEERING (PRODUCTION)

For the State of Uttar Pradesh

Prepared by:
IRDT, Kanpur

(Effective from session 2026-27)

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

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PREFACE

An important issue generally debated amongst 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 programmes 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 programmes. The curricula for diploma programmes 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.
Kanpur

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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.

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 for Diploma in Mechanical Engineering (Six Semester): (Production)
Semester: V

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credit	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	Summer Internship-II (4-6 Weeks)	-	-	-	2	-	60	60	-	-	40	3	40	100	Practical
2	Theory of Machines & Mechanisms	4	0	0	4	40	-	40	60	3	-	-	60	100	Theory
3	Design of Machine Elements	4	0	0	4	40	-	40	60	3	-	-	60	100	Theory
4	Minor Project	0	0	8	4	-	60	60	-	-	40	3	40	100	Practical
5	Program Specific Subject (Practicum) • Advanced Manufacturing Processes	3	0	3	4	-	40	40	60	3	-	-	60	100	Practicum
6	Advance Skill Development OR Open Elective-III (Anyone from the list)	2	0	-	2	50	-	50	-	-	-	-	-	-	Qualifying
7.	Indian Constitution	2	0	0	0	50	-	50	-	-	-	--	-	-	Qualifying
#Student Centred Activities (SCA)		-	-	10	-	-	50	**50**	-	-	-	-	-	50	-
Total		**15**	**0**	**21**	**20**	**80**	**210**	**290**	**180**	**-**	**80**	**-**	**260**	**550**	**-**

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.

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-III (Any one) :

SR. NO.	SUBJECT NAME
1.	Computer Aided Design & manufacturing
2.	Reverse Engineering
3.	Artificial Intelligence
4.	Automobile Engineering
5.	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 Electric Vehicle (Tata Tech) o Fundamentals of Innovation & Design Thinking (Tata Tech)

*** 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.

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 for Diploma in Mechanical Engineering (Six Semester): (Production)
Semester: VI
A: Normal Pathways

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credit	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	Project	-	-	24	12	-	240	240	-	-	160	3	160	400	Practical
2	Entrepreneurship and Start-ups **	2	0	0	2	40	-	40	60	3	-	-	60	100	Practical
3	**Elective Pathway: (Any One)** • Advanced Engineering Mathematics • Additive Manufacturing • Project Management • Finance Fundamentals • Industry 4.0	3	0	0	3	40	-	40	60	3	-	-	60	100	Theory
4	**Elective Specialization** (Any One): • Green Energy & Engineering • Maintenance of Machine Tools • Non-Destructive Testing • Product Design & Development	3	0	0	3	40	-	40	60	3	-	-	60	100	Theory
#Student Centred Activities (SCA)		-	-	4	-	-	50	50	-	-	-	-	-	50	-
Total		**08**	**0**	**28**	**20**	**120**	**290**	**410**	**180**	**-**	**160**	**-**	**340**	**750**	**-**

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.

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.
** Common with other Engineering diploma courses

Elective Pathway: (Any One)

- Advanced Engineering Mathematics
- Additive Manufacturing
- Project Management
- Finance Fundamentals
- Industry 4.0

Elective Specialization (Any One):

- Green Energy & Engineering
- Maintenance of Machine Tools
- Non-Destructive Testing
- Product Design & Development

*** 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.

Semester: VI
B: Internship Pathway

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		
6.1	**Entrepreneurship And Start-Ups (Online Mode)	-	-	-	2	-	-	-	100	3	-	-	100	100	Theory
6.2	Industry Hands on Practice	-	-	-	4	-	-	-	-	-	-	-	-	350	-
	Industrial Project	-	-	-	12	-	-	-	-	-	-	-	-	200	-
	Seminar (In Institute)	-	-	-	**2**	**-**	100	100	-	-	-	-	-	100	Seminar
Total		**-**	**-**	**-**	**20**	**-**	**100**	**100**	**100**	**-**	**-**	**-**	**100**	**750**	**-**

** Common with another diploma programme

NOTE:

1. The Industrial training tenure should not be less than 4 months.
2. Industry must be registered with MSME / Directorate of industries/Limited Organization/ State/Central Government establishments.
3. Monthly progress reports of Intern/ Trainee should be attested and forwarded by industrial supervisor (allotted to Intern/Trainee) during industrial Internship/Training.
4. The Industrial unit/organisation must evaluate students using the format provided by polytechnic in the form of marks.
5. The Industrial Hands on Practice, Industrial Project and seminar must be evaluated on the basis of the BTE Internship / Training Policy -2025.
6. “Entrepreneurship and Start-up” course is also mandatory in Industrial internship/training mode. It will be conducted online mode by his/her polytechnic institute. After completing the online course, students must appear for exam conducted by the Board of Technical Education, Lucknow.

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

5.1	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 engage 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%

5.2	THEORY OF MACHINE & MECHANISMS	L	T	P	C
Theory		4	0	0	4

RATIONALE

A diploma holder in this course is required to assist in the design and development of prototype and other components. For this, it is essential that he is made conversant with the principles related to design of components and machine and application of these principles for designing. The aim of the subject is to develop knowledge and skills about various aspects related to design of machine components.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Explain the fundamentals and kinematics of mechanisms, links, pairs, and chains.

CO2: Explain cams and followers, their motions, displacement diagrams, and draw cam profiles.

CO3: Analyze and select power transmission systems including belts, chains, gears, and ropes.

CO4: Analyze the concepts, applications, and analysis of flywheels and governors.

CO5: Explain the construction, working, and applications of brakes, clutches, and bearings.

CO6: Analyze balancing of rotating masses and understand causes, effects, and remedies of vibrations.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	3	2	NA	NA	NA	2	*	*
CO2	3	3	3	2	NA	NA	2	*	*
CO3	3	3	3	3	2	2	2	*	*
CO4	3	3	2	2	2	2	2	*	*
CO5	3	2	2	3	2	2	NA	*	*
CO6	3	2	2	3	2	NA	2	*	*

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional**.**

DETAILED CONTENT

UNIT I: Introduction to Mechanisms and Machines: Introduction of Mechanism and Machine, Basic elements- Link, Pairs, Chains, Inversions, different types of mechanisms, Displacement, velocity and acceleration of plane mechanisms.

Cams and Followers: Definition and application of Cams and Followers; Classification of Cams and Followers; Different follower motions and their displacement diagrams like uniform velocity, SHM, uniform acceleration and Retardation; Drawing of profile of radial cam with knife-edge and roller follower.

UNIT II: Power Transmission: Basics of Power Transmission
Belt Drives: Flat belt, V– belt & its applications; Material for flat and V-belt; Angle of lap, Belt length, Slip and Creep; Determination of Velocity Ratio, Ratio of tight side and slack side tension; Centrifugal tension and Initial tension; Condition for maximum power transmission (Simple numerical).
Chain Drives: Advantages & Disadvantages; Selection of Chain& Sprocket wheels; Methods of lubrication.
Gear Drives: Gear terminology; Types of gears and gear trains, their selection for different applications; Train value & Velocity ratio for simple and compound, gear train, law of gearing; Rope Drives – Types, applications, advantages & limitations of Steel ropes.

UNIT III: Flywheel and Governors: Concept, function and application of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C. Engine; Coefficient of fluctuation of energy, Coefficient of fluctuation of speed and its significance.
Governor Types and explanation with neat sketches (Centrifugal-Watt and Porter); Concept, function and applications & Terminology of Governors; Comparison between Flywheel and Governor.

UNIT IV: Brakes, Dynamometers, Clutches & Bearings: Function of brakes and dynamometers; Types of brakes and Dynamometers; Comparison between brakes and dynamometers; Construction and working of i) shoe brake, ii) Band Brake, iii) Internal expanding shoe brake iv) Disc Brake; Concept of Self Locking & Self energizing brakes.
Clutches: Uniform pressure and Uniform Wear theories; Function of Clutch and its application; Construction and working ofSingle plate, Multiplate, Centrifugal and Cone clutch.
Bearings i) Simple Pivot, ii) Collar Bearing, iii) Conical pivot.

UNIT V: Balancing & Vibrations: Concept of balancing; Balancing of single rotating mass; Graphical method for balancing of several masses revolving in same plane.
Concept and terminology used in vibrations, Causes of vibrations in machines; their harmful effects and remedies.

INSTRUCTIONAL STRATEGY
- Use teaching aids for classroom teaching
- Give assignments for solving numerical problems
- Arrange industry visits to augment explaining use of various machine components like belt,
- rope, chain, gear drives, action due to unbalanced masses, brake clutch, governors, fly
  wheels, cams and gear drives
- Video films may be used to explain the working of mechanisms and machine components like clutch, governors, brake etc.

MEANS OF ASSESSMENT
1. Assignments and quiz/class tests
2. Sessional test
3. Viva-voce

REFERENCE BOOKS/ ONLINE RESOURCES

1. Theory of machines – S.S .Rattan ,Tata McGraw-Hill publications.
2. Theory of machines – R.K.Bansal ,Laxmi publications
3. Theory of machines – R.S. Khurmi &J.K.Gupta , S.Chand publications.
4. Dynamics of Machines – J B K Das, Sapna Publications.

SUGGESTED DISTRIBUTION OF MARKS

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

5.3	Design of Machine Elements	L	T	P	C
Theory		4	0	0	4

RATIONALE

The subject "Design of Machine Elements" is crucial for mechanical engineering diploma students as it equips them with the knowledge and skills needed to create and improve machine components. This subject focuses on the principles of designing various machine elements such as bearings, gears, springs, and fasteners. Understanding these principles helps students to analyse and solve real-world engineering problems, ensuring the reliability and efficiency of mechanical systems. By learning to design machine elements, students can prevent failures, optimize performance, and contribute to the development of innovative and cost-effective mechanical solutions.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Explain the fundamentals of machine design.

CO2: Design simple machine elements such as cotter joints, knuckle joints, levers, C-clamps, and overhang cranks.

CO3: Design bearings and springs based on load and deflection requirements.

CO4: Design shafts, keys, and couplings for strength, rigidity, and standardization.

CO5: Design spur gears, including tooth profile and module selection.

CO6: Design power screws and fasteners, including screw jacks, bolts, riveted and welded joints, considering efficiency and load requirements.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	3	2	1	2	1	2	*	*
CO2	3	3	3	2	1	2	2	*	*
CO3	3	3	3	3	2	2	2	*	*
CO4	3	3	3	3	2	2	2	*	*
CO5	3	3	3	2	2	2	2	*	*
CO6	3	3	3	2	2	2	2	*	*

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional**.**

DETAILED CONTENT:

UNIT-I: Introduction to Design: Procedure of Design, General considerations in Machine Design, Use of standards in design and preferred numbers series; Stresses; Bearing pressure Intensity; Crushing; Creep Curve; Fatigue; S-N curve; Endurance Limit; Factor of Safety and Factors governing selection of factor of Safety; Stress Concentration: Causes & Remedies; selection criteria of materials; Introduction to Theories of Failures; Ergonomics & Aesthetic consideration in design.

UNIT-II: **Design of simple machine parts**: Cotter Joint; Knuckle Joint; Design of Levers: Hand/Foot Lever & Bell Crank Lever; Design of C–Clamp; Overhang Crank;.

Bearings: Introduction, Types of bearing and terminology of bearings, Life Load relationship, Selection of bearings using manufacturer's catalogue.

Springs: Classification and Applications of Springs; Spring terminology; Materials and Specifications; Stresses in springs; Wahl's correction factor; Deflection of springs; Energy stored in springs; Design of Helical, Tension and Compression springs subjected to uniform applied loads like I.C. engine valves, Weighing balance, Railway buffers and Governor springs; Leaf springs: Construction and Application.

UNIT-III: **Design of Shafts, Keys, Couplings:** Types of Shafts; Shaft materials; Standard Sizes; Design of Shafts (Hollow and Solid) using strength and rigidity criteria; determination of shaft diameter (Hollow and Solid), ASME code of design for shafts. Design of Sunk Keys; Effect of Keyways on strength of shaft.

Introduction and function of keys, types, material and failure of keys. Design of keys(Sunk key only),

Necessity, advantages and types of Couplings, Design of couplings – Muff Coupling and Flange Coupling (Protected and unprotected);

UNIT-IV: **Design of Spur Gear**: Mechanical drive, classification of gears, selection of gear, involute and cyloidal profile of teeth, terminology of spur gear, standard system of gear teeth, Spur gear design considerations; Lewis equation for static beam strength of spur gear teeth; design procedure of spur gear (module determination). Power transmission capacity of spur gears in bending.

UNIT-V: **Design of Power screws and Fasteners:** Introduction of power screw, terms used in screw threads, Thread Profiles used for power Screws; Torque required to overcome thread friction; Self-locking and overhauling property; Efficiency of power screws; Design of Screw Jack.

Introduction of Fasteners, Types of Fasteners, Bolts of uniform strength, design of bolted joints, design of parallel and transverse welded, design riveted joints, failure and efficiency of riveted joints, leak proofing of riveted joints- caulking and fullering.

INSTRUCTIONAL STRATEGY

- Combine interactive lectures with hands-on projects and the use of CAD software.
- Incorporate real-world examples, disassembly exercises, and simulation tools.
- case studies and problem-solving sessions.
- Guest lectures and industry visits can provide practical insights.
- Utilizing online resources and hosting design competitions can further engage students and foster innovation.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Sessional test
- Small projects
- Viva-voce

REFERENCE BOOKS/ ONLINE RESOURCES

1. Machine Design – Sadhu Singh, Khanna Book Publishing Co., Delhi (ISBN: 978-9382609-575)
2. Machine Design Data Book – Sadhu Singh, Revised Edition, Khanna Book Publishing Co., Delhi (ISBN: 978-9382609-513)
3. Introduction to Machine Design – V.B.Bhandari, Tata Mc- Graw Hill, New Delhi.
4. Mechanical Engineering Design – Joseph Edward Shigley, Tata Mc- Graw Hill, New Delhi.
5. Machine design – Pandya & Shah, Dhanpat Rai & Son, New Delhi.
6. Machine design – R.K.Jain, Khanna Publication, New Delhi.
7. Design Data Book – PSG Coimbtore, PSG Coimbtore.
8. Hand Book of Properties of Engineering Materials & Design Data for Machine Elements – Abdulla Shariff, Dhanpat Rai & Sons, New Delhi.

SUGGESTED DISTRIBUTION OF MARKS

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

5.4	MINOR PROJECT	L	T	P	C
Practical		0	0	8	4

RATIONALE

Minor projects for mechanical engineering diploma students are essential because it provides them advantage like apply theoretical knowledge to real-world problems, develop critical skills like problem-solving and teamwork, provide hands-on experience with tools and technologies, encourage innovation and creativity, prepare students for their careers by demonstrating initiative and independence, Familiarize students with industry standards.

LEARNING OUTCOMES

After undergoing this subject, the student will be able to:

- Use effectively oral, written and visual communication
- Demonstrate skill and knowledge of current technological tools and techniques specific to the professional field of study.
- Identify, analyse and solve problems creatively through sustained critical investigation.
- Develop leadership abilities.
- Apply fundamental and disciplinary concepts and methods in ways appropriate to their areas of study.

Minor projects are crucial for mechanical engineering diploma students for several reasons:

1. **Application of Knowledge**: They allow students to apply theoretical concepts learned in class to practical, real-world problems, reinforcing their understanding.
2. **Skill Development**: Projects help in developing essential skills such as problem-solving, critical thinking, teamwork, and project management, which are highly valued in the engineering industry.
3. **Hands-On Experience**: Students gain hands-on experience with tools, materials, and technologies used in mechanical engineering, which is invaluable for their future careers.
4. **Innovation and Creativity**: Working on projects encourages students to think creatively and come up with innovative solutions to engineering challenges.
5. **Career Preparation**: Completing projects demonstrates a student's ability to take initiative, work independently, and successfully complete tasks, making them more attractive to potential employers.
6. **Industry Standards**: Projects familiarize students with industry standards and practices, preparing them for professional work environments.
7. **Networking**: Collaborating on projects provides opportunities to build networks with peers, faculty, and industry professionals, which can be beneficial for future career prospects.

Note: The teachers may guide /help students to identify their minor project work and check out their plan of action well in advance.

Suggested list of minor projects-

Following are some project ideas for mechanical engineering diploma students:

1. **Solar-Powered Water Pump**: Design and build a water pump that operates using solar energy. This project can help in understanding renewable energy applications and fluid mechanics.
2. **Automatic Pneumatic Bumper System**: Create a system that deploys a bumper automatically to prevent vehicle damage during collisions. This involves knowledge of pneumatics and safety systems.
3. **Fabrication of Seed Sowing Machine**: Develop a machine that can sow seeds at specific intervals and depths. This project combines agricultural engineering with mechanical design.
4. **Electricity Generation from Speed Breakers**: Design a mechanism to generate electricity when vehicles pass over speed breakers. This project explores energy conversion and mechanical design.
5. **Hydraulic Scissor Lift**: Build a scissor lift powered by hydraulics. This project helps in understanding hydraulic systems and mechanical linkages.
6. **Solar-Powered Air Conditioning System**: Develop an air conditioning system that runs on solar power. This project involves thermodynamics and renewable energy.
7. **Automatic Side Stand Retrieving System for Two-Wheelers**: Create a system that automatically retracts the side stand of a motorcycle when the vehicle starts moving. This project focuses on safety mechanisms and automation.
8. **Fabrication of a Mini Wind Turbine**: Design and construct a small wind turbine to generate electricity. This project involves aerodynamics and renewable energy.
9. **Design and Fabrication of a Go-Kart**: Build a small, lightweight vehicle for recreational purposes. This project covers vehicle dynamics, design, and fabrication.
10. **Water Purification System Using Solar Energy**: Develop a system that purifies water using solar energy. This project combines environmental engineering with mechanical design.

These projects not only provide hands-on experience but also help in understanding various
mechanical engineering concepts.

As a minor project activity each student is supposed to study the operations at site and prepare a detail project report of the observations/processes/activities by him/her. The students should be guided by the respective subject teachers. Each teacher may guide a group of 4 to 5 students.

The teachers along with field supervisors/engineers will conduct performance assessment of students.

Criteria for assessment will be as follows:

S.NO.	**CRITERIA**		**MARKS**
1.	Attendance and Punctuality		10
2.	State of the Art through-	Synopsis	25
		PPT	25
		Total	60

5.5 PRACTICUM	ADVANCED MANUFACTURING PROCESSES	L	T	P	C
		3	-	3	4

RATIONALE

In today's competitive industrial environment, the demand for high precision, productivity, quality, and cost-effectiveness in manufacturing has led to the development and adoption of advanced manufacturing processes. Traditional machining methods, though still vital, are often inadequate for processing modern engineering materials or for meeting the desired specifications. Hence, knowledge of advanced manufacturing processes has become essential for diploma engineering students.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Explain the geometry, materials, performance, and maintenance of cutting tools, and analyze the effects of machining parameters.

CO2: Describe and compare plastic processing techniques and powder metallurgy processes.

CO3: Analyze the principles, process parameters, capabilities, and applications of modern, non-traditional, and hybrid machining processes**.**

CO4: Interpret CNC machine configurations and develop basic CNC part programs using G-codes and M-codes.

CO5: Explain the concepts of automation, PLCs, and industrial robotics, and evaluate their applications.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	1	2	NA	NA	NA	*	*
CO2	3	2	1	1	2	NA	NA	*	*
CO3	3	3	2	2	NA	NA	NA	*	*
CO4	3	2	3	2	NA	1	NA	*	*
CO5	3	2	2	1	2	2	1	*	*

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional**.**

DETAILED CONTENT

UNIT-I: Cutting Tools - Various types of single point cutting tools and their uses, Single point cutting tool geometry, tool signature and its effect, Heat produced during cutting and its effect, Cutting speed, feed and depth of cut and their effect , multipoint cutting tools, reamer, drill, milling cutter, throw-away inserts, chip breaker, tool and cutter maintenance, regrinding and lapping of tools.

Cutting Tool Materials - Properties of cutting tool material, Study of various cutting tool materials viz. High-speed steel, tungsten carbide, cobalt steel cemented carbides, stellite, ceramics and diamond.

UNIT-II: Plastic Processing: Processing of plastics; Moulding processes: Injection moulding, Compression moulding, Transfer moulding; Extruding; Casting; Calendaring; Fabrication methods-Sheet forming, Blow moulding, Laminating plastics (sheets, rods & tubes), Reinforcing; Applications of Plastics.
Powder Metallurgy: Introduction, Powder Fabrication: Mechanical & Chemical fabrication, Powder Characterization: Particle size measurement, BET surface area, Interparticle friction, Powder packing, mixing and blending, Shaping and Compaction, Slurry techniques and Sintering.

Unit-III: Modern Machining Processes: Introduction – comparison with traditional machining; Ultrasonic Machining: principle, Description of equipment, applications; Electric Discharge Machining: Principle, Description of equipment, Dielectric fluid, tools (electrodes), Process parameters, Output characteristics, applications; Wire cut EDM: Principle, Description of equipment, Controlling parameters; applications; Abrasive Jet Machining: principle, description of equipment, application; Laser Beam Machining: principle, description of equipment, application; Electro Chemical Machining: description of equipment, application.
Hybrid Machining Processes: Concept; Classification of Hybrid Machining Processes; Major Elements of Hybrid Machining Technology; Benefits of Hybrid Machining Technology.

Unit-IV: CNC Machining and Operations: Vertical and horizontal machining center: Constructional features, Axis identification, Electronic control system. Automatic tool changer and tool magazine. CNC programming: Preparatory functions (G code), miscellaneous functions (M code), Part programming including subroutines and canned cycles. Principles of computer aided part programming.

UNIT-V: Automation and Robotics: Introduction and Need; (A) Single spindle automates, transfer lines. (B) Elements of control system, Limit switches, Proximity switches, Block diagram for feedback and servo control system, Introduction to PLC, Block diagram of PLC.
Robotics: Definition, Classification of Robots - Geometric classification and Control classification, Laws of Robotics, Robot Components, Coordinate Systems, Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Limitation of usage of robots in processing operation.

LIST OF PRACTICALS:

1. Study the constructional details of EDM Machine.
2. Study the constructional details of CNC lathe.
3. Study the constructional details of CNC milling machine.
4. Develop a part programme for lathe operations and make a job on CNC lathe and CNC turning centre.
5. Develop a part programme for milling operations and make a job on CNC milling.
6. Prepare a specimen of composite material with two or more materials.
7. Observe the microstructure of composite material specimen.
8. Find the mechanical strength of composite material specimen.

INSTRUCTIONAL STRATEGY

1. Lay greater emphasis on practical aspects of maintenance.
2. Make use of transparencies, video films and CD's.
3. Expose the students to real life situation.
4. Promote continued learning through properly planned assignments.
5. Demonstrate sample of all types of gear and bearings.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Model/prototype making

Reference Books:

1. Production Technology – HMT, Banglore, Tata Mc-Graw Hill
2. CNC machines – Pabla B. S. & M. Adithan, New Age international limited.
3. Non conventional Machining – P. K. Mistra, Narvasa Publishining House
4. Manufacturing Processes – Begman & Amsted, John Willey and Sons.
5. Advanced manufacturing technology – David L. Goetsch 6. Exploring Advanced Manufacturing Technologies – Stephen F. Krar & Arthur Gil, Industrial Press

Websites for Reference:

http://swayam.gov.in

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	06	12
2	06	12
3	10	12
4	10	12
5	10	12
Total	**42**	**60**

5.6.1	COMPUTER AIDED DESIGN AND MANUFACTURING (Open Elective-III)	L	T	P	C
QUALIFYING		2	-	-	2

RATIONALE

Manufacturing of this century belongs to computerized equipment & machine tools to manufacture a variety of components with high quality, high precision & low cost at a faster rate. Commuter Aided Designing, Computer Aided Manufacturing, & Flexible Manufacturing Systems-all are the part of Computer Integrated Manufacturing which help to achieve the desired goals in manufacturing. After studying the subject, the students will be able to know about these integrated techniques which help a manufacturer to achieve his goal with in stipulated time.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Explain the fundamentals of CAD, CAM, CNC, product cycle, CNC programming (G-codes, M-codes, APT) and rapid prototyping technologies.
CO2: Create and modify 2D and 3D surface and solid models using parametric CAD tools, solid primitives, Boolean operations, transformations, and dimensioning techniques.
CO3: Analyze the concepts, components, flexibility types, advantages, and limitations of Flexible Manufacturing Systems (FMS) for modern manufacturing environments.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	1	NA	NA	NA	NA	1	*	*
CO2	2	2	3	3	NA	1	1	*	*
CO3	2	2	1	NA	3	1	2	*	*

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional**.**

DETAILED CONTENTS

Unit I: Introduction

Introduction to CAD,CAM & CIM, Advantages of CAD&CAM,Product Cycle, Reasons for implementation of CAD & CAM,Steps involved in CAM operation, Intoduction of CNC , CNC programming (G-codes, M-codes,APT programming).

Rapid Prototyping : 3D printing, Fused deposition modeling, Laminated object manufacturing, Selective laser Sintering , Stereo lithography , Ball 3 to 2 particle manufacturing

Unit II: Surface / Solid Modelling Using CAD/CAM:

Introduction to parametric and non-parametric surfaces, Creation of simple surfaces using revolved surface, ruled surface and 3D surfaces commands, Designing Software used in creation of solid models, Concept of solid models, Solid Primitives- Box, cylinder, Cone, Sphere, Wedge and torus, Construction of solid using Region, Extrude and Revolved feature, Creation of Composite solid using Boolean function e.g. Union, Subtraction and Intersection. Sectioning of Solids and modification of solid Edges and faces using solid editing commands. Shell, Separate commands. Performing 3D operations like 3D array, mirror and rotate, Creation of fillets and chamfers, Dimensioning of solids, 2D and 3D transformation: Translation, Scaling, rotation, mirror, zooming, panning and clipping.

Unit III : Flexible Manufacturing System

Introduction to FMS, Principles of flexibility, changes in manufacturing system - external changes and internal changes job flexibility, machine flexibility, Features of FMS – production equipment, support system, material handling system, computer control system, Advantages & limitations of FMS.

REFERENCE BOOKS/ ONLINE RESOURCES

1. CAD/CAM by Mikell Groover and Zimmers; Prentice Hall of India Pvt. Ltd., Delhi.
2. Computer Aided Manufacturing by Rao, Kundra and Tiwari; Tata McGraw Hill, NewDelhi.
3. Introduction to Robotics by John J. Craig; Pearson Education Asia, Singapore.
4. Industrial Robot by Groover; Prentice Hall of India Pvt. Ltd., Delhi.
5. Robotics by Yorem Korem; McGraw Hill International. Book Co., New Delhi.
6. CAD/CAM – Theory and Practice by Zeid; Tata McGraw Hill Publishers, New Delhi.
7. CAD/CAM/CIM by S. Radha Krishan.
8. CNC Machines by Dr. B.S. Pabla – New Age Publications.
9. e-books/e-tools/relevant software to be used as recommended by AICTE/BTE/NITTTR, Chandigarh.
10. http://swayam.gov.in

5.6.2	Reverse Engineering (Open Elective- III)	L	T	P	C
QUALIFYING		2	-	-	2

RATIONALE: To meet out Globalization, technological advances and to sustain, we have to explore the knowledge about machine tools covering the various operations and Maintenance skill sets required for the development of a nation and its people.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Explain the principles, processes, phases, and tools of reverse engineering including dimensional measurement, surface/solid model reconstruction, and material characterization.

CO2: Analyze material characteristics, alloy structures, mechanical properties, and failure mechanisms to assess part durability and life limitations.

CO3: Apply reverse engineering techniques to solve industrial problems in automotive and aerospace sectors.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	1	NA	2	NA	NA	1	*	*
CO2	2	3	NA	2	2	NA	1	*	*
CO3	2	2	3	1	3	2	2	*	*

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional**.**

DETAILED CONTENTS

Unit I INTRODUCTION

Definition–Uses–the Generic Process–Phases–Computer Aided Reverse Engineering-Surface and Solid Model Reconstruction–Dimensional Measurement Prototyping. Material Specification, Composition Determination, Microstructure Analysis, Manufacturing Process Verification.

UNIT II: MATERIAL CHARACTERISTICS,PART DURABILITY AND LIFE LIMITATION

Alloy Structure Equivalency–Phase Formation and Identification–Mechanical Strength–Hardness–Part Failure Analysis–Fatigue–Creep and Stress Rupture Environmentally Induced Failure

Unit III: INDUSTRIAL APPLICATIONS

Reverse Engineering in the Automotive Industry; Aerospace Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality:Patent–Copyrights–Trade Secret–Third-Party Materials.

Text and Reference Books:

1. Reverse Engineering: An Industrial Perspective by V. Raja andK. Fernandes, Springer Verlag.Wego
2. Kevin Otto , "Product Design : Techniques in Reverse Engineering and New Product Development", ISBN-13: 9788177588217, Dorling Kindersley
3. Robert Messler, "Reverse Engineering: Mechanisms, Structures, Systems & Materials", McGraw Hill Education, ISBN: 9780071825160
4. Reverse Engineering by K. A. Ingle, McGraw-Hill. 5. Raja, Vinesh, Fernandes, Kiran J. , "Reverse Engineering An Industrial Perspective" ISBN 978-1-84628-856-2, Springe

5.6.3	Artificial Intelligence	L	T	P	C
QUALIFYING	(Open Elective-III)	2	-	-	2

RATIONALE: Introducing AI at the diploma level enables students to understand the fundamentals of intelligent systems, machine learning, decision-making algorithms, and data-driven technologies. The subject provides insights into how machines can simulate human intelligence to perform tasks like speech recognition, vision processing, problem-solving, and autonomous control.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Explain the definition, goals, history, and applications of Artificial Intelligence in solving real-world problems.
CO2: Analyze intelligent agents, environment properties, and apply brute-force, heuristic, and local search algorithms to problem-solving tasks.
CO3: Apply fuzzy logic systems and neural network models, including perceptron and backpropagation algorithms, to develop basic intelligent systems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	1	NA	NA	2	NA	1	*	*
CO2	2	3	1	2	NA	NA	1	*	*
CO3	2	2	3	3	NA	1	2	*	*

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional**.**

DETAILED CONTENTS

Unit 1 – Introduction to Artificial Intelligence
- Artificial Intelligence (AI) definition
- Goals of AI
- History of AI
- Applications of AI

Unit 2-Agents ,Environments & Algorithms Terminology
- Agent Terminology, Types of Agents – Simple Reflex Agents, Model Based Reflex Agents, Goal Based Agents
- Nature of Environments, Properties of Environments
- Brute Force Search Strategies – Breadth First Search, Depth First Search.
- Heuristic Search Strategies, Local Search Algorithms.

Unit 3 – Fuzzy Logic Systems & Neural Networks

Introduction to Fuzzy Logic and Fuzzy systems,

- Membership functions,
- Fuzzification/Defuzzification
- Basic structure of Neural Networks
- Perceptron
- Back-propagation

Text and Reference Books:

1. Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases Denis Rothman Packt Publishing ISBN – 978-1788990547
2. Artificial Intelligence by E. Balagurusamy
3. Artificial Intelligence: A Simplified Approach by Sinha, P.Royston
4. Introduction to Artificial Intelligence by Dan W. Patterson

5.6.4	Electric Vehicle (Tata Tech) (Open Elective-III)	L	T	P	C
QUALIFYING			-	4	2

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 Electric vehicle** • Overview electric Vehicle Technologies • India policy regarding electric vehicles • Electric vehicle advantages and limitations • Electric vehicle effects on the economy and environment
3	**Electric Vehicle Architecture** • Types of Electric Vehicles (Overview of electric vehicle technologies like BEV, HEV, PHEV and FCEV.) • Basic architecture of electric vehicle drivetrains. • Overview of various system and subsystem of Electrical Vehicle and their functions.
4	**Electric Vehicle Motors & Controller** • Function and operation of electric vehicle motors. • Classification of electrical vehicle motors • Types of loads acing on vehicle. • Motor specifications • Motor calculation for electric vehicle • Motor selection • Motor controllers and its function, Motor controller selection • Function and operation of a DC-to-DC converter • Basic Wiring harness for EV • Overview of regenerative braking, function & working

5	**Energy Storage System & Charging System** • Electric Vehicle Energy Storage & Charging System • Overview of battery pack. (Cell selection, battery connection, battery pack construction) • Overview of battery pack sizing • Thermal management • Charging system types • Fundamentals of constant voltage and constant current charging. • Standards for electric car charging • Connector standards for charging electric vehicles. • Calculation for battery recharging and discharge • Pros and Limitations of batteries for electric vehicles • Regenerative Braking Systems
6	**Electric Vehicle Battery Management System and Basic Regulatory Requirements** • Introduction to Battery Management System, function of a battery management system (BMS) • Block diagram of the battery management system. • Thermal control system, cell load distribution, and State of Charge (SOC) and State of Health (SOH) analysis • Difference between high voltage and low voltage system • Maintenance & repairing of electric vehicle system. • Basic Regulatory Requirements.
7	**Electric Vehicle Circuit Protection and Safety** • Introduction to electrical wiring harness. • Importance of colour coding and labelling on wiring harness • Materials used for wiring harness and its selection criteria. • Design consideration in wiring harness. • Understand wire gauge and power rating capacity. • Types of Electric vehicle Fuses. • Electric Vehicle Relays. • Selection of relay type. • Positioning Fuses and relays in Electric vehicle circuit.
	Repair and Maintenance of EV • Preventive Maintenance of EV • Standard procedure to work on high voltage systems • Diagnosis and fault finding • Schedule Servicing of EV • Predictive Maintenance of EV
8	**Electric Vehicle testing and technology advancement in electric vehicle** • Vehicle Performance testing for acceleration, top speed, range, braking, hill climbing, vehicle structure, road handling, weather resistance, etc. • Vehicle Durability testing or life expectancy of parts, materials, and components.

	• Safety: battery safety, charging system safety, and occupant safety. • Emission standard and its testing • Vehicle Noise standards and its testing • Advancements in electrical vehicle: - Autonomous Driving - Battery Technology to improved range, greater efficiency, and faster charging, life span of batteries. - Charging Infrastructure (public charging networks, on-the-go charge, development in vehicle overnight charging technology, wireless Charging).

COURSE PRACTICALS

1. List the industrial safety procedures.
2. Identify the different parts, components & assemblies of electric vehicles, and explain its function.
3. Perform safe storage, handle, and dispose of high voltage battery systems
4. Replace defective Battery Module of 48V Module Systems.
5. Arrange batteries (lead acid) in series configuration to achieve specific requirement.
6. Arrange batteries (lead acid) in parallel configuration to achieve specific requirement.
7. Arrange batteries (lead acid) in series and parallel configuration to achieve specific requirement.
8. Sketch architecture of EV and list the important components, its function, and specifications of each component. (Motor, Motor Controller, Battery Pack, Battery Management System, charging system, etc.)
9. Remove and install rotor from stator.
10. Assume a simple Electric vehicle and calculate power requirement for selecting EV Motor (make necessary assumptions).
11. Assume a simple Electrical vehicle and calculate Battery capacity requirement for selected EV Motor (make necessary assumptions).
12. List out various safety systems, sensors & controllers used in electric vehicles.
13. Assembly & disassembly of electric vehicle components.
14. Compare specifications of any two Electric vehicles (Motor Type, Peak Power, Torque, Battery Capacity, Range etc.)

15. Compare Electric Vehicle Architecture of two different vehicles.
16. Disassemble and Assemble EV Motor.
17. Draw the sketch of various components of EV Motor and list the function of each component.
18. Disassemble and Assemble EV Motor Controller.
19. Disassemble and Assemble DC – DC controller.
20. List of requirements for charging inputs for different types of chargers.
21. Connecting battery to a charger for charging, inspecting a battery after charging. Prepare a table and note the reading.
22. Study the EV motor assembly for issues like noise, shudder, overheating, etc. with performance.
23. Draw a simple wiring diagram of electric vehicle.
24. Perform EV repair and maintenance.
25. Perform basic preventive maintenance.
26. Prepare a list for regulatory requirements.
27. Prepare a list for advancements in electrical vehicle.
28. Case studies
29. Mini project

5.6.5	Fundamentals of Innovation & Design Thinking (Tata Tech) (Open Elective-III)	L	T	P	C
QUALIFYING		-	-	4	2

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 Innovation & Design Thinking** • Introduction of Innovation, • Necessity of innovation, Case studies of innovation • Different Types of Innovation, Closed and Open Innovation, Innovation Linear and Non-Linear, Stages from innovation to industry • Introduction to Design thinking • Importance of design thinking, Principle & mindset of design thinking • Impact & value proposition of innovation • Risk vs Reward innovation concept study • Steps to convert Innovation to start-up • Scoping of design thinking • Key principle & mindset
3	**Details of Design Thinking tools & Idea Generation** • Introduction to brainstorming & its Importance • Brainstorming tools & techniques • Generation of ideas & its generation methods • Introduction of phases of design thinking-Explore, Empathies, Experiment, Engage, Evolve • Design Thinking foundation built-up • Understanding & Uncovering Deep user human needs (SPICE) • Use of SCOPES tool • Use of STEEP Trend analysis • Use of POEMS tool, Ideation using scamper, Analogous inspiration, Selection of idea, Concept development, Prototyping • Concept of Storytelling & co-creation methods, Strategic requirements • Concept of change Management, Importance of continual Improvement • Design thinking case studies

4	**Introduction to 3D modeling & Additive Manufacturing** • Introduction to Design Tools and CAD software, Concept Creation and 3D Modelling, Detail Design & Engineering, Product Drawing Creation, Industrial drawing reading, projection methods, GD&T, Bill of Material • Introduction to Prototyping, use of prototyping in Industry • Additive Manufacturing, Additive Manufacturing-Evolution through Time, Additive Vs Traditional Manufacturing, Applications of Additive Manufacturing in Various Fields, • Steps involved in Additive Manufacturing, Precautions, Do and Don't, 3D Printer specification. • Key Parameters to be considered for 3D printing. • Various types of 3D Printers, 3D printer components, 3D printer parameter. • Working of Additive Manufacturing, Introduction to 3D printer software: • Slicing software to optimize the material consumption and lead time required for production.
5	**Applications, Advantages, Limitation & Advancements of Additive Mfg.** • Applications of Additive manufacturing in Automotive industry, Aerospace industry, Artistic Industry, Medical Industry, Architectural Industry, Functional Prototype, Tooling, Advantages of Additive Manufacturing, Limitations of Additive manufacturing. • Types of 3D printing materials & 3D printing Technologies, Additive manufacturing Materials: Thermoplastics: Acrylonitrile Butadiene Styrene (ABS); Polyvinyl Alcohol (PVA); Polylactide (PLA); Nylon, Polycarbonate (PC), Ceramics, Glass, Biochemicals; study of other 3D printing materials such as Titanium; Stainless Steel; Aluminum; High performance alloys; cobalt chrome alloys; nickel alloys • Study of various types of 3D printers such as SLS 3D printing, SLM 3D Printing, DLP 3D printing • Case Studies on Additive manufacturing, Advanced Methodologies & Technologies, Latest Trends in Additive Manufacturing • Reverse Engineering • Introducing to Laser cutting and engraving, various components of Laser cutting machine, various steps involved in laser cutting, materials used for laser cutting • Applications of laser cutting, benefits of laser cutting, limitations of laser cutting, case studies
6	**Start-up & Business plan** • Introduction to management, Leadership Decision making & Communication, Introduction to cost, Human Resource Management, Industrial Legislation, Production Management, Marketing management, Entrepreneur and Entrepreneurship, Forms of Business, Forms of organisation, Micro and Small Enterprises, Support to

	Entrepreneurs • Concept of start-up & its necessity, Understanding Business Terminology • Opportunities for Start-up, Market Research, Types of industry & trending opportunity for new business, Business Plan, Benchmarking, Product Vision, Product Mission, Product Road Map, how to position your services • Business Model, Managing Start Ups, Start-up failure reasons, Start-up project plan, Start-up sales forecast, Start-up operations, Start-up Breakeven Analysis, Tips and Tricks. • Intellectual Property Rights • Continuous Improvement • Case studies • Project Work

COURSE PRACTICALS

Conduct practicals as per lesson plan.

1. Group activity on understanding Disruptive Technologies,
2. Group activity on problems solving and listing of innovative solutions
3. Group activity on Brainstorming, ideation.
4. Group activity for Idea selection based on impact related to commercial value, social, environmental, safety etc.
5. Prepare storyboard for visually describes series of activities of the solution idea.
6. Conversion of concept Idea into prototyping with the help of tools, Software & Machining equipments as per requirements.
7. Field visit and interaction with users to understand their pain areas.
8. Identify stakeholders pertaining given innovations.
9. Group activity on Social Innovation.
10. Group activity on innovations pertaining to your area of interest.
11. Group activity on innovative solutions related pertaining to your area of interest.
12. Group activity on innovative solutions for environment friendly product or service.
13. Finding the better meet of the user's needs using co-creation tool.
14. Group activity on prototyping of innovative solutions.
15. Defining the strategic requirement to utilize available capabilities, assets & resource.
16. Prepare Business Plan
17. List out the industrial safety standards for Additive manufacturing.
18. Selection of Additive manufacturing process with the help of case studies
19. Create the 3D model using computer aided design software.
20. Convert the design model into STL, OBJ, AMF, and 3MF for 3D Printer compatible input format
21. Preprocessing and slicing of model

22. Simulate the time & design for manufacturing, reduce the manufacturing time, calculate the consumption of material using slicing software.
23. Operate 3D printer to create prototype model of any cad model.
24. Post Processing of 3D printed part.
25. Use laser cutting machine to modify product according to design requirement.
26. Reverse Engineering of any given product.
27. Case studies
28. Mini Project

5.6.6	Automobile Engineering (Open Elective-III)	L	T	P	C
QUALIFYING		2	-		2

RATIONALE: These days, automobile has become a necessity instead of luxury. The diploma holders in this course are required to supervise production and repair and maintenance of vehicles. For this purpose, knowledge and skills are required to be imparted to them regarding automobile industry as a whole. This subject aims at developing required knowledge and skills in this area.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Explain the basic structure of an automobile, chassis layout, engine technologies, fuel governing systems, emission control methods, and Bharat emission norms.
CO2: Describe and analyze the construction, working, and applications of automobile transmission systems including clutch, gear box, torque converter, axles, wheels, and tyres.
CO3: Explain the principles, construction, and working of steering, suspension, and braking systems including power steering, suspension types, and anti-lock braking systems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	1	NA	NA	3	NA	1	*	*
CO2	3	2	1	1	NA	NA	1	*	*
CO3	3	2	1	2	2	NA	1	*	*

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional**.**

COURSE CONTENT

UNIT-I: Introduction to basic structure of an automobile:

Automobile and its development, Classification of automobiles, Layout of chassis, Types of drives-front wheel, rear wheel, four wheel, Introduction to electric and hybrid vehicles. Governing of fuel- carburetor, electronic control module (ECM i.e, 8 bit,16 bit and 32 bit computers),Concept of double overhead cam, single overhead cam, Twin cam 16 valve technology in 4 cylinder engine.Types and use of catalytic converters, selective catalytic reduction methods for emission control, emission norm standards i.e. Bharat norms.

Unit-II: Transmission System:

Clutch - Function, Constructional details of single plate and multi plate friction clutches, Centrifugal and semi centrifugal clutch, Cone clutch, Hydraulic clutch Gear Box - Function, Working of sliding mesh, constant mesh and synchromesh gear box, Torque

converter and overdrive, Introduction to Automated Manual Transmission, Automatic transmission and Continuously Variable Transmission. Propeller shaft and rear axle - Function, Universal joint, Differential, axles and axle drives. Wheels and Tyres - Types of wheels, Toe in, toe out, camber, caster, kingpin inclination, Wheel balancing and alignment, Factors affecting tyre life.

Unit-III: Steering ,Suspension and Braking System:

Steering system, Ackerman and Davis steering gears, Types of steering gears ,Power steering-Hydraulic and Electrical, Function and types of Coil spring, leaf spring, Air suspension, Shock absorber – Telescopic type.

Constructional details and working of mechanical, hydraulic, air and vacuum brake, Relative merits and demerits. Details of master cylinder, wheel cylinder, Concept of brake drum, brake lining/pad and Brake adjustment, Introduction to Anti-lock Brake System and its working.

Reference Books:

1. Automobile Engineering Vol I, II, Kirpal Singh, Standard Publishers Distributors, Delhi. 2012.
2. Automobile Mechanics, A.K. Babu, S.C. Sharma, Khanna Publications, New Delhi
3. Automotive Mechanics: Principles and Practices, Joseph Heitner, East West Press
4. Automotive Mechanics, S. Srinivasan, 2nd Edition, Tata McGraw Hill
5. Automobile Engineering Vol I and Vol II, K. M. Gupta, Umesh Publications.
6. Automotive Engineering, Jain and Asthana, Tata McGraw Hill.

Website for Reference

http://swayam.gov.in

5.7	Indian Constitution (Q)	L	T	P	C
Audit Course		2	0	0	0

COURSE OBJECTIVES

This Course on Constitutional Law is designed to give to the students a basic knowledge and understanding about Fundamental Rights and Directive Principles of State Policy which constitute a very important part of our Constitution that is committed to individual liberty and freedom.

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

1. Explain the history, structure, and interpretation of the Indian Constitution, including the Preamble, Fundamental Rights, and Duties.

2. Describe the structure and functions of the Union Government, including the roles and powers of the President, Prime Minister, and Council of Ministers.

3. Analyze the composition, powers, and functions of the Indian Legislature (Lok Sabha and Rajya Sabha) and Judiciary (Supreme Court), including the appointment of judges.

4. Illustrate the roles, powers, and structure of the State Government, including the Governor, Chief Minister, and State Secretariat.

5. Assess the functions and structure of local administration units (District Administration, Municipal Corporation, Zila Panchayat) and the Election Commission of India.

Course Content

Unit 1 – The Constitution – Introduction
- The History of the Making of the Indian Constitution
- Preamble and the Basic Structure, and its interpretation
- Fundamental Rights and Duties and their interpretation

Unit 2 – Union Government
- Structure of the Indian Union Government
- President – Election, Role and Power
- Prime Minister and Council of Ministers

Unit 3- Indian Legislature & Judiciary
- Composition of Lok Sabha and Rajya Sabha
- Powers & Functions of Lok Sabha and Rajya Sabha
- Structure of Supreme Court including Appointment of Judges
- Powers & Functions of Supreme Court

Unit 4 – State Government
- Governor – Role and Power
- Chief Minister and Council of Ministers
- State Secretariat

Unit 5 – Local Administration

- District Administration
- Municipal Corporation
- Zila Panchayat

Unit 6 – Election Commission

- Structure of Election Commission of India
- Role and Function of Election Commission

REFERENCE BOOKS/ONLINE RESOURCES:

1. Ethics and Politics of the Indian Constitution Rajeev Bhargava Oxford University Press, New Delhi, 2008
2. The Constitution of India B.L. Fadia Sahitya Bhawan; New edition (2017)
3. Introduction to the Constitution of India DD Basu Lexis Nexis; Twenty-Third 2018 edition
4. Our Constitution Subhash Chand Kashyap NBT New Delhi.

Suggested Software/Learning Websites:

a. https://www.constitution.org/cons/india/const.html
b. http://www.legislative.gov.in/constitution-of-india
c. https://www.sci.gov.in/constitution
d. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/
e. https://ncert.nic.in/textbook.php

6.1	Project	L	T	P	C
		-	-	24	12

RATIONALE

Major projects for mechanical engineering diploma students are essential because it provides them advantage like apply theoretical knowledge to real-world problems, develop critical skills like problem-solving and teamwork, provide hands-on experience with tools and technologies, encourage innovation and creativity, prepare students for their careers by demonstrating initiative and independence, Familiarize students with industry standards.

LEARNING OUTCOMES

After undergoing this subject, the student will be able to:

- Use effectively oral, written and visual communication
- Demonstrate skill and knowledge of current technological tools and techniques specific to the professional field of study.
- Identify, analyse and solve problems creatively through sustained critical investigation.
- Develop leadership abilities.
- Apply fundamental and disciplinary concepts and methods in ways appropriate to their areas of study.

Major projects are crucial for mechanical engineering diploma students for several reasons:

1. **Application of Knowledge**: They allow students to apply theoretical concepts learned in class to practical, real-world problems, reinforcing their understanding.
2. **Skill Development**: Projects help in developing essential skills such as problem-solving, critical thinking, teamwork, and project management, which are highly valued in the engineering industry.
3. **Hands-On Experience**: Students gain hands-on experience with tools, materials, and technologies used in mechanical engineering, which is invaluable for their future careers.
4. **Innovation and Creativity**: Working on projects encourages students to think creatively and come up with innovative solutions to engineering challenges.
5. **Career Preparation**: Completing projects demonstrates a student's ability to take initiative, work independently, and successfully complete tasks, making them more attractive to potential employers.
6. **Industry Standards**: Projects familiarize students with industry standards and practices, preparing them for professional work environments.
7. **Networking**: Collaborating on projects provides opportunities to build networks with peers, faculty, and industry professionals, which can be beneficial for future career prospects.

Note: The Project selected in the 5th semester will be continued in 6th Semester.

As a major project activity each student is supposed to study the operations at site and prepare a detail project report of the observations/processes/activities by him/her. The students should be guided by the respective subject teachers. Each teacher may guide a group of 4 to 5 students.

The teachers along with field supervisors/engineers will conduct performance assessment of students. Criteria for assessment will be as follows:

S.NO.	CRITERIA	MARKS
1.	Attendance and Punctuality	40
2.	Project Progress Presentation-I	50
3.	Project Progress Presentation-II	50
4.	Project Model & final Presentation	90
5.	Report Writing	60
Total		240

6.2	Entrepreneurship and Start-ups **	L	T	P	C
Theory		2	-	-	2

RATIONALE

The subject of Entrepreneurship and Start-Ups is essential for diploma students as it fosters an entrepreneurial mindset and equips them with the skills needed to identify and capitalize on business opportunities. This subject encourages creativity, innovation, and critical thinking, which are crucial for developing new business ideas and solving real-world problems. By studying entrepreneurship, students learn how to create business plans, understand market dynamics, and manage resources effectively. This knowledge not only prepares them to start their own ventures but also makes them valuable assets in any organization by promoting intrapreneurship—innovation within a company. Overall, this subject empowers students to take calculated risks, adapt to changing environments, and contribute to economic growth and job creation.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Study the fundamentals of entrepreneurship and start-up ecosystem
CO2: Identify and evaluate business ideas and prepare business plans
CO3: Apply marketing and strategic tools for start-up development
CO4: Familiarise management principles and organizational practices
CO5: Analyze financing options and intellectual property protection
CO6: Study succession planning, dissolution, and exit strategies

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	2	1	NA	NA	2	1	2	*	*
CO2	2	3	2	NA	2	3	2	*	*
CO3	1	2	2	NA	2	3	1	*	*
CO4	1	NA	NA	NA	1	3	1	*	*
CO5	1	2	1	NA	2	2	2	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guide-lines, formulated PSO is optional.

DETAILED CONTENT

Unit I : Introduction to Entrepreneurship and Start – Ups: Definitions, Classification of Entrepreneur, Traits of an Entrepreneur, Intrapreneurship, Motivation, Types of Business Structures- On the Basis of size and on the basis of ownership, Similarities/differences between entrepreneurs and managers

Unit II : Business Ideas and their implementation: Discovering ideas and visualizing the business, Activity map, Business Plan (Case Study)

Unit III: Ideas to Start-up: Marketing and Accounting- Definition and Importance, Market Analysis – STP (Segmentation, Targeting, Positioning), Competition evaluation and Strategy Development – Vision, Mission, Goal, Objectives, Risk analysis- SWOT Analysis.

Unit IV: Management: Definition Concept and Functions of Management, Company's Organization Structure- Concept and Classification, Recruitment and Selection- Definition, Training and Development- Importance.

Unit V: Financing and Protection of Ideas: Financing methods available for Entrepreneurship/ Startups in India (Government Scheme, Banking, NBFCs, SHG and Micro Financing), Intellectual Property Rights- Overview of - Copyrights, Trademark, Geographical Indicators, Patenting and Licenses, Communication of Ideas to potential investors – Investor Pitch.

Unit VI: Succession, Dissolution and Harvesting strategy: Ways of succession, Types of Dissolution

INSTRUCTIONAL STRATEGY

To effectively teach Entrepreneurship and Start-Ups to diploma students in mechanical engineering, a variety of instructional strategies can be employed. Interactive lectures can be used to introduce key concepts, supported by visual aids such as diagrams and flowcharts to enhance understanding. Case studies and real-world examples can help students relate theoretical knowledge to practical applications.

MEANS OF ASSEESSMENT

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

REFERENCE BOOKS/ ONLINE RESOURCES

1. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company, Steve Blank and Bob Dorf, K & S Ranch
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries, Penguin UK
3. Demand: Creating What People Love Before They Know They Want It, by Adrian J. Slywotzky with Karl Weber, Headline Book Publishing
4. The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business, by Clayton M. Chris tensen, Harvard business
5. https://www.fundable.com/learn/resources/guides/startup
6. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporatestructure/
7. https://www.finder.com/small-business-finance-tips

8. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	05	10
2	05	10
3	05	10
4	05	10
5	04	10
6	04	10
Total	**28**	**60**

6.3.1	Elective Pathway	L	T	P	C
THEORY	Advanced Engineering Mathematics	3	0	0	3

RATIONALE:

Mathematics is essential for engineering students to understand core engineering subjects. It provides the framework for engineers to solve problems in engineering domains. This course is designed to bridge the gap between diploma mathematics and B.E/B.Tech mathematics in matrix algebra, differential calculus, vector calculus, differential equations, and Laplace transforms.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Compute eigenvalues and eigenvectors of matrices and apply Cayley–Hamilton theorem to solve engineering problems.

CO2: Apply partial differentiation techniques, Jacobians, and optimization methods to functions of several variables.

CO3: Analyze scalar and vector fields using gradient, divergence, and curl in engineering applications.

CO4: Formulate and solve ordinary differential equations of first and second order arising in engineering systems.

CO5: Apply Laplace transform techniques to solve differential equations and analyze dynamic systems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic / Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	1	NA	NA	NA	1	*	*
CO2	3	3	1	NA	NA	NA	1	*	*
CO3	3	3	2	1	NA	NA	1	*	*
CO4	3	3	2	1	NA	NA	1	*	*
CO5	3	3	2	2	NA	NA	1	*	*

- PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulated PSO is optional.

DETAILED CONTENT

Unit I: EIGEN VALUES AND EIGEN VECTORS

Characteristic equation – Eigen-values of 2 × 2 and 3 × 3 real matrices –Eigen-vectors of 2 × 2 real matrices – Properties of eigen-values (excluding proof) –Cayley-Hamilton theorem (excluding proof) – Simple problems.

Unit II FUNCTIONS OF SEVERAL VARIABLES
Partial derivatives of two variable and three variable functions (up to second order)– Homogeneous functions and Euler's theorem (excluding proof) – Jacobian matrix and determinant – Maxima and minima of functions of two variables –Simple problems.

Unit III VECTOR CALCULUS
Scalar field and Vector field – Vector differential operator – Gradient of a scalar field – Directional derivative – Divergence and curl of a vector field (excluding properties) – Solenoidal and irrotational vector fields – Simple problems.

Unit IV DIFFERENTIAL EQUATIONS
Differential equation – Formation – Order and degree – Solution of a differential equation – Equations of first order and first degree – Variable separable method – Leibnitz's Linear equations – Second order equations of the form where and are constants aD and the auxiliary 2 (+ bD + c)y = enx a, b, c n equation am has only real roots) – Complementary function – 2 + bm + c = 0 Particular integral – General solution – Simple problems.

Unit V LAPLACE TRANSFORMS
Definition of Laplace transform – Laplace transforms of standard functions - Linearity and change of scale property (excluding proofs) – First shifting property– Laplace transforms of derivatives – Properties (excluding proofs) – Inverse Laplace transforms – Properties (excluding proofs) – Solving first order ordinary differential equation using Laplace transforms – Simple problems.

Reference Books:
1. John Bird, Higher Engineering Mathematics, Routledge, 9th Edition, 2021.
2. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012.
3. Arumugam, S., Thangapandi Isaac, A., & Somasundaram, A., Differential Equations and Applications, Yes Dee Publishing Pvt. Ltd., 2020.
4. Duraipandian, P., & Kayalal Pachaiyappa, Vector Analysis, S Chand and Company Limited,
2014.
5. Narayanan, S., & Manicavachagom Pillai T.K., Calculus Volume I and II, .Viswanathan Publishers Pvt. Ltd., 2007.

Web Reference
1. https://www.khanacademy.org/math/
2. https://www.mathportal.org/
3. https://openstax.org/subjects/math/
4. https://www.mathhelp.com/
5. https://www.geogebra.org/
6. https://www.desmos.com/
7. https://phet.colorado.edu/

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	08	12
2	08	12
3	08	12
4	08	12
5	10	12
Total	**42**	**60**

6.3.2	Additive Manufacturing	L	T	P	C
THEORY		3	0	0	3

RATIONALE:
This course is mainly designed to have a complete knowledge about Additive Manufacturing technologies which is a main component among the nine pillars of Industrie 4.0. This course is suitable for students opting for any pathway under Diploma in Mechanical Engineering stream. This course enhances the technical skills of students such as newer product design, testing and validation, problem solving, innovation, etc

Course Outcomes (COs)

At the end of the subject, the students will be able to:
CO1: familiarise the fundamentals, evolution, materials, and classification of Additive Manufacturing technologies.
CO2: Apply Design for Additive Manufacturing (DfAM) principles including CAD preparation, slicing, support generation, and reverse engineering.
CO3: Explain the construction, working principles, and process parameters of extrusion and sheet metal based AM processes.
CO4: Analyze photo-polymerization and powder-based AM processes and compare their advantages and limitations.
CO5: Identify and evaluate applications of Additive Manufacturing in various industrial and biomedical sectors.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	1	NA	NA	1	NA	1	*	*
CO2	3	2	3	2	NA	1	1	*	*
CO3	3	2	2	1	NA	NA	1	*	*
CO4	3	2	2	2	NA	NA	1	*	*
CO5	2	1	2	NA	3	1	2	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulated PSO is optional.

DETAILED CONTENT

Unit I Introduction to Additive Manufacturing (AM)

Additive Manufacturing-Overview–Need–History–Classification–working principles (concepts only)-Materials for AM–PLA, ABS, PMMA, ceramics, composites and liquid resins–AM processes-Advantages, Limitations and Challenges–Rapid Prototyping–Rapid Tooling.

Unit II Design for Additive Manufacturing

Basic concept–CAD model preparation-file formats- Part orientation–Support material generation–Model slicing–honeycomb structure- Digitization techniques–Model reconstruction–Slicing software-Reverse Engineering–RE application in AM.

Unit III Extrusion and Sheet metal based Processes

Fused Deposition Modeling (FDM)–construction, working principle,advantages process parameters involved-Laminated Object Manufacturing (LOM) construction,working principle,advantages-gluing and adhesive bonding-Poly Jet construction,working principle,advantages.

Unit IV Photo polymerization and Powder based Processes

Stereo lithography process (SLA)–construction, photo curable materials,working principle, advantages–Selective Laser Sintering (SLS)-construction, working principle, advantages–Electron Beam Melting (EBM)-construction, working principle, advantages–Laser Engineered Net Shaping (LENS)-construction, working principle,advantages.

Unit V Applications of Additive Manufacturing

Applications of Additive manufacturing technologies–new product development after sales and service-automobile, aerospace, consumer products, healthcare industries–customized implants, bio-organs, bio-bones etc

Reference Books:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
5. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRCpress, 2000.
6. TomPage"Design for Additive Manufacturing" LAP Lambert Academic Publishing, 2012

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	08	12
2	08	12
3	08	12
4	08	12
5	10	12
Total	**42**	**60**

6.3.3	Project management	L	T	P	C
THEORY		3	0	0	3

RATIONALE:

Project management is the systematic application of knowledge, skills, tools, and techniques to project activities to meet specific project requirements. It involves planning, organizing, and managing resources to achieve project goals within defined scope, time, and budget constraints. Project management encompasses several key processes and phases, including initiation, planning, execution, monitoring and controlling, and closing. It is essential across various industries to ensure projects are completed successfully, efficiently, and effectively, aligning with organizational objectives and stakeholder expectations. Project managers play a crucial role in leading teams, managing risks, ensuring quality, and communicating with stakeholders to drive project success.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Familiarise with fundamentals of project management, project structures, portfolio management, and causes of project delays.

CO2: Analyze project feasibility studies, project life cycle phases, and project constraints.

CO3: Evaluate projects under certainty and uncertainty using financial, commercial, and social cost–benefit analysis techniques.

CO4: Develop and analyze project networks using PERT and CPM techniques and apply project appraisal and control mechanisms.

CO5: Apply project leadership and team management principles to effectively manage stakeholders and project teams.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	NA	NA	1	2	1	*	*
CO2	2	3	1	NA	2	1	1	*	*
CO3	3	3	1	NA	3	1	1	*	*
CO4	3	3	2	2	1	2	1	*	*
CO5	1	1	NA	NA	2	3	2	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulated PSO is optional.

DETAILED CONTENT

Unit I Project Management – An Overview, Project Portfolio Management System and Structure, Steps in Defining Project and Project Delays

Project – Classification – Importance of Project Management – An Integrated Approach – Project Portfolio Management System – The Need – Choosing the appropriate Project Management Structure: Organizational considerations and project considerations – steps in defining the project – project Rollup – Process
breakdown structure – Responsibility Matrices – External causes of delay and internal constraints.

Unit II Various Stages and Components of Project Feasibility Studies, Phases of a Project, Stages in Project Life Cycle and Project Constraints
Project feasibility studies - Opportunity studies, General opportunity studies, specific opportunity studies, pre-feasibility studies, functional studies or support studies, feasibility study – components of project feasibility studies – Managing Project resources flow – project planning to project completion: Pre-investment phase, Investment Phase and operational phase – Project Life Cycle – Project constraints.

Unit III Project Evaluation under Certainty and Uncertainty, Project Evaluation, Commercial and Social Cost Benefit Analysis
Project Evaluation under certainty - Net Present Value (Problems - Case Study), Benefit Cost Ratio, Internal Rate of Return, Urgency, Payback Period, ARR – Project Evaluation under uncertainty – Methodology for project evaluation – Commercial vs. National Profitability – Social Cost Benefit Analysis, Commercial or National Profitability, social or national profitability.

Unit IV Developing Project Network using PERT and CPM, Project Appraisal and Control Process.
Developing a Project Plan - Developing the Project Network – Constructing a Project Network (Problems) – PERT – CPM – Crashing of Project Network (Problems – Case Study) – Resource Leveling and Resource Allocation – how to avoid cost and time overruns – Steps in Project Appraisal Process – Project Control Process – Control Issues – Project Audits – the Project Audit Process – project closure – team, team member and project manager evaluations.

Unit V Project Managing Versus Leading of Project, Qualities of Project Manager and Managing Project Teams, Team Building Models and Performance Teams and Team Pitfalls.
Managing versus leading a project - managing project stakeholders – social network building (Including management by wandering around) – qualities of an effective project manager – managing project teams – Five Stage Team Development Model – Situational factors affecting team development – project team pitfalls.

Reference Books:
1. Clifford F. Gray And Erik W. Larson, Project Management – The Managerial Process, Tata Mcgraw Hill.
2. Dragan Z. Milosevic, Project Management Toolbox: Tools And Techniques For The Practicing Project Manager,
3. Gopalakrishnan, P/ Ramamoorthy, V E, Textbook Of Project Management, Macmillan India. Ltd.
4. Harold Kerzner, Project Management: A Systems Approach To Planning, Scheduling, And Controlling, Eighth Edition, John Wiley & Sons
5. Jason Charvat, Project Management Methodologies: Selecting, Implementing, And Supporting Methodologies And Processes For Projects, John Wiley & Sons

6. Kevin Forsberg, Ph.D, Hal Mooz, Visualizing Project Management: A Model For Business And Technical Success, Second Edition, Pmp And Howard Cotterman, John Wiley & Sons.

Web Reference

https://youtu.be/pc9nvBsXsuM
NPTEL Courses
https://youtu.be/PqQqTAu_FiM

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	08	12
2	08	12
3	08	12
4	08	12
5	10	12
Total	**42**	**60**

6.3.4	Finance Fundamentals	L	T	P	C
THEORY		3	0	0	3

RATIONALE:
This course gives a deep insight into the finance fundamentals such as money management and the process of acquiring needed funds. It also encompasses the oversight, creation, and study of money, banking, credit, investments, assets, liabilities that make up financial systems and improves overall financial literacy.

Course Outcomes (COs)

At the end of the subject, the students will be able to:
CO1: Study the personal finance concepts, savings instruments, risk–return trade-offs, and financial discipline.
CO2: Analyze various sources of business funding including venture capital, banking, and government schemes.
CO3: Interpret financial terminology and classify financial statements elements accurately.
CO4: Prepare and analyze different budgets using budgetary control techniques.
CO5: Apply marginal costing techniques for managerial decision-making.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	NA	NA	2	1	2	*	*
CO2	2	2	1	NA	2	1	1	*	*
CO3	3	2	NA	NA	1	1	1	*	*
CO4	3	3	1	NA	1	1	1	*	*
CO5	3	3	2	NA	2	1	1	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulated PSO is optional.

DETAILED CONTENT

UNIT I Personal Finance

Personal Finance – Meaning, Objectives and advantages – Individual Perspective – Family Perspective – Time Value of Money – Personal Savings: Meaning, Different modes of Saving – Bank Deposit, Online Investments, Insurance, Stocks, Gold, Real Estate – Returns Vs Risk – Financial Discipline – Setting Alerts for commitments (With Real time Examples).

UNIT II Business Funding

Sources: Personal Savings – Borrowings - Venture Capital – Venture Capital Process– Commercial Banks – Government Grants and Scheme.

UNIT III Finance language

Capital – Drawing – Income – Expenditure – Revenue Vs Capital Items – Assets – Fixed Assets – Current Assets – Fictitious Assets – Liabilities – Long-term Liabilities – Current Liabilities – Internal Liabilities – External Liabilities –Shareholders fund: Equity Share capital, Preference Share Capital, Reserve & Surplus – Borrowings: Debentures, Bank Loan, Other Loan – Depreciation – Reserve Vs Provision.

UNIT IV Budgeting

Budgetary Control – Meaning – Preparation of various budgets – Purchase budget – Sales Budget – Production budget – Cash Budget – Flexible budgets.
(With Problems)

UNIT V Marginal Costing

Marginal Costing – Meaning – Marginal Costing Vs Absorption Costing – Concepts of Variable Cost, Fixed Cost and Contribution – PV Ratio – Break Even Point – Margin of Safety – Key Factor – Application of Marginal Costing in decision making – Make or Buy – Shutdown or Continue – Exploring New Markets (With Problems)

Reference Books:

1. Banking Theory, Law & Practice - Dr.L.Natarajan, Margham Publications.
2. Corporate Accounting by T.S.Reddy and Dr.A.Murthy, Margham Publications.
3. Management Accounting by T.S.Reddy and Dr.Y.Hariprasd Reddy, Margham Publications.
4. Cost Accounting by T.S.Reddy and Dr.Y.Hariprasd Reddy, Margham Publications.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	08	12
2	08	12
3	08	12
4	08	12
5	10	12
Total	**42**	**60**

6.3.5	Industry 4.0	L	T	P	C
THEORY		3	0	0	3

RATIONALE:

Industry 4.0, also known as the Fourth Industrial Revolution, represents the current trend of automation and data exchange in manufacturing technologies. It integrates advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), cloud computing, and big data analytics to create "smart factories" that are highly efficient and adaptive. Industry 4.0 is transforming the manufacturing landscape by leveraging advanced technologies to create more efficient, flexible, and intelligent production processes. For diploma engineering students, understanding these concepts is crucial as they will play a key role in the future of engineering and manufacturing. Learning Industry 4.0 will not only enhance your technical skills but also prepare you for the evolving job market in the digital age.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Study the concepts, goals, design principles, and enabling technologies of Industry 4.0.

CO2: Explain the fundamentals, applications, societal impact, challenges, and future prospects of Artificial Intelligence.

CO3: Analyze Robotic Process Automation concepts, architectures, programming constructs, and industrial use cases.

CO4: Describe the Augmented Reality, Virtual Reality, and Mixed Reality technologies and their applications in education and industry.

CO5: Design and develop basic IoT applications using sensors, actuators, and Arduino with an understanding of security issues.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	1	NA	NA	2	NA	2	1	*	*
CO2	2	1	NA	3	NA	2	2	*	*
CO3	2	2	1	2	NA	1	2	*	*
CO4	1	2	1	2	NA	1	1	*	*
CO5	3	3	3	2	1	1	3	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulated PSO is optional.

DETAILED CONTENT

Unit I: Introduction to Industry 4.0

Need – Reason for Adopting Industry 4.0 - Definition – Goals and Design Principles - Technologies of Industry 4.0 – Big Data – Artificial Intelligence (AI) –

Industrial Internet of Things - Cyber Security – Cloud – Augmented Reality.

Unit II: Artificial Intelligence

Artificial Intelligence: Artificial Intelligence (AI) – What & Why? - History of AI - Foundations of AI -The AI - Environment - Societal Influences of AI – Application Domains and Tools - Associated Technologies of AI - Future Prospects of AI - Challenges of AI.

Unit III: Robotic Process Automation (RPA)

Robotic Process Automation (RPA): Introduction to RPA – Need for automation – Programming constructs in RPA – Robots and Softbots – RPA architecture and process methodologies - Industries best suited for RPA - Risks & Challenges with RPA.

Unit IV: Augmented & Virtual Reality

Augmented Reality: Definition - Tools for Augmented Reality – Hololens - Advantages and Challenges of AR - Applications of AR in Education, Industries -
Mixed Reality. Virtual Reality: Definition – Types of Head Mounted Displays – Tools for Virtual Reality – Applications of VR in Education, Industries - Difference between VR and AR.

Unit V: IoT, Sensors and Actuators

Evolution of IoT – Definition & Characteristics of IoT - Architecture of IoT – Technologies for IoT – Developing IoT Applications – Applications of IoT – Industrial IoT – Security in IoT Analog and Digital Sensors – Interfacing temperature sensor, ultrasound sensor and infrared (IR) sensor with Arduino – Interfacing LED and Buzzer with Arduino.

Textbook:

1. Sudip Misra, Chandana roy, and Anandarup Mukherjee, Introduction to Industrial Internet
of Things and Industry 4.0, Taylor & Francis India, 2021.
2. Dr Anand Kumar Singh and Dr. Manish Gangil, INDUSTRY 4.0, Shashwat Publication, 2022.
3. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, 1st Edition, Apress, 2017.
4. Dr Kamlesh Lakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, and Kamal Kant Hiran, Internet of Things (IoT), First Edition, BPB Publications, 2020.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	08	12
2	08	12
3	08	12
4	08	12
5	10	12
Total	**42**	**60**

6.4.1	ELECTIVE SPECIALIZATION GREEN ENERGY & ENGINEERING	L	T	P	C
THEORY		3	0	0	3

RATIONALE

Traditional energy sources such as coal, oil, and natural gas contribute significantly greenhouse gas emissions, air pollution, and environmental degradation. By transitioning to green energy sources such as solar, wind, hydroelectric, and biomass, engineers can mitigate these harmful effects while meeting the growing global demand for energy. The green energy projects often have lower life cycle carbon footprints compared to conventional energy sources, making them essential for achieving climate targets and promoting sustainable development. In essence, incorporating green energy into engineering practices is not only necessary for addressing environmental concerns but also essential for creating a resilient, equitable, and prosperous future for all.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Study the conventional and renewable energy sources, energy scenarios, sustainability aspects, and environmental impacts.

CO2: Explain the principles, components, and applications of solar and wind energy conversion systems.

CO3: Analyze ocean energy, biomass energy systems, and various hydrogen production technologies.

CO4: Study energy-efficient systems including motors, lighting, fuel cells, compressors, and pumps.

CO5: Apply concepts of green manufacturing, sustainable production systems, and zero-waste manufacturing practices.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	NA	NA	3	NA	2	*	*
CO2	3	3	2	1	2	NA	1	*	*
CO3	3	3	2	1	2	NA	1	*	*
CO4	3	2	2	1	2	NA	1	*	*
CO5	2	2	2	NA	3	1	2	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guide-lines, formulated PSO is optional.

DETAILED CONTENT

UNIT 1: **INTRODUCTION**- Overview of conventional & renewable energy sources, types of renewable energy systems, Future of Energy Use, Present Indian and international energy scenario of conventional and RE sources, Energy for sustainable development, Environmental Aspects of Energy, Limitations of RE sources.

UNIT 2 : SOLAR ENERGY & WIND ENERGY- Theory of solar cells - Concept of Solar PV systems - Flat plate and concentrating collectors, Solar PV Applications - solar heating/cooling technique, solar distillation and solar drying, solar cookers. Energy from Wind - Horizontal axis Wind Turbine -Vertical Axis Wind Turbine - Wind Energy Conversion Systems .

UNIT 3: **OCEAN ENERGY, BIO-MASS ENERGY & HYDROGEN PRODUCTION-** OTEC, Principles of utilization, setting of OTEC plants - Tidal and wave energy. Principles of bio-conversion - types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects. Chemical Production of Hydrogen- Electrolytic Hydrogen- Thermolytic Hydrogen- Photolytic HydrogenPhotobiologic Hydrogen Production.

UNIT 4: ENERGY EFFICIENT SYSTEMS - Energy efficient motors, energy efficient lighting and control. Fuel cells- prin thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps.

UNIT 5: **GREEN MANUFACTURING SYSTEMS-** Environment impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, Sustainable green production systems - alternate casting and joining techniques, zero waste manufacturing.

INSTRUCTIONAL STRATEGY

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory-demonstrate-practice-activity strategy throughout the course to ensure outcome-driven learning and employability.

MEANS OF ASSEESSMENT

1 Assignments and quiz/class tests
2 Sessional test
3 Viva-voce

REFERENCE BOOKS/ ONLINE RESOURCES
Text and Reference Books:

1. D. S. Chauhan & S. K. Srivastava, Non-Conventional Energy Resources, New Age International Private Limited, 4 th Edition, 2021.
2. John Twidell & Tony Weir, Renewable Energy Resources, Routledge; 3 rd Edition, 2015.
3. D.P. Kothari, K.C. Singal & Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning; 3 rd Edition, 2022.

4. Ritu Dogra, Renewable Energy and Green Technology, Brillion Publishing, 1 st Edition, 2023.
5. Soli J. Arceivala, Green Technologies, McGraw Hill Education (India) Private Limited, 1 st Edition, 2017.
6. Chandan Deep Singh & Harleen Kaur, Sustainable Green Development and Manufacturing Performance through Modern Production Techniques, Taylor & Francis Ltd, 1 st Edition, 2021.

Web-based/Online Resources:

- https://onlinecourses.nptel.ac.in/noc21_ch11/preview

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	08	12
2	08	12
3	10	12
4	08	12
5	08	12
Total	**42**	**60**

6.4.2	Elective Specialization	L	T	P	C
THEORY	MAINTENANCE OF MACHINE TOOLS	3	0	0	3

RATIONALE

Diploma technocrats who are in the field of maintenance of machine tools should have thorough knowledge about the dismantling and assembly procedure, installation, maintenance and repair of the machines and know about the technology used for the prediction of premature failure of components in advance.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Describe the objectives, types, and importance of maintenance and identify instruments required for effective maintenance.

CO2: Identify and use measuring equipment and tools for testing and evaluating the accuracy of machine tools.

CO3: Perform maintenance activities on lathe machines including alignment, adjustments, and inspection of components.

CO4: Analyze and carry out geometrical checks and alignment tests on various machine tools such as milling, grinding machines, and slotters.

CO5: Inspect lubricants and coolants, identify wear and contaminants, and perform oil removal and refilling operations for gearboxes.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	NA	1	1	NA	1	*	*
CO2	3	2	NA	3	NA	NA	1	*	*
CO3	3	3	1	3	NA	NA	1	*	*
CO4	3	3	1	3	NA	NA	1	*	*
CO5	2	2	NA	3	2	NA	1	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guide-lines, formulated PSO is optional.

DETAILED CONTENT

UNIT 1: MAINTENANCE: Objective-Definition –Types of maintenance-Advantages of good maintenance-Disadvantages of bad maintenance-Instruments needed for maintenance.

UNIT 2 : TESTING OF MACHINE TOOLS Measuring Equipment and Tools used for testing of machine tools: Dial gauges – test mandrels – straight edges - squares- spirit levels- level measurement by water level- alignment by wire and measuring microscope.

UNIT 3: Maintenance of Lathe: Lathe maintenance-Drive belts- Adjusting belt tension, Gib adjustment (cross slide, Compound slide),Wiper pads, Adjusting the Tail stock clamp. Alignment test on lathe

UNIT 4: Types of geometrical checks on machine tools-Various test conducted on machine tools-Alignment test on surface grinding and milling .Details for testing various machine tools : Slotter maintenance- Diving Pulley alignment checking-Belt tension adjustment –Pinion gear inspection , table jib adjustment.

UNIT 5: Inspection of the drained oil for contaminants & wear debris with focus on visual inspection. Preparation of coolants. Practice on oil removing & filling for a gear box.

INSTRUCTIONAL STRATEGY

●Engage and Motivate: Instructors should actively engage students to boost their learning confidence

- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory-demonstrate-practice-activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyse potential sources of error in case of discrepancies

MEANS OF ASSEESSMENT

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

REFERENCE BOOKS/ ONLINE RESOURCES

Text and Reference Books:

1. Er.Sushil kumar Srivastava - Maintenance Engineering - Reprint2016 - S.Chand publication.
2. Georg Schlesinger, F. Koenigsberger , M. Burdekin - TESTING MACHINE TOOLS - 8th edition- Pergamon Press-1978.
3. K.J.Bag- Preventive Maintenance - ISTE Professional centre continuing education Programme- Distributed by ISTE Professional centre AnnaUniversity campus, Chennai.

Web-based/Online Resources:

- https://www.youtube.com/watch?v=f58SW0Hwcf0 –Principle of Maintenance – NPTELIIT Kharagpur DIRECTORATE OF TECHNICAL EDUCATION, CHENNAI –

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	06	12
2	08	12
3	10	12
4	10	12
5	08	12
Total	**42**	**60**

6.4.3	Elective Specialization	L	T	P	C
THEORY	Non-Destructive Testing	3	0	0	3

RATIONALE

Non-destructive testing (NDT)is a multidisciplinary profession that blends quality assurance and materials science. NDT is used to inspect and evaluate materials, components, or assemblies without destroying their serviceability. Through a set of test methods, skilled technicians identify cracks, voids, inclusions, and weld discontinuities, as well as identify mis- assembled subcomponents. This makes NDT crucial to help prevent catastrophic failures such as air plane and locomotive crashes, pipeline leaks and explosions, nuclear reactor failures, and ship disasters.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Study the fundamentals of Non-Destructive Testing, types of defects, and compare NDT with destructive testing methods.

CO2: Explain the principles, procedures, advantages, and limitations of Visual Inspection and Liquid Penetrant Testing (LPT).

CO3: Analyze the principles, instrumentation, applications, and limitations of Magnetic Particle Testing (MPT) and Eddy Current Testing (ECT).

CO4: Explain the working principles, techniques, and applications of Ultrasonic Testing (UT) and Radiographic Testing (RT).

CO5: Study advanced and special NDT techniques such as acoustic emission, microwave inspection, thermal inspection, residual stress measurement, and optical holography.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic / Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	NA	NA	1	NA	1	*	*
CO2	3	2	NA	3	NA	NA	1	*	*
CO3	3	3	NA	3	NA	NA	1	*	*
CO4	3	3	NA	3	1	NA	1	*	*
CO5	2	2	NA	2	1	NA	2	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guide-lines, formulated PSO is optional.

DETAILED CONTENTS

Unit I-Introduction

Non-Destructive Testing (NDT) and comparison with Destructive Testing Defects/flaws due to: Primary processing, Secondary processing, In-service conditions ,Types of defects detected by NDT, Common NDT techniques ,Advantages, limitations, and applications of NDT

Unit II -Visual Inspection Liquid Penetrant Test (LPT)

Principle of Visual Inspection, Defects detectable by unaided visual inspection, Optical aids used in visual inspection ,Advantages and limitations of visual inspection, Advantages and limitations of LPT, Physical principles of LPT, Procedure for conducting LPT
,Penetrant methods, Materials used in LPT

Unit III -Magnetic Particle Test (MPT) & Eddy Current Test (ECT)
Advantages and limitations of MPT, Procedure for MPT ,Magnetizing techniques, Magnetic particles and suspending liquids, Detectable discontinuities, Non-relevant indications , Applications, Advantages and limitations of ECT, Operating variables, Eddy current instrumentation
,Reference standards, Applications.

Unit IV -Ultrasonic Test (UT) & Radiography Test (RT)
Advantages and limitations of UT, General characteristics of ultrasonic waves,Wave propagation and types of ultrasonic waves,Major variables in UT ,Angle beam techniques,Immersion testing,Applications .,Uses and applicability of RT,Advantages and limitations of RT,Interaction between penetrating radiation and matter (attenuation),Image conversion media,Film radiography,Real-time radiography

UNIT V- Other Non-Destructive Inspection Techniques
Acoustic emission inspection, Microwave inspection, Thermal inspection, Electromagnetic techniques for residual stress measurements, Optical holography.

TEXTBOOKS AND REFERENCES
1. "Non Destructive Evaluation and Quality Control",Metals Handbook, Vol. 17, 9thEd., ASM.1989
2. Srivastava,K.C.,"Handbook of Magnetic Particle Testing",Oscar publications.1998
3. Hull,B.,"Non Destructive Testing",Springer.2012
4.Dr.V.Jayakumar,Dr. K.Elangovan"Non-Destructive Testing of Materials"Lakshmi Publications,Chennai,2017
5. Baldev Raj, Jayakumar T, ThavasimuthuM , Practical Non-Destructive Testing,3rdEd., Narosa.201

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	06	12
2	08	12
3	10	12
4	10	12
5	08	12
Total	**42**	**60**

6.4.4	Elective Specialization	L	T	P	C
THEORY	PRODUCT DESIGN & DEVELOPMENT	3	0	0	3

RATIONALE

A product is something sold by an enterprise to its customers. Product design deals with conversion of ideas into reality and, as in other forms of human activity, aims at fulfilling human needs. Product development is the set of activities beginning with the perception of a market opportunity and ending in the production, sale, and delivery of a product.

Course Outcomes (COs)

At the end of the subject, the students will be able to:

CO1: Study the product life cycle, product policies, and the new product design and development process including commercialization.

CO2: Apply product planning methodologies to identify opportunities, evaluate projects, allocate resources, and manage pre-project planning.

CO3: Identify and analyze customer needs to translate them into product specifications and establish targets.

CO4: Develop product concepts and architecture, assess industrial design requirements, and manage the design process effectively.

CO5: Study prototyping principles, technologies, and economic considerations in product development and conduct qualitative and quantitative project analyses.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):
3 – Strong | 2 – Moderate | 1 – Low | NA- Not Applicable

CO \PO	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Socio/Economic/ Environmental impact assessment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	2	1	2	2	2	*	*
CO2	3	3	2	1	2	3	2	*	*
CO3	3	3	3	1	2	3	2	*	*
CO4	3	3	3	1	2	3	2	*	*
CO5	3	3	3	2	3	3	2	*	*

*PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guide-lines, formulated PSO is optional.

DETAILED CONTENTS

Unit I- INTRODUCTION

Product life cycle, Product policy of an organization, Selection of a profit able product,Product design process,New product strategy Idea generation, Screening Concept development,Testing Business analysis ,Product development testing and Analysis Commercialization Collaboration. Gantt chart product life-cycle management .

Unit II - PRODUCT PLANNING

The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, pre project planning.

Unit III -IDENTIFYING CUSTOMER NEEDS

Gather raw data from customers, interpret raw data in terms of customer needs,organize the needs into a hierarchy,establish the relative importance of the needs and reflect on the results and the process. Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

Unit IV CONCEPT GENERATION

Product implications of the architecture, establishing the architecture, variety and supply chain considerations. Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design process,managing the industrial design process,assessing the quality of industrial design.

Unit V PROTOTYPING

Prototyping basics, principles of prototyping, technologies, planning for prototypes. Product development economics,Elements of economic analysis,base case financial mode, sensitive analysis, project trade-offs, influence of qualitative factors on project success,qualitative analysis.

Text and Reference Books:

1. Karl TUlrich, StevenDEppinger , "ProductDesign&Development."TataMcGrawhillNew Delhi2003 2.HollinsB&PughS"SuccessfulProductDesign."ButterworthsLondon. 3.BrallaJG"HandbookofProductDesignforManufacture,McGrawhillNewYork.
4. A K Chitale and R C Gupta, Product Design and Manufacturing, 6th Edition, PHI, New Delhi, 2003.
5. Boothroyd G, Dewhurst P and Knight W, Product Design for Manufacture and Assembly, 2nd Edition, Marcel Dekker, New York, 2002

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted
1	06	12
2	08	12
3	10	12
4	10	12
5	08	12
Total	**42**	**60**

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)			
	Computer Server	01	1,28,000
1.	Headphone With Mic	01	
2.	Webcam: HD	01	
3.	Server OS; Windows/Linux	01	
4.	Monitor	01	
5.	Computer system (i7 processor,16 GB 512 SSD latest configuration)	40	3000000
6.	UPS 5KVA Online (At Least 60 Min. backup)	02	350000
7.	Computer Chair and Table	40	400000
8.	AC	02	100000
9.	Laser Printer with ADF scanner	01	50000
10.	LAN Setup	LS	20,000
11.	Language lab Software License/ Open Source	01	1,00,000
12.	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 Tuning fork set	2	14,000
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
	Burette 50ml	30	3,000
	Pipette 25ml	60	4,000
	Beakers 100ml	60	4,000
	Burette stand	30	30,000
	Glazed tile	30	1,000
	Conical flask 50ml (Titration flask)	60	4,000
	Standard (Measuring) flask (to prepare standard solution) 250ml/100ml	30	6,000
	Able's Flash Point apparatus	2	10,000
	(1/10)°C thermometer	06	6,000
	Candles	20	100
	Crucible with lid	06	2,000
	Muffle furnace	1	18,000
	Decicators	06	8,000
	Pair of tongue (small and big)	24 (small) 2 (big)	2,000
	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
	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		
10.	Soldering irons		
11.	Pedestal grinder		
12.	Metal spraying gun		
13.	Spot welder		
14.	TIG welding set		
15.	MIG welding set		
16.	Welding Partition Screen		
17.	Miscellaneous		
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		
17.	Single cylinder 2 stroke petrol engine test rig		
18.	Single cylinder 4 stroke petrol engine test rig		
19.	Multicylinder petrol engine test rig (Morse test rig)		
20.	Open cup apparatus		
21.	Closed cup apparatus		
22.	Four stroke petrol engine cut section model for valve timing diagram.		
23.	Four stroke diesel engine cut section model for valve timing diagram.		
24.	Two stroke petrol cut section model for port timing diagram.		
25.	Four Stroke Petrol Engine or Diesel Engine Test rig.		
26.	Multi- Cylinder Petrol or Diesel Engine Test rig.		
27.	Air Compressor Test rig.		
28.	Exhaust Gas Analyzer.		
29.	Reciprocating and Rotary Air compressor for dismantling and assembling		

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)
	Forced circulation tempering furnace	1	50,000
	Quenching tank	2	10,000
	Models of- Simple Cubic , BCC, FCC and HCP	1 each	10,000
	Pedestal Grinder	1	8,000
	Specimen Kit (Ferrous and Non-ferrous Metals	1	10,000
	Metallurgical microscope	2	60,000 each
	Specimen Polishing Machine (Double Disk type)	1	50,000
	Set of Specimen of different alloys	1	5,000
	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		2	LS. Rs.24000
	Dry & Wet bulb wall hygrometer. Dial type hygrometer Fortin's barometer Manometers		2	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	2000

		@200	
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 each 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)

1 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 engage 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
3. Ashish Kumar, Head of Department Mechanical Engineering, Government Polytechnic Mawana Khurd Meerut
4. Stuti Srivastava, Head of Department Mechanical Engineering, Government Polytechnic Mirzapur.
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.
8. Himanshu Bhaskar, Head of Department Mechanical Engineering, Government Polytechnic Pilibhit.
9. Anupama Yadav, Lecturer Mechanical Engineering, Government Polytechnic Kanpur.
10. Pranjul Mishra, Lecturer Mechanical Engineering, Government Polytechnic Deeh Unnao
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
15. Premantusha, Lecturer Mechanical Engineering, Government Polytechnic Lucknow
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
25. Gaurav Kishor Kanaujiya, Assistant Professor/Course Co-Ordinator, IRDT U.P. Kanpur.

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