COMPETENCY BASED CURRICULUM

DIPLOMA IN
MECHANICAL ENGINEERING

(Duration 3 Years)
NSQF Level – 5

Under
Haryana State Board of Technical Education

Developed By

Curriculum Development Center
National Institute of Technical Teachers Training & Research
(Ministry of Education, Government of India)
Sector - 26, Chandigarh, UT, India.

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PREFACE

Learning and learning experience are the foundation of any education system. Appropriateness of education and its useful implications stand on the platform of knowledge and skill. But the knowledge and skill cannot be quantified qualitatively without ensuring learning experience. Curriculum is the pathway to select and organise learning experience. It helps the teachers to provide tangible resources, goals and objectives to learners. Curriculum acts as a catalyst to stimulate creativity, innovation, ethics, values, responsibility and many human factors. Curriculum embodies rigour and high standards and creates coherence to empower learner to meet the industrial and societal needs. Curriculum is a central guide for a teacher to plan a standard based sequence for the instructional delivery.

The industrial revolution 4.0 has forced the technical education system to reinvent the curriculum to meet the human resource requirement of the industry. The data driven systems relying on the subjects like machine-learning, Artificial Intelligence, Data Science etc are literally forcing the technical education system to offer different subjects differently to address the emerging challenges. The non-linear way of learning now facilitates students to choose path of knowledge to skill or vice-versa. The bi-directional process requires innovative curriculum design and revision. Diploma programme is now more challenging than ever. The level of skill and knowledge demanded by industry from diploma holders are highly interdisciplinary at the same time address special need. Hence, there is a need to align the curriculum to National Skill Qualification Framework (NSQF).

National Education Policy, NEP-2020 has now opened up diversities for the education system to explore and exploit to make the education relevant. The policy emphasises to inculcate value, ethics, respect to culture and society etc along with industry ready knowledge and skill among the students. The interdisciplinary nature of curriculum, academic bank of credits and integration of technology in teaching-learning envisaged in NEP-2020 make it more challenging for curriculum development. NITTTR, Chandigarh has developed the art of curriculum development over 54 years of its existence. The expertise and experience available in the institute follow time-tested and acclaimed scientific methods to design/revise curriculum. The experienced faculty members entrusted with the curriculum development or revision activities are well-versed with NSQF, NEP and Outcome based education. I am happy to note that **Haryana State Board of Technical Education, Panchkula, Haryana** reposed their confidence on this expertise to develop **AICTE/NSQF/NEP 2020** aligned curriculum for the state. This documented curriculum is an outcome of meticulous planning and discussions among renowned experts of the subject through series of workshops. The effective implementation of this curriculum supported with quality instructional resources will go a long way in infusing the learning experience among learners to make them industry ready.

Director
National Institute of Technical Teachers Training & Research, Chandigarh

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Professor & Head
Curriculum Development Center
National Institute of Technical Teachers Training & Research, Chandigarh

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1. SALIENT FEATURES

1.	Name	:	**Diploma in Mechanical Engineering**
2.	Duration	:	**03 Years**
3.	Hours per week	:	**35**
4.	Entry Qualification	:	**10th Pass**
5.	Student Intake	:	**As per sanctioned strength**
6.	Pattern	:	**Semester**
7.	Scheme	**:**	**Multi Point Entry and Exit**
8.	NSQF Level	:	**5**
9.	Theory Practical Ratio	:	**40 : 60**
10.	Project Work	:	**Minor and Major Project**
11.	In-house/Industrial Training	:	**Mandatory after First and Second Year**

2. NSQF GUIDELINES

National Skill Qualification Framework has defined total Ten Levels. Each level of the NSQF is associated with a set of descriptors made up of five outcome statements, which describe in general terms, the minimum knowledge, skills and attributes that a learner needs to acquire in order to be certified for that level.

Fig.1: NSQF Domains

NSQF LEVEL - 3 COMPLIANCE

The NSQF level - 3 descriptor is as follows:

Process	• Person may carry out a job which may require limited range of activities routine and predictable.
Professional Knowledge	• Basic facts, process and principle applied in trade of employment.
Professional Skill	• Recall and demonstrate practical skill, routine and repetitive in narrow range of application.
Core Skill	• Communication written and oral, with minimum required clarity, skill of basic arithmetic and algebraic principles, personal banking, basic understanding of social and natural environment.
Responsibility	• Under close supervision. Some responsibility for own work within defined limit.

Fig 2: NSQF Level – 3 Descriptor

Work requiring knowledge, skills and aptitudes at level 3 will be routine and predictable. Job holders will be responsible for carrying out a limited range of jobs under close supervision. Their work may require the completion of a number of related tasks. People carrying out these job roles may be described as "Semi skilled workers". Individuals in jobs which require level 3 qualifications will normally be expected to be able to communicate clearly in speech and writing and may be required to use arithmetic and algebraic processes. They will be expected to have previous knowledge and skills in the occupation and should know the basic facts, processes and principles applied in the trade for which they are qualified and be able to apply the basic skills of the trade to a limited range of straightforward jobs in the occupation.

They will be expected to understand what constitutes quality in their job role and more widely in the sector or sub-sector and to distinguish between good and bad quality in the context of the jobs they are given. Job holders at this level will be expected to carry out the jobs they are given safely and securely. They will work hygienically and in ways which show an understanding of environmental issues. This means that they will be expected to take responsibility for their own health and safety and that of fellow workers and, where appropriate, customers and/or clients. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social environment. They should be able to make a good contribution to team work.

NSQF LEVEL - 4 COMPLIANCE

The NSQF level-4 descriptor is given below:

Process	• Work in familiar, predictable, routine, situation of clear choice
Professional Knowledge	• Factual knowledge of field of knowledge or study.
Professional Skill	• Recall and demonstrate practical skill, routine and repetitive in narrow range of application, using appropriate rule and tool, using quality concepts.
Core Skill	• Communication written and oral, with required clarity, skill of basic arithmetic and algebraic principles, personal banking, basic understanding of social and natural environment.
Responsibility	• Responsibility for own work and learning.

Fig 3: NSQF Level – 4 Descriptor

Work requiring knowledge, skills and aptitudes at level 4 will be carried out in familiar, predictable and routine situations. Job holders will be responsible for carrying out a range of jobs, some of which will require them to make choices about the approaches they adopt. They will be expected to learn and improve their practice on the job. People carrying out these jobs may be described as "skilled workers". Individuals in jobs which require level 4 qualifications should be able to communicate clearly in speech and writing and may be required to use arithmetic and algebraic processes. They will be expected to have previous knowledge and skills in the occupation in which they are employed, to appreciate the nature of the occupation and to understand and apply the rules which govern good practice. They will be able to make choices about the best way to carry out routine jobs where the choices are clear.

They will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their job roles. Job holders at this level will be expected to carry out their work safely and securely and take full account of the health and safety on colleagues and customers. They will work hygienically and in ways which show an understanding of environmental issues. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social and political environment. They should be able to guide or lead teams on work within their capability.

NSQF LEVEL - 5 COMPLIANCE

The NSQF level-5 description is given below:

Process	• Job that requires well developed skill, with clear choice of procedures in familiar context.
Professional Knowledge	• Knowledge of facts, principles, processes and general concepts, in a field of work or study.
Professional Skill	• A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information.
Core Skill	• Desired mathematical skill; understanding of social, political; and some skill of collecting and organising information, communication.
Responsibility	• Responsibility for own work and learning and some responsibility for others' works and learning

Fig 4: NSQF Level – 5 Descriptor

Work requiring knowledge, skills and aptitudes at level 5 will also be carried out in familiar situations, but also ones where problems may arise. Job holders will be able to make choices about the best procedures to adopt to address problems where the choices are clear. Individuals in jobs which require level 5 qualifications will normally be responsible for the completion of their own work and expected to learn and improve their performance on the job. They will require well developed practical and cognitive skills to complete their work. They may also have some responsibility for others' work and learning. People carrying out these jobs may be described as "fully skilled workers" or "supervisors".

Individuals employed to carry out these jobs will be expected to be able to communicate clearly in speech and writing and may be required to apply mathematical processes. They should also be able to collect and organise information to communicate about the work. They will solve problems by selecting and applying methods, tools, materials and information. They will be expected to have previous knowledge and skills in the occupation, and to know and apply facts, principles, processes and general concepts in the occupation. They will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their work. They will be expected to operate hygienically and in ways which show an understanding of environmental issues. They will take account of health and safety issues as they affect the work they carry out or supervise.

In working with others, they will be expected to conduct themselves in ways which show an understanding of the social and political environment.

3. NATIONAL EDUCATION POLICY (NEP) - 2020

NEP 2020 aims at a comprehensive holistic education to develop all capacities of human beings - intellectual, aesthetic, social, physical, emotional, and moral - in an integrated manner. A holistic arts education will help develop well-rounded individuals that possess: critical 21st century capacities in fields across the arts, humanities, languages, sciences, social sciences, and professional, technical, and vocational fields; an ethic of social engagement; soft skills, such as communication, discussion and debate; and rigorous specialization in a chosen field or fields. Such a holistic education shall be, in the long term, the approach of all undergraduate programmes, including those in professional, technical, and vocational disciplines.

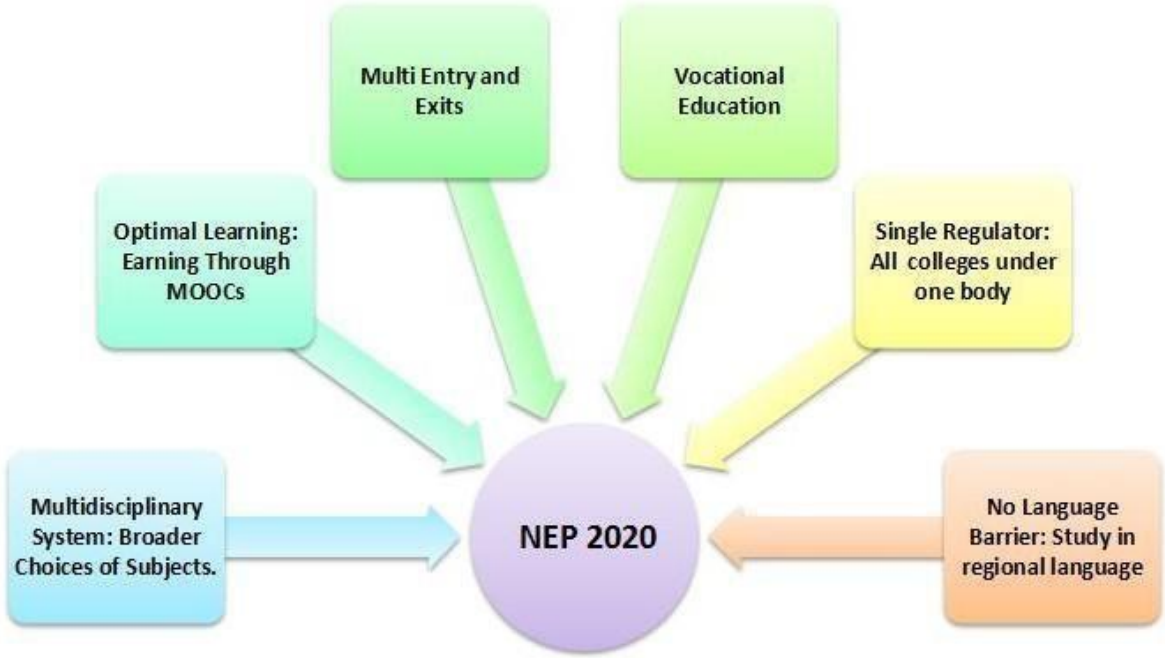

Fig 5: NEP 2020

Flexibility in curriculum and novel and engaging course options will be on offer to students, in addition to rigorous specialisation in a subject or subjects. Pedagogy for courses will strive for significantly less rote learning and an increased emphasis on communication, discussion, debate, research, and opportunities for cross-disciplinary and interdisciplinary thinking. The flexible and innovative curriculum shall emphasize on offering credit-based courses and projects in the areas of community engagement and service, environmental education and value-based education. as part of a holistic education, students will be provided with opportunities for internships with local industry, businesses, artists, crafts persons, villages and local communities, etc., as well as

research internships with faculty and researchers at their own or other HEIs or research institutions, so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability.

Effective learning requires relevant curriculum, engaging pedagogy, continuous formative assessment and adequate student support. The curriculum must be updated regularly aligning with the latest knowledge requirements and shall meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students - thus directly influencing learning outcomes. The assessment methods have to be scientific and test the application of knowledge. Higher Education Institutes should move to a criterion-based grading system that assesses student achievement based on the learning goals for each programme, making the system fairer and outcomes more comparable. HEIs should also move away from high-stakes examinations towards more continuous and comprehensive evaluation.

4. DIPLOMA PROGRAMME OUTCOMES

The programme outcomes are derived from five domains of NSQF Level namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this programme, the student will be able to:

PO1: Perform tasks in limited range of activities, familiar situation with clear choice of procedures.

PO2: Acquire knowledge of principles and processes in the field of Mechanical Engineering.

PO3: Develop skills to accomplish quality tasks and solve problems using methods, tools, materials and information**.**

PO4: Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.

PO5: Take the responsibility of own works and supervise others work.

PO6: Select multidisciplinary subjects of own interest from broader choices.

PO7: Perform Self Learning through Massive Open Online Courses (MOOCs).

5. DERIVING CURRICULUM AREAS FROM PROGRAMME OUTCOMES

The following curriculum subject areas have been derived from Programme outcomes:

Sr. No.	Programme Outcomes	Curriculum Subject Areas
1.	Perform tasks in limited range of activities, familiar situation with clear choice of procedures.	• General Workshop Practice • Workshop Practice I • Workshop Practice – II • Workshop Practice – III • Workshop Practice – IV • Engineering Graphics • Applied Mechanics • Applied Physics - I • Applied Physics - II • Applied Chemistry • Basics of Electrical and Electronics Engineering
2.	Acquire knowledge of principles and processes in Mechanical Engineering related field.	• Workshop Technology-I • Workshop Technology – II • Workshop Technology – III • Applied Mechanics • Applied Physics - I • Applied Physics – II • Strength of Materials • Thermodynamics – I • Thermodynamics II • Machine Design • Theory of Machines • Automobile Engineering • Metrology and Quality Control • Entrepreneurship Development & Management

3.	Develop skills to accomplish quality tasks and solve problems using methods, tools, materials and information**.**	• General Workshop Practice • Workshop Practice I • Workshop Practice – II • Workshop Practice – III • Workshop Practice – IV • Engineering Graphics • Mechanical Engg Drawing I • Mechanical Engineering Drawing II • Industrial /In-House Training. • Industrial Training-II • CAD/CAM • CNC Machines and Automation • Theory of Machines • Minor Project • Metrology and Quality Control
4.	Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.	• English and Communication Skills – I • English and Communication Skills - II • Applied Mathematics – I • Applied Mathematics – II • Fundamentals of IT • Environmental Studies & Disaster Management • Entrepreneurship Development & Management
5.	Take the responsibility of own works and supervise others work.	• General Workshop Practice • Workshop Practice I • Workshop Practice – II • Workshop Practice – III • Workshop Practice – IV • Industrial / In-House Training • Industrial Training-II • CAD/CAM • CNC Machines and Automation

		• Minor Project • Metrology and Quality Control • Entrepreneurship Development & Management
6.	Select multidisciplinary subjects of own interest from broader choices	• Strength of Materials • Thermodynamics – I • Thermodynamics II • CAD/CAM • CNC Machines and Automation • Programme Elective – 1 • Programme Elective II • Minor Project • Industrial Internship / Major Project
7.	Perform Self Learning through Massive Open Online Courses (MOOCs).	• Open Elective – I (MOOCs) Multidisciplinary Elective • Multidisciplinary Elective (MOOCs+/Offline) • Minor Project • Industrial Internship / Major Project

FIRST YEAR
NSQF LEVEL - 3

6. DIPLOMA PROGRAMME STUDY AND EVALUATION SCHEME
FIRST YEAR

FIRST SEMESTER:

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
1.1	*English and Communication Skills –I	2	2	2+1=3	40	40	80	60	60	120	200
1.2	*Applied Mathematics I	4	-	4+0=4	40	-	40	60	-	60	100
1.3	*Applied Physics-I	2	2	2+1=3	40	40	80	60	60	120	200
1.4	*Engineering Graphics	-	6	0+3=3	-	40	40	60	-	60	100
1.5	*Fundamentals of IT	2	4	2+2=4	40	40	80	60	60	120	200
1.6	*Environmental Studies & Disaster Management	2	-	2+0=2	40	-	40	60	-	60	100
1.7	*General Workshop Practice	-	6	0+3 = 3	-	40	40	-	60	60	100
#Student Centred Activities (SCA)		-	3	-	-	-	-	-	-	-	-
Total		**12**	**23**	**22**	**200**	**200**	**400**	**360**	**240**	**600**	**1000**

* Common with other diploma programmes

Student Centred Activities will comprise of co-curricular activities like extension lectures on Constitution of India, etc, Games, Yoga, Human Values & Ethics, Knowledge of Indian System, Hobby Clubs e.g. Photography etc., Seminars, Declamation Contests, Educational Field Visits, NCC, NSS, Cultural Activities and Self-study etc.

SECOND SEMESTER:

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
2.1	*Applied Mathematics II	4	-	4+0=4	40	-	40	60	-	60	100
2.2	*Applied Physics-II	2	2	2+1=3	40	40	80	60	60	120	200
2.3	*Applied Chemistry	3	2	3+1=4	40	40	80	60	60	120	200
2.4	Applied Mechanics	3	2	3+1=4	40	40	80	60	60	120	200
2.5	Mechanical Engineering Drawing- I	-	6	0+3=3	-	40	40	60	-	60	100
2.6	Workshop Technology -I	3	-	3+0=3	40	-	40	60	-	60	100
2.7	Workshop Practice- I	-	6	0+3=3	-	40	40	-	60	60	100
#Student Centred Activities (SCA)		-	2	-	-	-	-	-	-	-	-
Total		**15**	**20**	**24**	**200**	**200**	**400**	**360**	**240**	**600**	**1000**

* Common with other diploma programmes

Student Centred Activities will comprise of co-curricular activities like extension lectures on Constitution of India, etc, Games, Yoga, Human Values & Ethics, Knowledge of Indian System, Hobby Clubs e.g. Photography etc., Seminars, Declamation Contests, Educational Field Visits, NCC, NSS, Cultural Activities and Self-study etc.

Summer Industrial/In-house Training: After 2nd semester, students shall undergo Summer Training **of 4 Weeks.**

8. DIPLOMA PROGRAMME HORIZONTAL AND VERTICAL ORGANIZATION OF SUBJECTS

Sr. No.	Subjects	Hours Per Week	
		First Semester	Second Semester
1.	English and Communication Skills - I	4	-
2.	Applied Physics	4	4
3.	Applied Chemistry	-	5
4.	Engineering Graphics	6	-
5.	Applied Mathematics	4	4
6.	General Workshop Practice	6	-
7.	Fundamentals of IT	6	-
8.	Applied Mechanics	-	5
9.	Workshop Technology I	-	3
10.	Environmental Studies & Disaster Management	2	-
11.	Mechanical Engineering Drawing I	-	6
12.	Workshop Practice I	-	6
13.	Student Centered Activities	3	2
	Total	**35**	**35**

8. COMPETENCY PROFILE AND EMPLOYMENT OPPORTUNITIES

In government and private sectors related to Mechanical Engineering, "Semi Skilled workers" are required to carry out a limited range of predictable tasks under close supervision. They are normally expected to communicate clearly in speech and along with knowledge of arithmetic and algebraic processes. They should know the basic facts, processes and principles applied in limited area of Mechanical Engineering.

The NSQF Level – 3 pass out students are expected to recall and demonstrate practical routine and repetitive skills, in narrow range of Mechanical Engineering applications. They are expected to understand what constitutes quality in their job role. They are also expected to carry out the jobs given to them safely and securely. They have wide scope to work as semi skilled employee on wage basis in following organizations:

- In manufacturing industries primarily in private sector and to some extent in public sector
- In Railways, Hospitals, Military Engineering Services, Boards and Corporations, Construction Companies, Transportation Departments, Telecommunication, PWD and Rural Development Agencies.

They have wide scope in establishing small start ups in the area of Marketing and Sales, Manufacturing Units and Repair and Maintenance units etc.

9. PROGRAMME OUTCOMES

The programme outcomes are derived from five domains of NSQF Level – 3 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this programme, the student will be able to:

PO1: Carry out a task which may require limited range of predictable activities.

PO2: Acquire knowledge of basic facts, process and principles related to Mechanical Engineering for employment.

PO3: Demonstrate practical skill in narrow range of Mechanical Engineering applications.

PO4: Communicate in written and oral, with minimum required clarity along with skill of basic arithmetic and algebraic principles, personal banking and basic understanding of social and natural environment.

PO5: Perform task under close supervision with some responsibility for own work within defined limit.

10. ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be Assessed	Assessment Criteria for the Course Outcomes
PO1: Carry out a task which may requirelimited range of predictable activities.	• Identify tools, equipment and materials used in preparing jobs. • Take measurements with the help of basic measuring tools/equipment. • Select materials, tools, and sequence of operations to make a job as per given specifications/drawing. • Prepare simple jobs independently and inspect the same. • Use safety equipment and Personal Protection Equipment (PPE). • Maintain good housekeeping practices. • Identify physical quantities, select their units and make measurements with accuracy. • Represent physical quantities as scalar and vector and identify type of motions, various forms of energy, their conversion and applications. • Differentiate between types of waves and their motion. • Illustrate laws of reflection and refraction of light. • Demonstrate competency in phenomena of electrostatics and electricity. • Classify the elements into metals, non-metals and metalloids. • Explain the extraction of metals from ores, their mechanical properties and modification of properties by alloy formation.

	• Classify fuels and lubricants and apply them in different engineering applications. • Identify the polymeric materials, assess their properties and design suitable polymeric materials for current and future applications. • Apply effective methods for corrosion prevention. • Draw free body diagrams by analyzing different types of forces acting on a body. • Determine the resultant of coplanar concurrent forces. • Solve problems by using principle of moment. • Calculate the least force required to maintain equilibrium on an inclined plane. • Determine the centroid/centre of gravity of plain and composite laminar and solid bodies. • Determine velocity ratio, mechanical advantage and efficiency of simple machines.
PO2: Acquire knowledge of basic facts, process and principles related to Mechanical Engineering for employment.	• Identify physical quantities, select their units and make measurements with accuracy. • Represent physical quantities as scalar and vector and identify type of motions, various forms of energy, their conversion and applications. • Demonstrate competency in phenomena of electrostatics and electricity. • Characterize properties of material to prepare new materials for various engineering applications.

	• Draw free body diagrams by analyzing different types of forces acting on a body. • Determine the resultant of coplanar concurrent forces. • Solve problems by using principle of moment. • Calculate the least force required to maintain equilibrium on an inclined plane. • Determine the centroid/centre of gravity of plain and composite laminar and solid bodies. • Determine velocity ratio, mechanical advantage and efficiency of simple machines. • Classify various types of hand tools. • Explain working principle of vernier caliper and micrometer for measurement. • Explain the parts of lathe and their functions. • Select material and tool geometry for cutting tools on lathe. • Explain geometry of single point tool, various types of lathe tools and tool materials. • Explain the working of drilling and boring process. • Explain the nomenclature of a drill and boring tools. • Select most appropriate process, electrodes, various process parameters for a job. • Explain principle of gas welding and arc welding process. • Select a cutting fluid for an operation.

PO3: Demonstrate Practical skill in narrow range of Mechanical Engineering applications.	• Elaborate scientific work, energy and power, forms of friction and solve problems related to them. • Comprehend properties of matter and effect of temperature on various matter and phenomenon. • Characterize properties of material to prepare new materials for various technical applications. • Demonstrate the use of physical principles andanalysis in various technical fields. • Demonstrate a strong foundation on Modern Physics to use at various technical applications • Identify tools, equipment and materials used in preparing jobs. • Take measurements with the help of basic measuring tools/equipment. • Select materials, tools, and sequence of operations to make a job as per given specifications/drawing. • Prepare simple jobs independently and inspect the same. • Use safety equipment and Personal Protection Equipment (PPE). • Maintain good housekeeping practices. • Draw Orthographic views of different objects viewed from different angles. • Draw and interpret sectional views of an object which are otherwise not visible in normal view. • Draw Isometric views of different solids and develop their surfaces.

	• Identify conventions for different engineering materials, symbols, sections of regular objects and general fittings used in Civil and Electrical household appliances /fittings. • Draw orthographic views of different objects by using basic commands of AutoCAD.
PO4: Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.	• Identify the nuances of Communication, both Oral and Written. • Acquire knowledge of the meaning of communication, communication process and speaking skills. • Acquire enhanced vocabulary and in- depth understanding of Grammatical Structures and their usage in the communication. • Communicate effectively with an increased confidence to read, write and speak in English language fluently. • Comprehend the importance of sustainable ecosystem. • Clarify interdisciplinary nature of environmental issues. • Describe corrective measures for the abatement of pollution. • Identify the role of non-conventional energy resources in environmental protection. • Recognize various types of disasters. • Explain the basic components of Computers, Internet and issues of abuses/ attacks on information and computers • Handle the computer/ laptop/mobiles/Internet Utilities and Install/Configure OS

	• Assemble a PC and connect it to external devices • Manage and Use Office practiced Automation Tools • Develop worksheets and Prepare presentations • Understand the geometric shapes used in engineering problems by Co-ordinate Geometry and Trigonometry. • Formulate engineering problems into mathematical formats with the use matrices, co-ordinate geometry and trigonometry. • Calculate the approximate value of roots of certain expressions in engineering problems by application of binomial theorem. • Explore the idea of location, graph, and linear relationships between two variables. • Formulate the engineering problems into mathematical format with the use of differential equations and differential • Use the differentiation and Integration in solving various Mathematical and Engineering problems. • Calculate the approximate area under a curve by applying integration and numerical methods. • Discuss the purposes of measures of central tendency and calculate the measures of central tendency (mode, median, mean) for a set of data. • Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

PO5: Perform task under close supervision with some responsibility for own work within defined limit.	• Take measurements with the help of basic measuring tools/equipment. • Select materials, tools, and sequence of operations to make a job as per given specifications/drawing. • Prepare simple jobs independently and inspect the same. • Use safety equipment and Personal Protection Equipment (PPE). • Maintain good housekeeping practices.

11. SUBJECTS & DETAILED CONTENTS

FIRST SEMESTER

1.1 ENGLISH & COMMUNICATION SKILLS – I

L	P
2	2

RATIONALE

Language as the most commonly used medium of self-expression remains indispensable in all spheres of human life –personal, social and professional. This course is intended to break fresh ground in teaching of Communicative English as per the requirements of National Skill Quality Framework. This course is designed to help students to acquire the concept of communication and develop an ability or skills to use them effectively to communicate with the individuals and community.

COURSE OUTCOMES

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

CO1: Identify the nuances of Communication, both Oral and Written.

CO2: Acquire knowledge of the meaning of communication, communication process and speaking skills.

CO3: Acquire enhanced vocabulary and in-depth understanding of Grammatical Structures and their usage in the communication.

CO4: Communicate effectively with an increased confidence to read, write and speak in English language fluently.

DETAILED CONTENTS

UNIT I

Reading

1.1 Techniques of reading: Skimming and Scanning

1.2 Extensive and Intensive Reading: Textual Study

1.3 Homecoming – R.N. Tagore

1.4 Life Sketch of Sir Mokshagundam Visvesvarayya

1.5 Life Sketch of Dr. Abdul Kalam

1.6 Narayan Murthy's speech at LBSNA, Dehradun

UNIT II

Fundamentals of Communication

2.1 Concept and Process of Communication

2.2 Types of Communication (Verbal Communication)

2.3 Barriers to Communication
2.4 Speaking Skill: Significance and essentials of Spoken Communication
2.5 Listening Skill: Significance and essentials of Listening

UNIT III

Grammar and Usage

3.1 Nouns
3.2 Pronouns
3.3 Articles
3.4 Verbs(Main and Auxiliary)
3.5 Tenses

UNIT IV

Writing Skills

4.1 Significance, essentials and effectiveness of Written Communication
4.2 Notice Writing
4.3 Official Letters and E-mails.
4.4 Frequently-used Abbreviations used in Letter-Writing
4.5 Paragraph Writing
4.6 Netiquettes

PRACTICAL EXERCISES

1. Reading

Reading Practice of lessons in the Lab Activity classes.

i. Comprehension exercises of unseen passages along with the lessons prescribed.
ii. Vocabulary enrichment and grammar exercises based on the selected readings.
iii. Reading aloud Newspaper headlines and important articles.

2. Fundamentals of Communication

i. Introducing oneself, others and leave- taking(talking about yourself)
ii. Just a minute (JAM) sessions: Speaking extempore for one minute on given topics
iii. Situational Conversation: Offering-Responding to offers; Congratulating; Apologizing and Forgiving; Complaining; Talking about likes and dislikes, Self-introduction Mock Interviews

3. Grammar and Usage

i. Written and Oral Drills will be undertaken in the class to facilitate holistic linguistic competency among learners.
ii. Exercises on the prescribed grammar topics.

4. Writing Skills

i. Students should be given Written Practice in groups so as to inculcate team-spirit and collaborative learning .

ii. Group exercises on writing paragraphs on given topics.

iii. Opening an e-mail account, receiving and sending emails

RECOMMENDED BOOKS

1) Alvinder Dhillon and Parmod Kumar Singla, "Text Book of English and Communication Skills Vol – 2", M/S Abhishek Publications, Chandigarh.
2) V Sasikumar & PV Dhamija, "Spoken English", Tata MC Graw Hills, New Delhi, Second Edition.
3) JK Gangal, "A Practical Course in Spoken English", PHI Learning Pvt. Ltd., New Delhi.
4) NK Aggarwal and FT Wood, "English Grammar, Composition and Usage", Macmillan Publishers India Ltd., New Delhi.
5) RC Sharma and Krishna Mohan, "Business Correspondence & Report writing", Tata MC Graw Hills, New Delhi, Fourth Edition.
6) Kavita Tyagi & Padma Misra, "Professional Communication", PHI Learning Pvt. Ltd., New Delhi.
7) Nira Konar, "Communication Skills for professionals", PHI Learning Pvt. Ltd., New Delhi.
8) Krishna Mohan & Meera Banerji, "Developing Communication Skills", Macmillan Publishers India Ltd., New Delhi, Second Edition
9) M. Ashraf Rizwi, "Effective Technical Communication", Tata MC Graw Hills, New Delhi.
10) Andrea J Rutherfoord, "Basic Communication Skills for Technology", Pearson Education, New Delhi.

INSTRUCTIONAL STRATEGY

This is practice based subject and topics taught in the class should be practiced as exercises in the Lab regularly for development of communication skills in the students. The students should be involved in activities to enhance their personality skills. This subject contains four units of equal weightage.

1.2 APPLIED MATHEMATICS - I

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RATIONALE

Contents of this course provide fundamental base for understanding engineering problems and their solution algorithms. Contents of this course will enable students to use basic tools like logarithm, binomial theorem, matrices, t-ratios and co-ordinates for solving complex engineering problems with exact solutions in a way which involve less computational task. By understanding the logarithm, they will be able to make long calculations in short time and it is also a pre-requisite for understanding Calculus.

COURSE OUTCOMES

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

CO1: Illustrate the geometric shapes used in engineering problems by Co-ordinate Geometry and Trigonometry.

CO2: Formulate engineering problems into mathematical formats with the use matrices, co-ordinate geometry and trigonometry

CO3: Calculate the approximate value of roots of certain expressions in engineering problems by application of binomial theorem.

CO4: Explore the idea of location, graph, and linear relationships between two variables.

CO5: Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

DETAILED CONTENTS

UNIT I

Algebra

- Complex Numbers: definition of complex number, real and imaginary parts of a complex number, Polar and Cartesian Form and their inter conversion, Conjugate of a complex number, modulus and amplitude, addition subtraction, multiplication and division of complex numb
- Logarithms and its basic properties

UNIT II

Binomial Theorem, Determinants and Matrices

- Meaning of ${}^{n}P_{r}$ & ${}^{n}C_{r}$ (mathematical expression). Binomial theorem (without proof) for positive integral index (expansion and general form); binomial theorem for any index (expansion up to 3 terms - without proof), first binomial approximation with application to engineering problems.
- Determinants and Matrices – Evaluation of determinants (upto 2^{nd}order), solution of equations (upto 2 unknowns) by Crammer's rule, definition of Matrices and its types, addition, subtraction and multiplication of matrices (upto 2^{nd} order).

UNIT III

Trigonometry

- Concept of angle, measurement of angle in degrees, grades, radians and their conversions.
- T-Ratios of Allied angles (without proof), Sum, Difference formulae and their applications (without proof). Product formulae (Transformation of product to sum, difference and vice versa
- Applications of Trigonometric terms in engineering problems such as to find an angle of elevation, height, distance etc.

UNIT-IV

Co-ordinate Geometry

- Cartesian and Polar co-ordinates (two dimensional), Distance between two points, mid- point, centroid of vertices of a triangle.
- Slope of a line, equation of straight line in various standards forms (without proof); (slope intercept form, intercept form, one-point form, two-point form, symmetric form, normal form, general form), intersection of two straight lines, concurrency of lines, angle between straight lines, parallel and perpendicular lines, perpendicular distance formula, conversion of general form of equation to the various forms.

UNIT V

- **Geometry of Circle and Software Circle**

General equation of a circle and its characteristics. To find the equation of a circle, given:

i. Centre and radius
ii. Three points lying on it
iii. Coordinates of end points of a diameter

- **Software**

MATLAB Or SciLab software – Theoretical Introduction, MATLAB or Scilab as Simple Calculator (Addition and subtraction of values –Trigonometric and Inverse Trigonometric functions) – General Practice

RECOMMENDED BOOKS

1. R. D. Sharma, "Applied Mathematics – I & II for Diploma Courses", Dhanpat Rai Publications.
2. "Mathematics for Class XI", NCERT Publication, New Delhi.
3. "Mathematics for Class XII", NCERT Publication, New Delhi.
4. H. K Dass, "Applied Mathematics for Polytechnics", CBS Publishers & Distributers.
5. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics – I", CBS Publisher, New Delhi.
6. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –II", CBS Publisher, New Delhi.
7. G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", Addison Wesley, Ninth Edition.
8. B S Grewal, "Elementary Engineering Mathematics", Khanna Publishers, Delhi, Thirty-fifth Edition.
9. R.K. Jain and S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, New Delhi, Second Edition, 2003.
10. SS Sabharwal & Dr Sunita Jain, "Applied Mathematics Vol. I & II", Eagle Parkashan, Jalandhar.
11. S Kohli, "Engineering Mathematics Vol. I & II", IPH, Jalandhar.
12. Reena Garg & Chandrika Prasad, "Advanced Engineering Mathematics", Khanna Publishing House, New Delhi
13. R. Pratap, "Getting Started with MATLAB 7", Oxford University Press, Seventh Edition.
14. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://www.scilab.org

INSTRUCTIONAL STATREGY

This is theoretical subject and contains five units of equal weight age. Basic elements of algebra, trigonometry and co-ordinate geometry can be taught in the light of their applications in the field of engineering and technology. By laying more emphasis on applied part, teacher can also help in providing a good continuing education base to the students. Students need to be taught the skills needed to use software tools built by experts through multiple problem solving based on the topics related to Algebra, Trigonometry and Coordinate Geometry that the industry requires. Examples to be used should be related to engineering.

Useful software MATLAB or open source software SciLab can be taught theoretically by books/online literatures and basic operations can be shown practically with practical software laboratory or small mobile apps of these software or authentic Trial version of MATLAB/ SciLab software. Students should be able to relate to the actual use of these examples and the way mathematical calculations will help them in doing their job.

1.3 APPLIED PHYSICS-I

L	P
2	2

RATIONALE

Applied physics includes the study of a large number of diverse topics all related to things that go on in the world around us. It aims to give an understanding of this world both by observation and by prediction of the way in which objects will behave. Concrete use of physical principles and analysis in various fields of technical are given prominence in the course content.

COURSE OUTCOMES

After completing this subject, student should be able to:

CO1: Identify physical quantities, select their units for use in engineering solutions, and make measurements with accuracy.

CO2: Represent physical quantities as scalar and vector and identify type of motions, various forms of energy, their conversion and applications.

CO3: Elaborate scientific work, energy and power, forms of friction and solve problems related to them.

CO4: Comprehend properties of matter and effect of temperature on various matter and phenomenon.

CO5: Demonstrate the use of physical principles and analysis in various fields of technology.

DETAILED CONTENTS

UNIT I

Unit and Dimensions

1.1 Definition of Physics, physical quantities- fundamental and derived

1.2 Units: fundamental and derived

1.3 System of units: CGS, FPS, MKS, SI

1.4 Dimension, dimensional formulae and SI units of physical quantities-distance, displacement, area, volume, density, velocity, acceleration, linear momentum, force, impulse, work, power, energy, pressure, surface tension, stress, strain)

1.5 Dimensional equations, principle of homogeneity of dimensional equation

1.6 Application of dimensional analysis: checking the correctness of physical equation, conversion of system of unit (force, work, acceleration)

UNIT II

Force and Motion

2.1 Scalar and vector quantities– definition and examples, representation of vector, types of vector (unit vector, position vector, co-initial vector, collinear vector, co-planar vector)

2.2 Vector algebra- addition of vectors, Triangle & Parallelogram law (statement and formula only),

2.3 Scalar and vector product (statement and formula only)

2.4 Force and its units, resolution of force (statement and formula only)

2.5 Newton's laws of motion (statement and examples)

2.6 Linear momentum, Law of conservation of linear momentum (statement and examples), Impulse

2.7 Circular motion: definition of angular displacement, angular velocity, angular acceleration, frequency, time period; Relation between linear and angular velocity, centripetal and centrifugal forces (definition and formula only), application of centripetal force in banking of road

2.8 Rotational motion: definition with examples

2.9 Definition of torque, angular momentum, moment of inertia and its physical significance

UNIT III

Work, Power and Energy

3.1 Work- definition, symbol, formula and SI unit, types of work (zero work, positive work and negative work) with example

3.2 Friction– definition and its simple daily life applications

3.3 Power- definition, formula and units

3.4 Energy- definition and its SI unit, examples of transformation of energy.

3.5 Kinetic energy- definition, examples, formula and its derivation

3.6 Potential energy- definition, examples, formula and its derivation

3.7 Law of conservation of mechanical energy for freely falling bodies (with derivation)

3.8 Simple numerical problems based on formula of Power and Energy

UNIT IV

Properties of Matter

4.1 Elasticity and plasticity- definition, deforming force, restoring force, example of elastic and plastic body

4.2 Definition of stress and strain, Hooke's law, modulus of elasticity

4.3 Pressure- definition, atmospheric pressure, gauge pressure, absolute pressure, Pascal's law

4.4 Surface tension- definition, SI unit, applications of surface tension, effect of temperature on surface tension

4.5 Viscosity: definition, unit, examples, effect of temperature on viscosity

UNIT V

Heat and Temperature

5.1 Definition of heat and temperature (on the basis of kinetic theory)

5.2 Difference between heat and temperature

5.3 Principle and working of mercury thermometer

5.4 Modes of transfer of heat- conduction, convection and radiation with examples.

5.5 Properties of heat radiation

5.6 Different scales of temperature and their relationship

PRACTICAL EXERCISES

1. Familiarization of measurement instruments and their parts (for example - vernier calliper, screw gauge, spherometer, travelling microscope etc.), and taking a reading. (compulsory to all students)
2. To find diameter of solid cylinder using a vernier calliper
3. To find internal diameter and depth of a beaker using a vernier calliper and hence find its volume.
4. To find the diameter of wire using screw gauge
5. To find thickness of paper using screw gauge.
6. To determine the thickness of glass strip using a spherometer
7. To determine radius of curvature of a given spherical surface by a spherometer.
8. To verify parallelogram law of force
9. To determine the atmospheric pressure at a place using Fortin's Barometer
10. To determine force constant of spring using Hooke's law
11. Measuring room temperature with the help of thermometer and its conversion in different scale.

RECOMMENDED BOOKS

1. "Text Book of Physics for Class XI (Part-I, Part-II)", N.C.E.R.T., Delhi.
2. Dr. HH Lal, "Applied Physics, Vol. I and Vol. II", TTTI Publications, Tata McGraw Hill, Delhi.
3. AS Vasudeva, "Applied Physics – I", Modern Publishers, Jalandhar.
4. R A Banwait, "Applied Physics – I", Eagle Prakashan, Jalandhar.
5. E-books/e-tools/relevant software to be used as recommended by AICTE/ HSBTE/ NITTTR.

6. C. L. Arora, “Practical Physics”, S Chand Publication.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. The Physics Classroom
3. https://www.khanacademy.org/science/physics

INSTRUCTIONAL STATREGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

Teacher may use various teaching aids like models, charts, graphs and experimental kits etc. for imparting effective instructions in the subject. Students need to be exposed to use of different sets of units and conversion from one unit type to another. Software may be used to solve problems involving conversion of units. The teacher should explain about field applications before teaching the basics of mechanics, work, power and energy, rotational motion, properties of matter etc. to develop proper understanding of the physical phenomenon. Use of demonstration can make the subject interesting and develop scientific temper in the students. Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to appreciate learning of these concepts and principles. In all contents, SI units should be followed. Working in different sets of units can be taught through relevant software.

1.4 ENGINEERING GRAPHICS

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RATIONALE

Drawing is the language of engineers and technicians. Reading and interpreting engineering drawings is their day to day responsibility. The subject is aimed at developing basic graphic skills in the students so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation. The emphasis, while imparting instructions, should be to develop conceptual skills in the students following BIS SP 46 – 1988.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Draw Orthographic views of different objects viewed from different angles.

CO2: Draw and interpret sectional views of an object which are otherwise not visible in normal view.

CO3: Draw Isometric views of different solids and develop their surfaces.

CO4: Identify conventions for different engineering materials, symbols, sections of regular objects and general fittings used in Civil and Electrical household appliances /fittings.

CO5: Draw orthographic views of different objects by using basic commands of AutoCAD.

DETAILED CONTENTS

UNIT I

- **Introduction to Engineering Drawing and Graphics**
  - Introduction to use and care of drawing instruments, drawing materials, layout and sizes of drawing sheets and drawing boards.
  - Symbols and conventions- Conventions of Engineering Materials, Sectional Breaks and Conventional lines, Civil Engineering Sanitary fitting symbols, Electrical fitting symbols for domestic interior installations.
  - Geometrical construction-geometrical figures such as triangles, rectangles, circles, ellipses and curves, hexagons, pentagons bisecting a line and arc , division of line and circle with the help of drawing instruments.
- **Technical Lettering of Alphabet and Numerals**
  - Definition and classification of lettering, Free hand (of height of 5,8,12 mm) and instrumental lettering (of height 20 to 35 mm) : upper case and lower case, single and

double stroke, vertical and inclined (Gothic lettering) at 75 degree to horizontal and with suitable height to width ratio 7:4.

- **Dimensioning**
  - Necessity of dimensioning, method and principles of dimensioning (mainly theoretical instructions).
  - Dimensioning of overall sizes, circles, threaded holes, chamfered surfaces, angles, tapered surfaces, holes, equally spaced on P.C.D., countersunk holes, counter bored holes, cylindrical parts, narrow spaces and gaps, radii, curves and arches.

- **Scales**
  - Scales –Needs and importance (theoretical instructions), Type of scales, Definition of Representative Fraction (R.F.) and Length of Scale.
  - To draw/construct plain and diagonal scales.

UNIT II

Orthographic Projections

- Theory of orthographic projections (Elaborate theoretical instructions).
- Three views of orthographic projections of different objects of given pictorial view of a block in 1st and 3rd angle.
- Projection of Points in different quadrant
- Projection of Straight Line (1st angle)
  - Line parallel to both the planes.
  - Line perpendicular to any one of the reference plane and parallel to others
  - Line inclined to any one of the references and parallel to another plane.
- Projection of Plane – Different lamina like square rectangular, triangular, circle and Hexagonal pentagon. Trace of planes (HT and VT).
- Identification of surfaces.

Sectioning

- Importance and salient features
- Drawing of full section, half section, partial or broken out sections, Offset sections, revolved sections and removed sections (theoretical only).
- Orthographic sectional views of different objects.

UNIT III

- Introduction of projection of right solids such as prism & pyramid (square, Pentagon, Hexagonal) cube, cone & cylinder (Axes perpendicular to H.P and parallel to V.P.)
- Introduction of sections of right solids - Section planes, Sections of Hexagonal prism,

pentagon pyramid, cylinder and cone (Section plane parallel to anyone reference planes and perpendicular to V.P. and inclined to H.P.)

- Development of Surfaces – Development of lateral surfaces of right solids like cone, cylinder, pentagonal prism, pyramid and hexagonal pyramid (Simple problems)

UNIT IV

Isometric Views

- Fundamentals of isometric projections and isometric scale.
- Isometric views of different laminas like circle, pentagon and hexagon.
- Isometric views of different regular solids like cylinder, cone, cube, cuboid, pyramid and prism.
- Isometric views from given different orthographic projections(front, side and top view)

UNIT V

Introduction to AutoCAD

Basic introduction and operational instructions of various commands in AutoCAD. At least two sheets of different objects on AutoCAD (given pictorial/isometric view of a block). AutoCAD skill of student is evaluated in internal assessment only not in external exam.

RECOMMENDED BOOKS

1. Surjit Singh, “A Text Book of Engineering Drawing”, Dhanpat Rai & Co., Delhi.
2. PS Gill, “Engineering Drawing”, SK Kataria & Sons, New Delhi.
3. ND Bhatt, “Elementary Engineering Drawing in First Angle Projection”, Charotar Publishing House Pvt. Ltd., Anands.
4. T. Jeyapoovan, “Engineering Drawing and Graphics using AutoCAD”, Vikas Publishing House Pvt, Ltd Noida.
5. S.R.Singhal and O.P.Saxena, “A Text Book of Engineering Drawing”, Asian Publisher, Delhi.
6. RB Gupta, “Engineering Drawing”, Satya Prakashan, New Delhi.

INSTRUCTIONAL STRATEGY

Teacher should show model of realia of the component/part whose drawing is to be made. Emphasis should be given on cleanliness, dimensioning and layout of sheet. Focus should be on proper selection of drawing instruments and their proper use. First angle projection is to be followed. Minimum of 20 sheets to be prepared and at least 2 sheets on AutoCAD**.** Instructions

relevant to various drawings may be given along with appropriate demonstrations, before assigning drawing practice to students. This subject contains five units of equal weight age.

1.5 FUNDAMENTALS OF IT

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RATIONALE

Information technology has great influence on all aspects of life. Almost all work places and living environment are being computerized. In order to prepare diploma holders to work in these environments, it is essential that they are exposed to various aspects of information technology such as understanding the concepts of information technology and its scope, operating a computer: use of various office management tools, using internet and mobile applications etc. This course is intended to make new students comfortable with computing environment - Learning basic computer skills, learning basic application software tools, Understanding Computer Hardware, Cyber security awareness.

COURSE OUTCOMES

At the end of the subject student will be able to

CO1: Explain the basic components of Computers, Internet and issues of abuses/ attacks on information and computers
CO2: Handle the computer/laptop/mobiles/Internet Utilities and Install/Configure OS
CO3: Assemble a PC and connect it to external devices
CO4: Manage and Use Office practiced Automation Tools
CO5: Develop worksheets and Prepare presentations

DETAILED CONTENTS

UNIT I

Basics of Computer

Brief history of development of computers, Definition of Computer, Block diagram of a Computer, Hardware, Software, Booting: Cold and Hot Booting, Interaction between the CPU and Memory with Input/Output devices, Function of CPU and major functional parts of CPU. Memory, Bit, Nibble, Byte, KB, MB, GB, TB, PB, Functions of memory, Use of storage devices in a Computer, List types of memory used in a Computer, Importance of cache memory, CPU speed and CPU word length

UNIT II

Basic Internet Skills

Understanding browser, Introduction to WWW, efficient use of search engines, awareness about Digital India portals (state and national portals) and college portals. Advantages of Email, Various email service providers, Creation of email id, sending and receiving emails, attaching documents with email and drive.

Effective use of Gmail, G-Drive, Google Calendar, Google Sites, Google Sheets, Online mode of communication using Google Meet & WebEx.

UNIT III

Basic Logic building

Introduction to Programming, Steps involved in problem solving, Definition of Algorithm, Definition of Flowchart, Steps involved in algorithm development, differentiate algorithm and flowchart, symbols used in flowcharts, algorithms for simple problems, flowcharts for simple problems, Practice logic building using flowchart/algorithms

UNIT IV

Office Tools

Office Tools like LibreOffice/OpenOffice/MSOffice.

OpenOffice Writer – Typesetting Text and Basic Formatting, Inserting Images, Hyperlinks, Bookmarks, Tables and Table Properties in Writer

Introducing LibreOffice/OpenOffice *Calc*, Working with Cells, Sheets, data, tables, using formulae and functions, using charts and graphics.

OpenOffice Impress – Creating and Viewing Presentations, Inserting Pictures and Tables, Slide Master and Slide Design, Custom Animation.

UNIT V

Use of Social Media

Introduction to Digital Marketing – Why Digital Marketing, Characteristics of Digital Marketing, Tools for Digital Marketing, , Effective use of Social Media like LinkedIn, Google+, Facebook, Twitter, etc.: Features of Social media, Advantages and Disadvantages of Social Media.

PRACTICAL EXERCISES

1. Browser features, browsing, using various search engines, writing search queries
2. Visit various e-governance/Digital India portals, understand their features, services offered
3. Read Wikipedia pages on computer hardware components, look at those components in lab, identify them, recognize various ports/interfaces and related cables, etc.
4. Using Administrative Tools/Control Panel Settings of Operating Systems

5. Connect various peripherals (printer, scanner, etc.) to computer, explore various features of peripheral and their device driver software.
6. Explore features of Open Office tools and MS-Office, create documents, create presentation, create spread sheet, using these features, do it multiple times
7. Working with Conversion Software like pdfToWord, WordToPPT, etc.
8. Working with Mobile Applications – Searching for Authentic Mobile app, Installation and Settings, Govt. of India Mobile Applications
9. Creating email id, sending and receiving mails with attachments.
10. Using Google drive, Google calendar
11. Create Flow chart and Algorithm for the following
    i. Addition of n numbers and display result
    ii. To convert temperature from Celsius to Fahrenheit
    iii. To find Area and Perimeter of Square
    iv. Swap Two Numbers
    v. find the smallest of two numbers
    vi. Find whether given number is Even or Odd
    vii. To print first n even Numbers
    viii. find sum of series 1+2+3+…..+N
    ix. print multiplication Table of a number
    x. generate first n Fibonacci terms 0,1,1,2,3,5…n (n>2)
    xi. sum and average of given series of numbers
    xii. Factorial of number n (n!=1x2x3x…n)
    xiii. Armstrong Number
    xiv. Find whether given number is Prime or not

RECOMMENDED BOOKS

1. R.S. Salaria, “Computer Fundamentals”, Khanna Publishing House.
2. Ramesh Bangia, “PC Software Made Easy – The PC Course Kit”, Khanna Publishing House.
3. Online Resources, Linux man pages, Wikipedia
4. Mokhtar Ebrahim and Andrew Mallett, “Mastering Linux Shell Scripting: A practical guide to Linux command-line, Bash scripting, and Shell programming”.
5. Vikas Gupta, “Comdex Hardware and Networking Course Kit”, Dream Tech press, New Delhi, 2008.
6. Sumitabha Das, “UNIX concepts and applications” Tata McGraw Hill, New Delhi, 2008, Fourth Edition.

SUGGESTED WEBSITES

1. https://nptel.ac.in/courses/106/106/106106222/ - NPTEL Course on Modern Application Development
2. https://onlinecourses.swayam2.ac.in/aic19_de01/preview -
3. https://spoken-tutorial.org/ - Tutorials on Introduction to Computers, HTML, LibreOffice Tools, etc.
4. NOTEPAD++
5. https://tms-outsource.com/blog/posts/web-development-ide/

INSTRUCTIONAL STRATEGY

This is a skill based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weight age.

1.6 ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT

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RATIONALE

A diploma holder must have knowledge of different types of pollution caused due to industrial and construction activities so that he/she may help in balancing the ecosystem and controlling pollution by various control measures. The course is intended to provide a general concept in the dimensions of environmental pollution and disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.

COURSE OUTCOMES

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

CO1: Comprehend the importance of sustainable ecosystem.
CO2: Clarify interdisciplinary nature of environmental issues.
CO3: Describe corrective measures for the abatement of pollution.
CO4: Identify the role of non-conventional energy resources in environmental protection.
CO5: Recognize various types of disasters.

DETAILED CONTENTS

UNIT I

Introduction

Basics of ecology, eco system- concept, and sustainable development, Sources, advantages, disadvantages of renewable and nonrenewable energy.

Rain water harvesting

Deforestation – its effects & control measures

UNIT II

Air and Noise Pollution

Air Pollution: Source of air pollution. Effect of air pollution on human health, economy, Air pollution control methods.

Noise Pollution: Source of noise pollution, Unit of noise, Effect of noise pollution, Acceptable noise level, Different method of minimizing noise pollution.

UNIT III

Water and Soil Pollution

Water Pollution: Impurities in water, Cause of water pollution, Source of water pollution. Effect of water pollution on human health, Concept of DO, BOD, COD. Prevention of water pollution-Water treatment processes, Sewage treatment. Water quality standard.

Soil Pollution :Sources of soil pollution, Effects and Control of soil pollution, Types of Solid waste- House hold, Industrial, Agricultural, Biomedical, Disposal of solid waste, Solid waste management E-waste, E – waste management

UNIT IV

Impact of Energy Usage on Environment

Global Warming, Green House Effect, Depletion of Ozone Layer, Acid Rain. Eco-friendly Material, Recycling of Material, Concept of Green Buildings, Concept of Carbon Credit & Carbon footprint.

UNIT V

Disaster Management

Different Types of Disaster

Natural Disaster: such as Flood, Cyclone, Earthquakes and Landslides etc.

Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc.

Disaster Preparedness

Disaster Preparedness Plan

Prediction, Early Warnings and Safety Measures of Disaster

Psychological response and Management (Trauma, Stress, Rumour and Panic)

RECOMMENDED BOOKS

1. S.C. Sharma & M.P. Poonia, “Environmental Studies”, Khanna Publishing House, New Delhi.
2. BR Sharma, “Environmental and Pollution Awareness”, Satya Prakashan, New Delhi.
3. Dr. RK Khitoliya, “Environmental Pollution”, S Chand Publishing, New Delhi.
4. Erach Bharucha, “Environmental Studies”, University Press (India) Private Ltd., Hyderabad.
5. Suresh K Dhamija, “Environmental Engineering and Management”, S K Kataria and Sons, New Delhi.
6. E-books/e-tools/relevant software to be used as recommended by AICTE/BTE/NITTTR, Chandigarh.
7. Dr. Mrinalini Pandey, “Disaster Management”, Wiley India Pvt. Ltd.

8. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill Education (India) Pvt. Ltd.

INSTRUCTIONAL STRATEGY

In addition to theoretical instructions, different activities pertaining to Environmental Studies and Disaster Management like expert lectures, seminars, visits etc. may also be organized This subject contains five units of equal weightage.

1.7 GENERAL WORKSHOP PRACTICE

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RATIONALE

In order to have a balanced overall development of diploma engineers, it is necessary to integrate theory with practice. General Workshop Practice is included in the curriculum in order to provide hands-on experience about use of different tools and basic manufacturing practices. This subject aims at developing general manual and machining skills in the students. In addition, the development of dignity of labour, safety at work place, team working and development of right attitude are the other objectives.

COURSE OUTCOMES

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

CO1: Identify tools, equipment and materials used in preparing jobs.

CO2: Take measurements with the help of basic measuring tools/equipment.

CO3: Select materials, tools, and sequence of operations to make a job as per given specifications/drawing.

CO4: Prepare simple jobs independently and inspect the same.

CO5: Use safety equipment and Personal Protection Equipment (PPE).

CO6: Maintain good housekeeping practices.

PRACTICAL EXERCISES

Note: The students are supposed to come in proper workshop dress prescribed by the institute. Wearing shoes in the workshop(s) is compulsory. Importance of safety and cleanliness, safety measures and upkeep of tools, equipment and environment in each of the following shops should be explained and practiced. The students should prepare sketches of various tools/jobs in their practical Notebook.

The following shops are included in the syllabus:

1. Welding Shop I
2. Fitting and Plumbing Shop I
3. Sheet Metal Shop
4. Carpentry Shop I
5. Painting Shop
6. Electric and Electronics Shop I

1. WELDING SHOP – I

1.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

1.2 Introduction and importance of welding process as compared to other material joining processes. Specifications and type of ARC welding machines, parts identification, classification, selection and coding of electrodes, welding parameters, welding joints and welding positions. Common weldable materials, safety precautions in welding shop, use of Personal Protective Equipment, Use of welding screens, Hazards and remedies during welding, Elementary symbolic representations, demo of tools, equipment, sample jobs prepared, set up of Gas welding apparatus, and welding defects.

1.3 Jobs to be prepared

- Job I Practice of striking arc and depositing uniform and straight beads onflat at different current levels. (Minimum 4 beads on M.S. flat at four setting of current level using shielded metal arc welding and differentiating their characteristics).
- Job II Edge Preparation and welding lap joint using shielded metal arcwelding (SMAW) process.
- Job III Edge Preparation and welding butt joint using shielded metal arcwelding process.
- Job IV Edge Preparation and welding T Joint using shielded metal arcwelding (100mm x 6 mm M.S. Flat).
- Job V To make a simple job using oxy acetylene gas welding.

2. FITTING AND PLUMBING SHOP – I

2.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

2.2 Introduction and Function of holding/ clamping devices, hand tools and cutting tools,

2.3 Practical applications of fitting and plumbing

2.4 Introduction, function and types of marking and measuring tools and instruments (surface plate, try square, caliper, steel rule, scriber and Vernier caliper)

2.5 Identification of materials. (Iron, Copper, Stainless Steel, Aluminum etc.) and identification of various steel sections (flat, angle, channel, bar etc.).

2.6 Introduction to various types of pipes (eg water, steam, gas etc) and functions of various pipe fitting items (GI pipe fittings, CPVC pipe fittings), Methods of pipe joints

2.7 Introduction to various types of threads (internal and external)

2.8 Description and demonstration of various types of drills, taps and dies.

2.9 Jobs to be prepared:

- Job I To fit hacksaw blade in its frame and perform hacksawing operation byusing marking media and marking tool and straight sawing practice.
- Job II To perform filing on MS workpiece (75 * 50 * 6 mm) for giving it aperfect rectangular shape and drilling, tapping operation.

Job III To perform step filing operation at right angle on MS workpiece.

Job IV Making external threads on a pipe by using die and to make a PVC/GI pipe connection using nipple and socket.

Job V Fitting of all components of wash basin and ball valve in a tank.

3. SHEET METAL SHOP

3.1. Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

3.2 Demonstration of various power tools, apparatus, equipment, hand tools used in sheet metal shop.

3.3 Jobs to be prepared

Job I Prepare a seam joint by using hand tools on GI sheet.

Job II To prepare riveted lap joint (single/double) on GI sheet.

Job III To fabricate a funnel of GI sheet using operations of shearing, flatteningand bending.

Job IV To fabricate a conduit joint using various sheet metal operations.

Job V To fabricate a utility job (eg soap case/file tray/canister box) of thin GIsheet.

4. CARPENTRY SHOP - I

4.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

4.2 Introduction and industrial applications of carpentry jobs.

4.2.1 Name and use of raw materials used in carpentry shop : wood & alternative materials(board, plywood)

4.2.2 Introduction to wood, timber and their identification, shapes and specifications, their properties, applications & defects. Study of the joints in roofs, doors, windows and furniture, seasoning of wood

4.2.3 Names, uses, and types of hand tools such as Saws, C-Clamp, Chisels, Mallets, Carpenter's vices, Marking gauges, Try-squares, Rulers and other commonly used tools and materials used in carpentry shop by segregating as cutting tools, supporting tools, holding tools, measuring tools etc.

4.2.4 Specification of iron jack plane used in carpentry shop.

4.3 Practice

4.3.1 Practices for Basic Carpentry Work

4.3.2 Sawing practice using different types of saws

4.3.3 Assembling jack plane — planning practice including sharpening and bladeadjustment of jack plane cutter

4.3.4 Chiselling practice using different types of chisels including sharpening ofchisel

4.3.5 Making of different types of wooden pin and fixing methods. Markingmeasuring and inspection of jobs.

4.3.6 Housekeeping practices and instructions.

4.4 Jobs to be Prepared

Job 1 Prepare a rectangular wooden block involving operations likeMarking, sawing, planning to size, chiseling.

Job II Prepare a Half Lap Joint (cross, L or T – any one).

Job III Prepare a Mortise and Tenon joint (T-Joint).

Job IV Prepare a Dove tail Joint (Half lap dovetail joint.

Job V Prepare a Bridle Joint.

5. PAINTING SHOP

5.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

5.2 Introduction to paints, varnishes, primers and their types, General properties of paints, Constituents of paints, polishes, their advantages and applications.

5.3 Introduction of powder coating and spray painting with their uses. Different types of tools and equipment used in polishing and painting.

5.4 Preparation of different colours of the paints by using prime colours, Practical demonstration of powder coating and spray painting on a utility object

5.5 Jobs to be Prepared

Job I Prepare wooden surface for painting such as cleaning, sanding, applying putty, filling procedure and application of primer coat andbrush paint the same.

Job II Painting on wooden and metallic surfaces by spray gun.

Job III Practice of lettering: name plates / sign board.

Job IV Practice of dip painting/powder coating.

Job V Prepare wooden surface for polishing, apply French polish on woodensurface.

6. ELECTRICAL AND ELECTRONICS SHOP - I

6.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

6.2 Demonstration and identification of common electrical materials with standard ratings and specifications such as wires, cables, switches, MCB & ELCB, fuses, cleats, clamps and allied items, tools and accessories.

6.3 Identification of phase, Neutral and Earth wires for connection to domestic electrical appliances and their connections to three pin plugs. Difference between series and parallel wiring.

6.4 Jobs to be performed

Job I Carrying out house wiring circuits using fuse, switches, sockets,ceiling rose etc. in batten or P.V.C. casing-caping. Demo of conduit wiring through junctions.

Job II To prepare a three level Godown wiring circuit with PVC conduitwiring system.

Job III Installation of Solar Panel, inverter and batteries.

6.5 Identification and familiarization with the following tools used in electronic shop such as Tweezers, Screw drivers (different sizes), Insulated Pliers, Cutter, Sniper, Philips Screw Driver (Star Screw Driver), L- Keys, Soldering Iron, soldering wire, flux and their demonstration and uses. Identification and familiarization with multimeter (analog and digital). Various types of protective devices such as wire fuse, cartridge fuse etc. Identification and familiarization with ear phone speaker connector, telephone jacks and similar male and female connectors (audio, video).

6.6 Jobs to be performed

Job IV Practice in the use of tools and instruments used in electronicshop. For this a small experimental set up may be done.

Job V Cut, strip, join an insulated wire with the help of soldering iron (repeat with different types of wires).

RECOMMENDED BOOKS

1. SK Hajra Choudhary and AK Choudhary, "Workshop Technology I, II, III", Media Promoters and Publishers Pvt. Ltd., Mumbai, Fifteenth Edition, 2016.
2. RK Jain, "Workshop Technology Vol I& II'', Khanna Publishers, New Delhi, First Edition,2021.
3. Manchanda, "Workshop Technology Vol. I, II, III", India Publishing House, Jalandhar.
4. S.S. Ubhi, "Workshop Training Manual Vol. I, II'', Katson Publishers, Ludhiana.
5. K Venkata Reddy, "Manual on Workshop Practice", MacMillan India Ltd., New Delhi,Sixth Edition, 2020.
6. "General Workshop Manual (Diploma Jobs)", Khanna Publishers, First Edition, 2021.
7. T Jeyapoovan, "Basic Workshop Practice Manual", Vikas Publishing House (P) Ltd., NewDelhi.
8. B. S. Raghuvanshi, "Workshop Technology, Vol. I", Dhanpat Rai and Sons, Delhi, EleventhEdition, 2017.
9. Kannaiah K L, Narayana, "Workshop Manual", Scitech Publications, Chennai, Second Edition 1998.
10. H S Bawa, "Workshop Practice", Tata McGraw Hill Publication, First Edition, 2004

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students.

SECOND SEMESTER

SECOND SEMESTER

2.1 APPLIED MATHEMATICS - II

L	P
4	-

RATIONALE

Applied mathematics forms the backbone of engineering students. Basic elements of Differential calculus, Integral calculus and Differential Equations have been included in this course. This will develop analytical abilities to apply in engineering field and will provide continuing educational base to the students.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Formulate the engineering problems into mathematical format with the use of differential equations and differential

C02: Use the differentiation and Integration in solving various Mathematical and Engineering problems.

CO3: Calculate the approximate area under a curve by applying integration and numerical methods.

CO4: Discuss the purposes of measures of central tendency and calculate the measures of central tendency (mode, median, mean) for a set of data.

CO5: Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

DETAILED CONTENTS

UNIT I

Differential Calculus

1.1 Definition of function; Concept of limits (Introduction only) and problems related to four standard limits only.

1.2 Differentiation of x^n, sin x, cos x, e^x by first principle.

1.3 Differentiation of sum, product and quotient of functions.

UNIT II

Differential Calculus and Its Applications

2.1 Differentiation of trigonometric functions, inverse trigonometric functions. Logarithmic differentiation, successive differentiation (upto 2nd order)

2.2 Application of differential calculus in:

(a) Rate measures (b) Maxima and minima

UNIT III

Integral Calculus

3.1 Integration as inverse operation of differentiation with simple examples.

3.2 Simple standard integrals and related problems, Integration by Substitution method and Integration by parts.

3.3 Evaluation of definite integrals with given limits.

Evaluation of $\int_0^{\pi/2} \sin^n x.\, dx$, $\int_0^{\pi/2} \cos^n x\, dx$, $\int_0^{\pi/2} \sin^m x\, \cos^n x\, dx$

using formulae without proof (m and n being positive integers only) using pre-existing mathematical models.

UNIT IV

Application of Integration, Numerical Integration and Differential Equations

4.1 Applications of integration: for evaluation of area under a curve and axes (Simple problems).

4.2 Numerical integration by Trapezoidal Rule and Simpson's $1/3^{rd}$ Rule using pre-existing mathematical models.

Differential Equations

4.3 Definition, order, degree, Type of differential Equations, linearity, Formulation of ordinary differential equation (up to 1^{st} order), solution of ODE (1^{st} order) by variable separation method.

UNIT V

Statistics and Software

Statistics

5.1 Measures of Central Tendency: Mean, Median, Mode

5.2 Measures of Dispersion: Mean deviation, Standard deviation

Software

5.3 SciLab software – Theoretical Introduction.

5.4 Basic difference between MATLAB and SciLab software,

5.5 Calculations with MATLAB or ScilLab - (a) Representation of matrix (2×2 order),
(b) Addition, Subtraction of matrices (2×2 order) in MATLAB or SciLab

RECOMMENDED BOOKS

1 R. D. Sharma, "Applied Mathematics – I & II for Diploma Courses", Dhanpat Rai Publications.

2 "Mathematics for Class XI", NCERT Publication, New Delhi.

3 "Mathematics for Class XII", NCERT Publication, New Delhi.

4 H. K Dass, "Applied Mathematics for Polytechnics", CBS Publishers & Distributers.
5 A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –I", CBS Publisher, New Delhi.
6 A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –II", CBS Publisher, New Delhi.
7 G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", Addison Wesley, Ninth Edition.
8 B S Grewal, "Elementary Engineering Mathematics", Khanna Publishers, Delhi, Thirty-fifth Edition.
9 R.K. Jain and S.R.K. Iyengar, "Advanced Engineering Mathematics" Narosa Publishing House, New Delhi, Second Edition, 2003.
10 SS Sabharwal & Dr Sunita Jain, "Applied Mathematics Vol. I & II", Eagle Parkashan, Jalandhar.
11 S Kohli, "Engineering Mathematics Vol. I & II", IPH, Jalandhar.
12 Reena Garg & Chandrika Prasad, "Advanced Engineering Mathematics", Khanna Publishing House, New Delhi.
13 R. Pratap, "Getting Started with MATLAB 7", Oxford University Press, Seventh Edition.
14 E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1) https://www.scilab.org
2) http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is theoretical subject and contains five units of 20% equal weight age.
Basic elements of Differential Calculus, Integral Calculus, and Differential Equations can be taught in the light of their applications in the field of engineering and technology. By laying more stress on applied part, teachers can also help in providing continuing education base to the students. Students need to be taught the skills needed to use software tools built by experts through multiple problem solving based on the topics that the industry requires. For example they need to know how to use mathematical models that use integration as opposed to learning how integration can be used. Useful authenticated software MATLAB or open source software SciLab can be taught theoretically by books/online literatures and basic operations can be shown practically with practical software laboratory or small mobile apps of these software or authentic Trial version of MATLAB/ SciLab software. Diploma students need to know which tools to use and how to do the job.

2.2 APPLIED PHYSICS - II

L	P
2	2

RATIONALE

Applied physics includes the study of a large number of diverse topics all related to things that go on in the world around us. It aims to give an understanding of this world both by observation and by prediction of the way in which objects will behave. Concrete use of physical principles and analysis in various technical fields are given prominence in the course content to prepare students for various technical applications.

COURSE OUTCOMES

At the end of this course, the students will be able to:

CO1: Differentiate between types of waves and their motion.
CO2: Illustrate laws of reflection and refraction of light.
CO3: Demonstrate competency in phenomena of electrostatics and electricity.
CO4: Characterize properties of material to prepare new materials for various technical applications.
CO5: Demonstrate a strong foundation on Modern Physics to use at various technical applications.

DETAILED CONTENTS

UNIT I

Wave Motion and its Applications

1.1 Waves: definition, types (mechanical and electromagnetic wave).
1.2 Wave motion- transverse and longitudinal with examples, terms used in wave motion like displacement, amplitude, time period, frequency, wavelength, wave velocity; relationship among wave velocity, frequency and wave length.
1.3 Simple harmonic motion (SHM): definition, examples.
1.4 Cantilever: definition, formula of time period (without derivation).
1.5 Free, forced and resonant vibrations with examples

1.6 Sound waves: types (infrasonic, audible, ultrasonic) on the basis of frequency, noise, coefficient of absorption of sound, echo

UNIT II

Optics

2.1 Reflection and refraction of light with laws, refractive index.

2.2 Lens: introduction, lens formulae (no derivation), power of lens and simple numerical problems.

2.3 Total internal reflection and its applications, critical angle and conditions for total internal reflection.

2.4 Superposition of waves (concept only), definition of Interference, Diffraction and Polarization of waves.

2.5 Introduction to Microscope, Telescope and their applications.

UNIT III

Electrostatics and Electricity

3.1 Electric charge, unit of charge, conservation of charge.

3.2 Coulomb's law of electrostatics.

3.3 Electric field, electric lines of force (definition and properties), electric field intensitydue to a point charge.

3.4 Definition of electric flux, Gauss law (statement and formula).

3.5 Capacitor and capacitance (with formula and unit).

3.6 Electric current and its SI Unit, direct and alternating current.

3.7 Resistance, conductance (definition and unit).

3.8 Series and parallel combination of resistances.

3.9 Ohm's law (statement and formula).

UNIT IV

Classification of Materials and their Properties

4.1 Definition of energy level, energy bands.

4.2 Types of materials (conductor, semiconductor, insulator and dielectric) with examples, intrinsic and extrinsic semiconductors (introduction only).

4.3 Introduction to magnetism, type of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials with examples

4.4 Magnetic field, magnetic lines of force, magnetic flux

4.5 Electromagnetic induction (definition)

UNIT V

Modern Physics

5.1 Laser: introduction, principle, absorption, spontaneous emission, stimulated emission, population inversion

5.2 Engineering and medical applications of laser

5.3 Fibre optics**:** introduction to optical fibers (definition, principle and parts), light propagation, fiber types (mono-mode, multi-mode), applications in medical, telecommunication and sensors

5.4 Nanotechnology: introduction, definition of nanomaterials with examples, properties at nanoscale, applications of nanotechnology (brief)

PRACTICAL EXERCISES

1. Familiarization with apparatus (resistor, rheostat, key, ammeter, voltmeter, telescope, microscope etc.)
2. To find the time period of a simple pendulum.
3. To study variation of time period of a simple pendulum with change in length of pendulum.
4. To determine and verify the time period of Cantilever.
5. To verify Ohm's laws by plotting a graph between voltage and current.
6. To study colour coding scheme of resistance.
7. To verify laws of resistances in series combination.
8. To verify laws of resistance in parallel combination.
9. To find resistance of galvanometer by half deflection method.
10. To verify laws of reflection of light using mirror.
11. To verify laws of refraction using glass slab.
12. To find the focal length of a concave lens, using a convex lens.

RECOMMENDED BOOKS

1. "Text Book of Physics for Class XII (Part-I, Part-II)", N.C.E.R.T., Delhi.
2. Dr. HH Lal, "Applied Physics, Vol. I & II", TTTI Publications, Tata McGraw Hill,Delhi.
3. AS Vasudeva, "Applied Physics –II", Modern Publishers, Jalandhar.
4. R A Banwait, "Applied Physics – II", Eagle Prakashan, Jalandhar.
5. N Subrahmanyam, Brij Lal and Avadhanulu, "A text book of OPTICS", S Chand Publishing, New Delhi.

6. E-books/e-tools/relevant software to be used as recommended by AICTE/ HSBTE/NITTTR.
7. M H Fulekar, "Nanotechnology: Importance and Applications", IK InternationalPublishing House (P) Ltd., New Delhi.
8. C. L. Arora, "Practical Physics", S Chand Publication.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STATREGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

Teacher may use various teaching aids like models, charts, graphs and experimental kits etc. for imparting effective instructions in the subject. Students need to be exposed to use of different sets of units and conversion from one unit type to another. Software may be used to solve problems involving conversion of units. The teacher should explain about field applications before teaching the basics of mechanics, work, power and energy, rotational motion, properties of matter etc. to develop proper understanding of the physical phenomenon. Use of demonstration can make the subject interesting and develop scientific temper in the students.

Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to appreciate learning of these concepts and principles. In all contents, SI units should be followed. Working in different sets of units can be taught through relevant software.

2.3 APPLIED CHEMISTRY

L	P
3	2

RATIONALE

The regular use of a variety of chemistry based materials and processes in diverse technical and engineering fields have repeatedly proven the importance of Applied Chemistry and its role in current and future technological advancements. Ever increasing use of chemical materials in the emerging engineering applications demands engineers and technocrats to acquire an in-depth knowledge of Applied Chemistry to be able to choose the best suited materials to meet their needs while maintaining the environment sustainability. An understanding of the principles of Applied Chemistry will develop scientific attitude in the budding engineers to understand the physical and chemical properties of the available materials for engineering applications as well as an ability to design new and effective materials.

COURSE OUTCOMES

After studying this subject, students will be able to:

CO1: Classify the elements into metals, non-metals and metalloids.

CO2: Explain the extraction of metals from ores, their mechanical properties and modification of properties by alloy formation.

CO3: Classify fuels and lubricants and apply them in different engineering applications.

CO4: Identify the polymeric materials, assess their properties and design suitable polymeric materials for current and future applications.

CO5: Apply effective methods for corrosion prevention,

DETAILED CONTENTS

UNIT 1

Atomic Structure, Periodic Table and Chemical Bonding.

1.1 Bohr's model of atom (qualitative treatment only), dual character of matter: derivation of de-Broglie's equation, Heisenberg's Principle of Uncertainty, modern concept of atomic structure: definition of orbitals, shapes of s, p and d-orbitals, quantum numbers and their significance. Electronic configuration: Aufbau and Pauli's exclusion principles and Hund's rule, electronic

configuration of elements up to atomic number 30.

1.2 Modern Periodic law and Periodic table, classification of elements into s, p, d and f-blocks, metals, non-metals and metalloids (periodicity in properties excluded).

1.3 Chemical bonding: cause of bonding, ionic bond, covalent bond, and metallic bond (electron sea or gas model), Physical properties of ionic, covalent and metallic substances.

UNIT II

Metals and Alloys

2.1 Metals: mechanical properties of metals such as conductivity, elasticity, strength and stiffness, luster, hardness, toughness, ductility, malleability, brittleness, and impact resistance and their uses.

2.2 Definition of a mineral, ore, gangue, flux and slag. Metallurgy of iron from haematite using a blast furnace. Commercial varieties of iron.

2.3 Alloys: definition, necessity of making alloys, composition, properties and uses of duralumin and steel. Heat treatment of steel- normalizing, annealing, quenching, tempering.

UNIT III

Water, Solutions, Acids and Bases

3.1 Solutions: definition, expression of the concentration of a solution in percentage (w/w, w/v and v/v), normality, molarity and molality and ppm. Simple problems on solution preparation.

3.2 Arrhenius concept of acids and bases, strong and weak acids and bases, pH value of a solution and its significance, pH scale. Simple numerical problems on pH of acids and bases.

3.3 Hard and soft water, causes of hardness of water, types of hardness – temporary and permanent hardness, expression of hardness of water, ppm unit of hardness; disadvantages of hard water; removal of hardness: removal of temporary hardness by boiling and Clark's method; removal of permanent hardness of water by Ion-Exchange method; boiler problems caused by hard water: scale and sludge formation, priming and foaming, caustic embrittlement; water sterilization by chlorine, UV radiation and RO.

UNIT IV

Fuels and Lubricants

4.1 Fuels: definition and classification of higher and lower calorific values, units of calorific value, characteristics of an ideal fuel. Petroleum: composition and refining of petroleum; gaseous fuels: composition, properties and uses of CNG, PNG, LNG, LPG; relative advantages of liquid and gaseous fuels over solid fuels. Scope of hydrogen as future fuel.

4.2 Lubricants- Functions and qualities of a good lubricant, classification of lubricants with

examples; lubrication mechanism (brief idea only); physical properties (brief idea only) of a lubricant: oiliness, viscosity, viscosity index, flash and fire point, ignition temperature, pour point.

UNIT V

Polymers and Electrochemistry

5.1 Polymers and Plastics: definition of polymer, classification, addition and condensation polymerization; preparation properties and uses of polythene, PVC, Nylon-66, Bakelite; definition of plastic, thermoplastics and thermosetting polymers; natural rubber and neoprene, other synthetic rubbers (names only).

5.2 Corrosion: definition, dry and wet corrosion, factors affecting rate of corrosion, methods of prevention of corrosion—hot dipping, metal cladding, cementation, quenching, cathodic protection methods

5.3 Introduction and application of nanotechnology: nano-materials and their classification, applications of nanotechnology in various engineering applications (brief).

PRACTICAL EXERCISES

1. To prepare standard solution of oxalic acid.
2. To dilute the given $KMnO_4$ solution
3. To find out the strength in grams per litre of an unknown solution of sodium hydroxide using a standard (N/10) oxalic acid solution.
4. To find out the total alkalinity in parts per million (ppm) of a water sample with the help of a standard sulphuric acid solution.
5. To determine the total hardness of given water sample by EDTA method
6. To determine the amount of total dissolved solids(TDS) in ppm in a given sample of water gravimetrically
7. To determine the pH of different solutions using a digital pH meter.
8. To determine the calorific value of a solid/liquid fuel using a Bomb calorimeter.
9. To determine the viscosity of a lubricating oil using a Redwood viscometer
10. To prepare a sample of Phenol-formaldehyde resin (Bakelite)/Nylon-66 in the lab.

RECOMMENDED BOOKS

1. "Textbook of Chemistry for class XI and XII (part I & II)", NCERT, Delhi, 2017-18.
2. C.N. R. Rao, "Understanding Chemistry", Universities Press (India) Pvt. Ltd, 2011.

3. Jain & Jain, "Engineering Chemistry", Dhanpat Rai and Sons; New Delhi, 2015.
4. Dr. G. H. Hugar & Prof A. N. Pathak, "Applied Chemistry Laboratory Practices, Vol. I andVol. II", NITTTR, Chandigarh, Publications, 2013-14.
5. Rajesh Agnihotri, "Chemistry for Engineers", Wiley India Pvt. Ltd, 2014.
6. "Applied Chemistry" by Usha Raju.

SUGGESTED WEBSITES

1. www.chemguide.co.uk/atommenu.html (Atomic structure and chemical bonding)
2. www.visionlearning.com (Atomic structure and chemical bonding)
3. www.cheml.com (Atomic structure and chemical bonding)
4. https://www.wastewaterelearning.com/elearning/ (Water treatment)
5. www.capital-refractories.com (Metals, Alloys, Cement, and Refractory Materials)
6. www.em-ea.org/guide%20books/book-2/2.1%20fuels%20and%20combustion.pdf (Fuel and Combustion)

INSTRUCTIONAL STRATEGY

Teachers may take help of various models and charts while imparting instructions to make the concept clear. More emphasis should be laid on discussing and explaining practical applications of various chemical process and reactions. In addition, students should be encouraged or motivated to study those processes in more details, which may find practical application in their future professional career. This subject contains five units of equal weightage.

2.4 APPLIED MECHANICS

L	P
3	2

RATIONALE

This course Applied Mechanics deals with basic concepts of mechanics like laws of forces, moments, friction, centre of gravity, laws of motion and simple machines which are required by the students for further understanding of other allied subjects. The subject enhances the analytical ability of the students.

COURSE OUTCOMES

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

CO1: Draw free body diagrams.by analyzing different types of forces acting on a body.
CO2: Determine the resultant of coplanar concurrent forces.
CO3: Solve problems by using principle of moment.
CO4: Calculate the least force required to maintain equilibrium on an inclined plane.
CO5: Determine the centroid/centre of gravity of plain and composite laminar and solid bodies.
CO6: Determine velocity ratio, mechanical advantage and efficiency of simple machines.

DETAILED CONTENTS

UNIT 1

Introduction

Concept of mechanics, Classification of mechanics, utility of mechanics in engineering field, Concept of rigid body, scalar and vector quantities.

Laws of forces

Definition of force, measurement of force in SI units, its representation, types of force: Point force/concentrated force & Uniformly distributed force, effects of force, characteristics of a force, Different force systems (coplanar and non-coplanar), principle of transmissibility of forces, law of superposition, Free body diagram, Composition and resolution of coplanar concurrent forces, resultant force, method of composition of forces, laws of forces, parallelogram law of forces (with derivation), triangle law of forces, polygon law of forces - graphically, analytically, resolution of forces, resolving

a force into two rectangular components, Lami's theorem, Simple numericals, Equilibrium of forces and its determination.

UNIT II

Moment

Concept of moment, Moment of a force and units of moment, Varignon's theorem (definition only), Principle of moment and its applications (Levers – simple and compound, steel yard, safety valve), Simple numericals. Parallel forces (like and unlike parallel force), calculating their resultant, Concept of couple, its properties and effects, General conditions of equilibrium of bodies under coplanar forces, Position of resultant force by moment.

UNIT III

Friction

Definition and concept of friction, types of friction, force of friction, Laws of static friction, coefficient of friction, angle of friction, angle of repose, cone of friction, Equilibrium of a body lying on a horizontal plane, equilibrium of a body lying on a rough inclined plane. Calculation of least force required to maintain equilibrium of a body on a rough inclined plane subjected to a force acting along the inclined plane and subjected to a force acting at some angle with the inclined plane, Simple numericals.

UNIT IV

Centre of Gravity and Centroid

Concept, definition of centroid of plain figures and centre of gravity of symmetrical solid bodies. Axis of symmetry, Reference axis. Determination of centroid of plain and composite lamina (T, L, C and I shape) using moment method only, centroid of bodies with removed portion. Determination of center of gravity of solid bodies - cone, cylinder, hemisphere and sphere; composite bodies and bodies with portion removed.

Laws of Motion

Newton’s laws of motion and their applications, Concept of momentum. Derivation of force equation from second law of motion, numerical problems on second law of motion. Bodies tied with string, Newton’s third law of motion, numerical problems, conservation of momentum, impulse and impulsive force.

UNIT V

Simple Machines

Definition of effort, velocity ratio, mechanical advantage and efficiency of a machine and their relationship, law of machines, Simple and compound machine (Examples). Definition of ideal machine, reversible and self locking machine. Effort lost in friction, Load lost in friction, determination of maximum mechanical advantage and maximum efficiency, Simple numericals. System of pulleys (first, second, third system of pulleys), determination of velocity ratio, mechanical advantage and efficiency. Working principle and application of wheel and axle, Weston's Differential Pulley Block, simple screw jack, worm and worm wheel, single and double winch crab. Expression for their velocity ratio and field of their application.

PRACTICAL EXERCISES

1. Verification of polygon law of forces using universal force table/Gravesend apparatus.
2. Verification of Lami's theorem.
3 To verify law of moments by using Bell crank lever.
4. To verify the forces in different members of jib crane.
5. To determine coefficient of friction between three pairs of given surface.
6. To find out center of gravity of regular lamina.
7. To find out center of gravity of irregular lamina.
8. To find the mechanical advantage, velocity ratio and efficiency of a screw jack.
9. To find the mechanical advantage, velocity ratio and efficiency of worm andworm wheel.
10. To find mechanical advantage, velocity ratio and efficiency of single purchase crab.

RECOMMENDED BOOKS

1. Birinder Singh,"Text Book of Applied Mechanics", Katson Publishing House, New Delhi.
2. A. K. Upadhyay, "Text Book of Applied Mechanics", SK Kataria & Sons, New Delhi.
3. S. Ramamurtham, "A Text Book of Applied Mechanics", Dhanpat Rai Publishing Company Pvt. Ltd, Delhi.
4. R. S. Khurmi, "A Text Book of Engineering Mechanics (Applied Mechanics)", S Chand andCo. Ltd., New Delhi.
5. R. K. Rajput, "A Text Book of Applied Mechanics", Laxmi Publications, New Delhi.
6. D. S. Bedi, "Engineering Mechanics", Khanna Publishing House, New Delhi.

INSTRUCTIONAL STRATEGY

This is hands-on practice based subject and topics taught in the class should be practiced in the lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

2.5 MECHANICAL ENGINEERING DRAWING-I

L	P
-	6

RATIONALE

Drawing is the language of engineers and technicians. Reading and interpreting engineering drawing is their day-to-day responsibility. The subject is aimed at developing basic graphic skills in the students so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation. The emphasis, while imparting instructions, should be to develop conceptual skills in the students following BIS SP 46 – 1988.

COURSE OUTCOMES

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

CO1: Draw the assembly from part details of objects.
CO2: Identify and draw different types of screw threads.
CO3: Draw different types of nuts, bolts and washers.
CO4: Draw various locking devices.
CO5: Draw different section of various types of keys and cotter joints.
CO6: Draw various riveted joints.
CO7: Draw various types of couplings used in power transmission.
CO8: Prepare drawing using AutoCAD.

PRACTICAL EXERCISES

Detail and Assembly Drawing **(02 sheets)**

Principle and utility of detail and assembly drawings, Practical exercise on drawing from detail to assembly or vice versa using different wooden joints as example (lap joint – T joint and corner joint, Mortise and tenon joint, Bridle joint, Mitre faced corner joint).

Threads **(02 sheets)**

Nomenclature of threads, types of threads. Single and multiple start threads, right hand and left hand thread. Forms of various external thread sections such as V thread (Metric thread, British associate,

American thread, Basic whitworth thread), Square, Acme, Knuckle, and Buttress thread. Simplified conventional representation of V thread.

Nuts and Bolts **(03 sheets)**

Different views of hexagonal and square headed nuts and bolts. Assembled view of nuts and bolts with washers. Foundation bolt- Rag bolt, Hook bolt. Lewis bolt, Eye bolt and curved bolt (Free hand)

Locking Devices **(01 sheet)**

Locking nuts - Castle nut, Sawn nut, and Split pin lock nut. Locking by spring washers,Locking plates.

Screws, Studs and Washers **(01 sheet)**

Drawing of various types of machine and set screws. Drawing of various types' of studs, through bolt, tap bolt and stud bolt.

Keys and Cotters **(03 sheets)**

Various types of keys and their application. Preparation of drawings of various keys and cotters. Various types of joints (a) Gib and Cotter joint (b) Knuckle joint (c) Spigot andSocket joint

Rivets and Riveted Joints **(02 sheets)**

Types of general purpose rivet heads (Snap Head, Pan Head , Flat and counter sunk). Types of riveted joints – lap (single and double riveted), butt (single cover plate and double cover plate), chain and zig-zag riveting (Double riveted). Caulking and fullering operation of riveted joints.

Shaft Coupling **(02 sheets)**

Introduction to coupling, their uses and types, Muff Coupling, Protected type flange coupling. Flexible or non-rigid coupling

Computer Aided Drafting (CAD) **(04 sheets)**

Introduction, Various 2 D commands – Draw, modify and option commands, Prepare at least 4 sheets using CAD software – one drawing each from wooden joint, threads, nut and bolts, coupling. (CAD drawing will be evaluated internally for sessional marks and not by final theory paper)

RECOMMENDED BOOKS

1. Surjit Singh, "A Text Book of Engineering Drawing", Dhanpat Rai Publishing Company,New Delhi.
2. P.S. Gill, "Engineering Drawing", SK Kataria and Sons, New Delhi.
3. N.D. Bhatt, "Mechanical Engineering Drawing", Charotar Publishing House, Anand

4. T Jeyapoovan, "Engineering Drawing and Graphics Using AutoCAD", Vikas Publishing House Pvt. Limited, Delhi.
5. Sham Tickoo and D. Sarvanan, "AutoCAD : For Engineers & Designers", Wiley India Pvt. Ltd., Delhi

INSTRUCTIONAL STRATEGY

The teachers should first demonstrate then assist the students to prepare drawing sheets. The student should also be encouraged and motivated to learn CAD software at the earliest and do the given exercises. Teachers should pay attention to:

1) First angle projection is to be followed.
2) Minimum 15 sheets to be prepared.
3) BIS Code SP 46-1988 should be followed.
4) Instructions relevant to various drawings may be given along with appropriate demonstration before assigning drawing practice to the students.
5) 20 percent of drawing sheets to be prepared on the third angle projection.
6) Use CAD software

2.6 WORKSHOP TECHNOLOGY- I

L	P
3	-

RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, knowledge about hand tools, measuring instruments, welding, and various machining processes is required to be imparted. Hence the subject of workshop technology.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Classify various types of hand tools.
CO2: Explain working principle of vernier caliper and micrometer for measurement.
CO3: Explain the parts of lathe and their functions.
CO4: Select material and tool geometry for cutting tools on lathe.
CO5: Explain geometry of single point tool, various types of lathe tools and tool materials.
CO6: Explain the working of drilling and boring process.
CO7: Explain the nomenclature of a drill and boring tools.
CO8: Select most appropriate process, electrodes, various process parameters for a job.
CO9: Explain principle of gas welding and arc welding process.
CO10: Select a cutting fluid for an operation.

DETAILED CONTENTS

UNIT I

Hand Tools

Chisels – Types and uses of chisels, wood working chisels, metal working chisels – cold chisel, hard chisel, stone chisel, masonry chisel. Hammers – Types, Basic design and variations, Physics of hammering, Hammer as force multiplier, effect of head's mass, effect of handle.

Saw – Saw terminology, types of saws, types of saw blades, material used for saw, Hacksaw frame and its types. Pliers – Function and types. Wrenches/ Spanners – Common General wrenches/spanners, Specialized wrenches/spanners, Surface plate, V block, files, Surface Gauge.

Measuring Instruments

Calipers – Types – Inside, outside, divider, Odd leg caliper. Vernier Caliper- Parts, uses, checking error, least count, working principle. Outside micrometer - Introduction, parts, Principle, Least count, Checking zero error.

UNIT II

Cutting Tools and Cutting Materials

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.

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 III

Welding

Welding Process - Principle of welding, Classification of welding processes, Advantages and limitations of welding, Industrial applications of welding, Welding positions and techniques, symbols. Safety precautions in welding.

Gas Welding - Principle of operation, Types of gas welding flames and their applications, Gas welding equipment - Gas welding torch, Oxygen cylinder, acetylene cylinder, cutting torch, Blow pipe, Pressure regulators, Filler rods and fluxes and personal safety equipment for welding.

Arc Welding - Principle of operation, Arc welding machines and equipment. A.C. and D.C. arc welding, Effect of polarity, current regulation and voltage regulation, Electrodes: Classification,

B.I.S. specification and selection, Flux for arc welding. Requirements of pre heating, post heating of electrodes and work piece. Welding defects and their testing methods.

UNIT IV

Lathe

Principle of turning, Description and function of various parts of a lathe. Classification and specification of various types of lathe, Drives and transmission, Work holding devices. Lathe tools: Parameters/Nomenclature and applications. Lathe operations - Plain and step turning, facing, parting off, taper turning, eccentric turning, drilling, reaming, boring, threading and knurling, form turning, spinning. Cutting parameters – Speed, feed and depth of cut for various materials and for various operations, machining time. Speed ratio, preferred numbers of speed selection. Lathe accessories:- Centers, dogs, different types of chucks, collets, face plate, angle plate, mandrel, steady rest, follower

rest, taper turning attachment, tool post grinder, milling attachment, Quick change device for tools. Brief description of capstan and turret lathe, comparison of capstan/turret lathe, work holding and tool guiding devices in capstan and turret lathe.

UNIT V

Drilling

Principle of drilling. Classification of drilling machines and their description. Various operation performed on drilling machine – drilling, spot facing, reaming, boring, counter boring, counter sinking, hole milling, tapping. Speeds and feeds during drilling, impact of these parameters on drilling, machining time. Types of drills and their features, nomenclature of a drill. Drill holding devices. Types of reamers.

Boring

Principle of boring, Classification of boring machines and their brief description. Specification of boring machines. Boring tools, boring bars and boring heads. Description ofjig boring machine.

Cutting Fluids and Lubricants

Function of cutting fluid, Types of cutting fluids, Difference between cutting fluid and lubricant, Selection of cutting fluids for different materials and operations, Common methods of lubrication of machine tools, Certifying Organizations (such as SAE, ASTM) forrating standards of lubricants.

RECOMMENDED BOOKS

1. B.S. Raghuwanshi, "A Course in Workshop Technology (Vol. I, Manufacturing Processes)'', Dhanpat Rai and Sons, New Delhi, 2015.
2. B.S. Raghuwanshi, "A Course in Workshop Technology (Vol. II Machine Tools)", Dhanpat Rai and Sons, New Delhi, 2017.
3. R. K. Jain, "Workshop Technology Vol I & II'', Khanna Publishers, New Delhi, First Edition, 2021.
4. T. L. Choudhary, "Workshop Technology Part - 1 & 2", Khanna Publishers, New Delhi, Sixth Edition, 2019.
5. S. K. Choudhry and Hajra, "Elements of Workshop Technology (Vol. I Manufacturing Processes)", Media Promoters and Publishers Pvt. Ltd., 2008.
6. S. K. Choudhry, Hajra and Nirja Roy, "Elements of Workshop Technology (Vol. II Machine Tools)'', Media Promoters and Publishers Pvt. Ltd., Fifteenth Edition, 2016.

7. P. C. Sharma, "A Text Book of Production Engineering'', S Chand and Company Ltd., Delhi, Eleventh Edition, 2013.
8. R. K. Jain, "Production Technology", New Delhi, Nineteenth Edition, 2019.
9. P. N. Rao, "Manufacturing Technology Volume –I '', Tata McGraw Hill, Delhi, Fifth Edition, 2019.
10. P. N. Rao, "Manufacturing Technology Volume –II'', Tata McGraw Hill, Delhi, Fourth Edition, 2019.

INSTRUCTIONAL STRATEGY

Teachers should lay emphasis in making students conversant with concepts and principles of manufacturing processes. This is theoretical subject and contains five units of equal weight age.

2.7 WORKSHOP PRACTICE - I

L	P
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RATIONALE

In order to have a balanced overall development of diploma engineers, it is necessary to integrate theory with practice. This course is included in the curriculum in order to provide hands-on experience about basic manufacturing practices. This subject aims at developing general manual skills in the students. In addition, the development of dignity of labour, safety at work place, team working and development of right attitude are the other objectives.

COURSE OUTCOMES

After completing the subject, the students will be able to:

CO1: Identify tools, equipment and materials used in preparing jobs.

CO2: Take measurements with the help of basic measuring tools/equipment.

CO3: Select materials, tools, and sequence of operations to make a job as per given specifications/drawing.

CO4: Prepare simple jobs independently and inspect the same.

CO5: Use safety equipment and Personal Protection Equipment (PPE).

CO6: Maintain good housekeeping practices.

PRACTICAL EXERCISES

The following shops are included in the syllabus.

1 Welding Shop – II
2 Fitting and Plumbing Shop – II
3 Carpentry Shop II
4 Smithy Shop
5 Electric and Electronics Shop II
6 Turning Shop

1. WELDING SHOP – II

1.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

1.2 Introduction to gas welding, gas welding equipment, introduction to soldering and brazing, introduction to resistance welding, safety precautions.

1.3 Identification and adjustment of various types of gas flames

1.4 Demonstration of brazing and gas cutting

1.5 Demonstration of Welding defects

1.6 Jobs to be prepared

Job I Beading Practice by gas welding.

Job II Preparation of lap joint on M.S. flat using gas welding.

Job III Preparation of double V butt joint/corner joint on M.S. flat using gaswelding / arc welding process

Job IV Preparation of pipe joint using gas/arc welding

Job V Preparation of a small cot frame/stool/table frame/drawing tableframe) using gas or arc welding.

2. FITTING AND PLUMBING SHOP – II

2.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

2.2 Handling of measuring instruments, Use of dial gauges and feeler gauges.

2.3 Demonstration of various types of drills, taps and dies.

2.4 Introduction to tapping and dieing

Job I To perform drilling and reaming operation on mild steel flat.

2.5 file and make angle, surfaces (Bevel gauge accuracy 1 degree) make simple open and sliding fits Inside square fit, make combined open and sliding fit, straight sides

Job II To make assembly for V shape or square shape fit.

Job III Radius form filing on the corners

2.6 Sliding fitting, Diamond fitting, Lapping flat surfaces using lapping plate. Application of lapping, material for lapping tools, lapping abrasives, charging of lapping tool. Surface finish importance, equipment for testing-terms relation to surface finish

Job IV To make step assembly.

2.7 Introduction to various types of threads (internal and external)-single start, multi-start,left hand and right hand threads.

2.8 Description and demonstration of various types of drills, taps and dies. Selection ofdies for threading, selection of drills, taps and reamers for tapping operations.

2.9 Introduction to use of plumbing tools like pipe wrench , plumber vice and materials likePutty, thread, duct(Teflon) tape, epoxy resin, araldite, m-seal.

2.10 Precautions while drilling soft metals, e.g. copper, brass, aluminium etc.

Job V To make overhead tank assembly with GI/C-PVC pipes and joints.

3. CARPENTRY SHOP – II

3.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

3.2 Introduction to joints, their relative advantages and uses.

Job I To make a dovetail joint.

Job II To make a mitred joint.

Job III To make a lengthening joint by using different joints.

3.3 Demonstration of machines like Band Saw and Circular Saw, Chain and Chisel, Universal wood working machine, Saw re-sharpening machine, Saw Brazing unit.

3.4 Introduction and function of various parts of Wood Working Lathe

a) Study of wood working lathe tool.

b) Sharpening of lathe tools.

c) Setting of jobs and tools.

Job IV To make a job using different type of wood turning operations including form turning and grooving.

OR Repair of any utility item.

Job V To make a medium size wooden dust bin/ wooden tray.

4. SMITHY SHOP

4.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

4.2 Introduction and industrial applications of smithy jobs.

4.2.1 Purpose of Smithy shop.

4.2.2 Different types of Hearths used in Smithy shop, Types of fuel used and maximum temperature obtained.

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

4.2.4 Types of raw materials used in Smithy shop.

4.2.5 Uses of Fire Bricks and Clays in Forging workshop.

4.3 Practice

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

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

Demonstration of making cube, hexagonal cube, hexagonal bar from round bar

4.3.3 Practice of Simple Heat treatment processes like Tempering, Normalizing, and Hardening.

4.4 Introduction to various heat treatment processes e.g annealing, hardening, tempering, normalizing.

4.5 Description of various types of power hammers and their usage (Demonstrationonly).

4.6 Jobs to be prepared

Job I To forge a square/hexagonal shape on both endsfrom a MS round by cold forging

Job II To make a utility item like fan hook, ring, U type door handle

Job III To make a ring of MS round by forge welding

Job IV To make a hexagonal chisel by hot forging process withhardening and tempering

Job V To perform bending process by hot forging.

5. ELECTRICAL AND ELECTRONICS SHOP - II

5.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

5.2 Introduction to single phase and three phase supply and wiring system. Importance of three phase supply (RYB) and its sequence and wiring system. Estimating and costing of power consumption.

Job I Connecting single phase energy meter with supply and load. Reading and working out power consumption and cost of energy.

5.3 Study of internal wiring diagram of common electrical appliances such as auto electric iron, electric kettle, ceiling/table fan, desert cooler etc. Demonstration of dismantling, servicing and reassembling of table/ceiling fan, air-cooler, auto electric iron, heater etc.

Job II Connection of single phase/three phase motor by using starter. Reversing direction of rotation of single phase and three phase motors.

Job III Cut, bend, tin components, leads, inserts. Solder components for example resistor, capacitor, diode, transistor and other components ona PCB.

5.4 Demonstrate the joining for connecting methods mounting and dismounting method as well as using of the various plugs, sockets, conductors, suitable for general purpose, audio video used conductors, banana plugs, socket and similar male and female conductor and terminal strips

5.5 Various types of switches such as normal, miniature toggle, slide, push button.

Job IV Wiring of a small circuit on a PCB/ TAG strip involving laying, sleeving and use of identifier tags.

Job V Cut, strip, join and insulate two lengths of wires/cables.

Desoldering practice with desoldering pump and desoldering wick.

6. TURNING SHOP

6.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

6.2 Jobs to be Prepared

Job 1 Centering practice in 4 jaw chuck, setting of cutting tool point at appropriate height and perform facing and plain turning operationson MS rod.

Job II To sharpen various angles of turning tool.

Job III To perform step turning on MS rod.

Job IV To perform taper turning and under cutting operation.

Job V To perform step turning and knurling operation on MS rod.

RECOMMENDED BOOKS

1. SK Hajra Choudhary and AK Choudhary, "Workshop Technology I,II,III", Media Promotersand Publishers Pvt. Ltd., Mumbai, Fifteenth Edition, 2016.
2. RK Jain, "Workshop Technology Vol I& II'', Khanna Publishers, New Delhi , First Edition, 2021.
3. Manchanda, "Workshop Technology Vol. I, II, III", India Publishing House, Jalandhar.
4. S.S. Ubhi, "Workshop Training Manual Vol. I, II'', Katson Publishers, Ludhiana.
5. K Venkata Reddy, "Manual on Workshop Practice", MacMillan India Ltd., New Delhi, Sixth Edition, 2020.
6. "General Workshop Manual (Diploma Jobs)", Khanna Publishers, First Edition, 2021.
7. T Jeyapoovan, "Basic Workshop Practice Manual", Vikas Publishing House (P) Ltd., New Delhi.
8. B. S. Raghuvanshi, "Workshop Technology, Vol. I", Dhanpat Rai and Sons, Delhi, Eleventh Edition, 2017.
9. Kannaiah K L, Narayana "Workshop Manual", Scitech Publications, Chennai, Second Edition 1998.
10. H S Bawa, "Workshop Practice", Tata McGraw Hill Publication, First Edition, 2004

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students.

SECOND YEAR

NSQF LEVEL - 4

12. STUDY AND EVALUATION SCHEME

THIRD SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
3.1	Industrial/In-house Training-I	-	2	0+1=1	-	40	40	-	60	60	100
3.2	**Strength of Materials	3	2	3+1=4	40	40	80	60	60	120	200
3.3	Mechanical Engineering Drawing II	-	6	0+3=3	-	40	40	60	-	60	100
3.4	Thermodynamics - I	3	2	3+1=4	40	40	80	60	60	120	200
3.5	**Workshop Technology – II	3	-	3+0=3	40	-	40	60	-	60	100
3.6	** Basics of Electrical and Electronics Engineering	2	-	2+0=2	40	-	40	60	-	60	100
3.7	Workshop Practice – II	-	6	0+3=3	-	40	40	-	60	60	100
3.8	Open Elective (MOOCs^{+}/Offline)	2	-	2+0=2	40	-	40	60	-	60	100
# Student Centered Activities(SCA)		-	4	-	-	-	-	-	-	-	-
	Total	**13**	**22**	**22**	**200**	**200**	**400**	**360**	**240**	**600**	**1000**

** Common with Diploma in Automobile Engineering.

+ Assessment of Open Elective through MOOCs shall be based on assignments out of 100 marks.

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

FOURTH SEMESTER :

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
4.1	*English and Communication Skills - II	2	2	2+1=3	40	40	80	60	60	120	200
4.2	Materials and Metallurgy	3	2	3+1=4	40	40	80	60	60	120	200
4.3	Hydraulics and Pneumatics	3	2	3+1=4	40	40	80	60	60	120	200
4.4	Workshop Technology – III	3	-	3+0=3	40	-	40	60	-	60	100
4.5	Machine Design	3	-	3+0=3	40	-	40	60	-	60	100
4.6	Thermodynamics II	3	2	3+1=4	40	40	80	60	60	120	200
4.7	Workshop Practice – III	-	6	0+3=3	-	40	40	-	60	60	100
4.8	CAD/CAM	-	4	0+2=2	-	40	40	-	60	60	100
# Student Centered Activities(SCA)		-	-	-	-	-	-	-	-	-	-
	Total	17	18	26	240	240	480	360	360	720	1200

* Common with other Diploma Courses

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

Industrial Training: After 4th Semester, students shall undergo Industrial Training of 4 Weeks.

13. HORIZONTAL AND VERTICAL SUBJECTS ORGANISATION

Sr. No.	Subjects	Hours Per Week	
		Third Semester	Fourth Semester
1.	Industrial/In-house Training I	2	-
2.	Strength of Materials	5	-
3.	Mechanical Engineering Drawing II	6	-
4.	Thermodynamics I	5	-
5.	Workshop Technology – II	3	-
6.	Basics of Electrical & Electronics Engineering	2	-
7.	Workshop Practice II	6	-
8.	Open Elective (MOOCs/Offline)	2	-
9.	English and Communication Skills II	-	4
10.	Materials and Metallurgy	-	5
11.	Hydraulics and Pneumatics	-	5
12.	Workshop Technology – III	-	3
13.	Machine Design	-	3
14.	Thermodynamics II	-	5
15.	Workshop Practice III	-	6
16.	CAD/CAM	-	4
17.	Student Centred Activities	4	-
	Total	**35**	**35**

14. COMPETENCY PROFILE & EMPLOYMENT OPPORTUNITIES

Government and private sectors related to Mechanical Engineering require **skilled workers** to work in familiar, predictable, routine situations of clear choice. They are expected to have factual knowledge of Mechanical Engineering field. They will be able to write and speak with required clarity. Students after passing level 4 shall have understanding of basic arithmetic, algebraic principles along with basic understanding of social and natural environment. They are expected to recall and demonstrate quality skill in narrow range of applications using appropriate rules and tools.

Skilled workers will be responsible for carrying out a range of jobs, some of which will require them to make choices about the approaches they adopt. They will be expected to learn and improve their practice on the job. They should know what constitutes quality in the occupation and should distinguish between good and bad quality in the context of their job roles. Skilled worker at this level will be expected to carry out their work safely and securely and take full account of the health and safety on colleagues and customers. They should work hygienically and in ways which show an understanding of environmental issues. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social and political environment.

Mechanical Engineering NSQF Level – 4 pass out students are expected have the knowledge of properties and testing of materials. They are expected to have good knowledge of thermodynamics. They are also expected to have good knowledge and skills in drawing and design of mechanical components. Level 4 pass out students should have good knowledge and skills regarding working of various machines.

Mechanical Engineering students have a wide scope to work in manufacturing industries primarily in private sector and to some extent in public sector. In addition, they have job avenues in railways, hospitals, military engineering services, boards and corporations, construction companies, transportation departments, telecommunication, P W D and rural development agencies. They have wide scope in establishing small startups in the area of marketing and sales, manufacturing units and repair and maintenance units etc.

15. PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 4 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

PO1: Carry out a task which may require limited range of predictable activities.

PO2: Acquire knowledge of basic facts, process and principles related to Mechanical Engineering for employment.

PO3: Demonstrate practical skill in narrow range of Mechanical Engineering applications.

PO4: Demonstrate skill of communication, basic mathematics, collecting and organizinginformation along with knowledge of social, political and natural environment.

PO5: Perform task under close supervision with some responsibility for own work within defined limit.

PO6: Select open elective of own interest to develop self-learning through MOOCs.

16. ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be Assessed	Assessment Criteria for the Course Outcomes
PO1: Carry out a task which may require limited range of predictable activities.	• Take necessary safety precautions and measures. • Work in team for solving industrial problems • Develop competencies and skills required by relevant industries.
PO2: Acquire knowledge of basic facts, process and principles related to Mechanical Engineering for employment.	• Understand the working environment of industries. • Learn about present and future requirement of industries. • Interpret various concepts and terms related to strength of materials • Calculate stresses in thin cylindrical shells. • Calculate energy stored by materials subjected to axial loads. • Calculate moment of inertia of different sections. • Draw and calculate bending moment and shear force diagrams of beam under given loading • Interpret the concept of bending and torsion and calculate stresses on different section of materials. • Calculate critical axial loads on column under different end constraints. • Determine the various parameters in closed coil helical and laminated springs • Interpret different limits and fits of components

	• Read and interpret drawings of mechanical components • Interpret gear terminology and draw spur gear teeth profile. • Apply thermodynamic laws. • Solve basic problems of gas equation using perfect gas laws. • Explain the working, construction and applications of steam boilers and steam generators • Determine various properties of steam • Determine enthalpy, specific heat capacity of an ideal and real gas. • Explain the working, construction and application of air compressor. • Demonstrate applications of various welding processes. • Explain the process of pattern making, moulding and casting • Explain procedure of various types of NDT for welding and casting. • Explain the working of various machining processes such as shaping, planning, milling and broaching • Understand functions and operations of various jigs and fixtures. • Interpret various electrical quantities. • Improve power factor in a given circuit. • Explain construction, working principle, and applications of transformer. • Identify different wires of distribution system. • Describe the working of single phase and three phase motors. • Follow electrical safety measures. • List the applications of diodes and ICs.

	• Distinguish between metals and non metals and ferrous and non ferrous materials. • Carryout various heat treatment processes. • Draw and interpret iron-carbon diagram. • Distinguish various grades of Stainless steel and the relative selection of fabrication process depending upon the metallurgy of SS • Classify various types of plastics and rubber. • Explain properties and applications of composites, ceramics and smart materials. • Select suitable material to be used for various engineering applications. • Explain fluid properties, their units and conversion. • Measure pressure using appropriate pressure measuring devices. • Measure flow & discharge rate using appropriate flow measuring devices. • Describe the construction and working of turbines. • Describe the construction and working of pumps. • Explain the functions of various components used in hydraulic and pneumatic system. • To understand the concept of gear manufacturing using different methods. • To understand grinding and finishing processes. • Explain the working and applications of modern machining practices. • Explain the working principle of metal forming.

	• Explain the working principle of metallic coating and finishing processes. • Explain the terms related to design. • Design shaft on the basis of strength and rigidity. • Design keys and couplings • Design temporary and permanent joints • Design screw jack and helical spring. • Explain the working of IC engine and functioning of various parts of IC engine. • Explain the working of fuel supply and ignition system in petrol engine. • Explain the functioning of different components of fuel supply of diesel engine. • Explain the working of lubrication and cooling system in IC engine. • Explain the functioning of steam turbine, gas turbine and jet propulsion.
PO3: Demonstrate practical skill in narrow range of Mechanical Engineering applications.	• Understand the working environment of industries. • Take necessary safety precautions and measures. • Work in team for solving industrial problems • Develop competencies and skills required by relevant industries. • Perform various tests related to strength on various machines as per Indian Standards. • Draw different kind of machine components like bearings, brackets, pulleys, pipe joints and lathe tool holder. • Read and interpret drawings of mechanical components

	• Prepare assembly drawings of mechanical machine parts like jig, vices & screw jack. • Prepare assembly drawings of boiler and I.C. engine parts. • Interpret gear terminology and draw spur gear teeth profile. • Solve basic problems of gas equation using perfect gas laws. • Prepare jobs on lathe, shaper, planer and milling machines. • Carry out welding of parts. • Carry out pattern making, moulding and casting operations. • Analyze microstructure and changes in microstructure due to heat treatment. • Carry out various heat treatment processes. • Measure pressure using appropriate pressure measuring devices. • Measure flow & discharge rate using appropriate flow measuring devices. • Design shaft on the basis of strength and rigidity. • Design keys and couplings • Design temporary and permanent joints • Design screw jack and helical spring. • Assist in testing an IC engine and understand pollution norms in India. • Prepare jobs using various conventional and advance machines. • Carry out metal coating and finishing operations. • Undertake advance fitting operations. • Draw 2D drawings of various parts using drafting software. • Draw 3D drawings using any part modelling software. • Generate part programs using CAM software.

PO4: Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.	• Communicate effectively with an increased confidence; read, write and speak in English language fluently. • Comprehend special features of format and style of formal communication through various modes. • Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews • Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships. • Develop writing, speaking and presentation skills. • Assist in testing an IC engine and understand pollution norms in India.
PO5: Perform task under close supervision with some responsibility for own work within defined limit.	• Take necessary safety precautions and measures. • Work in team for solving industrial problems • Develop competencies and skills required by relevant industries.
PO6: Select open elective of own interest to develop self-learning through MOOCs.	• State the basic concepts and principles about the subject of interest. • Perform in a better way in the professional world. • Select and learn the subject related to own interest. • Explore latest developments in the field of interest. • Develop the habit of self-learning through online courses.

17. SUBJECTS & CONTENTS

(SECOND YEAR)

THIRD SEMESTER

3.1 INDUSTRIAL / IN – HOUSE TRAINING-II

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RATIONALE

Industrial training / In – house training will help the students to understand the working environment of relevant industries. The student will learn to work in team to solve the industrial problems. It will also give exposure about the present and future requirements of the relevant industries. This training is very important for development of required competencies and skills for employment and start–ups.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1: Understand the working environment of industries
CO2: Take necessary safety precautions and measures.
CO3: Learn about present and future requirement of industries.
CO4: Work in team for solving industrial problems
CO5: Develop competencies and skills required by relevant industries.
CO6: Develop writing, speaking and presentations skills.

PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.

GUIDELINES

Students will be evaluated based on Industrial training / In – house training report and their presentation using Power Point about the knowledge and skills gained during the training. The Head of the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation. The following performance parameters are to be considered for assessment of the students out of 100 marks:

	Parameter	**Weightage**
i	Industrial / In-house assessment of the candidate by the trainer	40%
ii	Report Writing	20%
iii	Power Point Presentation	20%
iv	Viva-voce	20%

3.2 STRENGTH OF MATERIALS

L	P
3	2

RATIONALE

Diploma holders in this course are required to analyze reasons for failure of different components and select the required material for different applications. For this purpose, it is essential to teach them concepts, principles, applications and practices covering stress, strain, bending moment, shearing force, shafts, columns and springs. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles in the solution of applied problems to develop the required competencies.

COURSE OUTCOMES

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

C01: Interpret various concepts and terms related to strength of materials
CO2: Calculate stresses in thin cylindrical shells.
CO3: Calculate energy stored by materials subjected to axial loads.
CO4: Calculate moment of inertia of different sections.
CO5: Draw and calculate bending moment and shear force diagrams of beam under given loading
CO6: Interpret the concept of bending and torsion and calculate stresses on different section of materials.
CO7: Calculate critical axial loads on column under different end constraints.
CO8: Determine the various parameters in closed coil helical and laminated springs
C09: Perform various tests related to strength on various machines as per Indian Standards.

DETAILED CONTENTS

UNIT I

Stresses and Strains

- Basic concept of load, stress and strain
- Tensile, compressive and shear stresses
- Linear strain, Lateral strain, Shear strain, Volumetric strain.
- Concept of Elasticity, Elastic limit and limit of proportionality
- Hook's Law, Elastic Constants and their relation (without derivation)

- Stress-strain curve for ductile and brittle materials
- Nominal stress
- Yield point, plastic stage
- Ultimate stress and breaking stress
- Percentage elongation
- Proof stress and working stress
- Factor of safety
- Poisson's Ratio
- Thermal stress and strain
- Longitudinal and circumferential stresses in seamless thin walled cylindrical shells.
- Introduction to Principal stresses

Resilience

- Strain Energy, Resilience, proof resilience and modulus of resilience
- Strain energy due to direct stresses and Shear Stress
- Stresses due to gradual, sudden and falling load.

UNIT II

Moment of Inertia

- Concept of moment of inertia and second moment of area
- Radius of gyration
- Theorem of perpendicular axis and parallel axis (with derivation)
- Second moment of area of common geometrical sections: Rectangle, Triangle, Circle (without derivation); Second moment of area for L,T and I section
- Section modulus

UNIT III

Bending Moment and Shearing Force

- Various types of beams and form of loading
- End supports-Roller, hinged and fixed
- Concept of bending moment and shearing force
- B.M. and S.F. Diagram for simply supported beam with and without overhang subjected to concentrated and U.D.L and cantilever beam.

UNIT IV

Bending Stresses

- Concept of Bending stresses
- Theory of simple bending, Derivation of Bending Equation
- Use of the equation $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$
- Concept of moment of resistance
- Bending stress diagram
- Section modulus for rectangular, circular and symmetrical I section.
- Calculation of maximum bending stress in beams of rectangular, circular, and T section.

Columns

- Concept of column, modes of failure
- Types of columns, modes of failure of columns
- Buckling load, crushing load
- Slenderness ratio
- Effective length
- End restraints
- Factors effecting strength of a column
- Strength of column by Euler Formula without derivation
- Rankine Gourdan formula (without derivation)

UNIT V

Torsion

- Concept of torsion, difference between torque and torsion.
- Derivation of Torsion Equation, use of torsion equation for circular shaft, (solid and hollow)
- Comparison between solid and hollow shaft with regard to their strength and weight.
- Concept of mean and maximum torque
- Power transmitted by shaft

Springs

- Closed coil helical springs subjected to axial load and calculation of Stress deformation, Stiffness and angle of twist and strain energy, Strain energy and proof resilience.
- Determination of number of plates of laminated spring (semi elliptical type only)

PRACTICAL EXERCISES

1. Tensile test on bars of Mild steel and Aluminum.
2. Bending test on a steel bar or a wooden beam.
3. Impact test on metals
   a) Izod test
   b) Charpy test
4. Torsion test of solid specimen of circular section of different metals for determining modulus of rigidity.
5. To plot a graph between load and extension and to determine the stiffness of a helical spring.
6. Hardness test on different metals.

Note : All the tests need to be done as per prescribed Indian Standards.

RECOMMENDED BOOKS

1. RS Khurmi, “Strength of Materials”, S.Chand & Co, New Delhi.
2. Dr. Kirpal Singh, “Mechanics of Materials”, Standard Publishers Distribution, New Delhi.
3. Birinder Singh, “Strength of Materials”, Katson Publishing House, New Delhi.
4. D.R. Malhotra and H.C.Gupta, “Elements of SOM”, Satya Prakashan, New Delhi.

INSTRUCTIONAL STRATEGY

This is hands-on practice based subject and topics taught in the class should be practiced in the lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

3.3 MECHANICAL ENGINEERING DRAWING II

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RATIONALE

Diploma holders in Mechanical Engineering are required to interpret drawings and therefore it is essential that they have skills of preparing drawings and sketches of mechanical components. This subject aims at development of drawing skills in the students.

COURSE OUTCOMES

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

CO1: Interpret different limits and fits of components

CO2: Draw different kind of machine components like bearings, brackets, pulleys, pipe joints and lathe tool holder.

CO3: Read and interpret drawings of mechanical components

CO4: Prepare assembly drawings of mechanical machine parts like jig, vices and screw jack

CO5: Prepare assembly drawings of boiler and I.C. engine parts.

CO6: Interpret gear terminology and draw spur gear teeth profile.

PRACTICAL EXERCISES

Limit, fits and tolerance (02 sheet)

Need of limit, fits and tolerance, Maximum limit of size, minimum limit of size, tolerance, allowance, deviation, upper deviation, lower deviation, fundamental deviation, clearance, maximum clearance, minimum clearance. Fits – clearance fit, interference fit and transition fit. Hole basis system, shaft basis system, tolerance grades, calculating values of clearance, interference, hole tolerance, shaft tolerance with given basic size for common assemblies like $H_7/g6$, $H_7/m6$, $H_8/p6$. Basic terminology and symbols of geometrical dimensioning and tolerances. Surface finish representation

Drawing of the following with complete dimensions, tolerances, bill of material and surface finish representation.

- Universal coupling and Oldham coupling (Assembly) (02 sheets)
- Bearings (04 sheets)

- Bushed Bearing (Assembly Drawing)
- Ball Bearing and Roller Bearing (Assembled Drawing)
- Plummer Block (Detail and Assembly Drawing)
- Foot step Bearing (Assembled Drawing)
- Pipe Joints (03 sheets)
- Types of pipe Joints, Symbol and line layout of pipe lines
- Expansion pipe joint (Assembly drawing)
- Flanged pipe and right angled bend joint (Assembly Drawing)
- Reading and interpretation of mechanical components and assembly drawings
- Sketching practice of wall bracket. (01 sheet)

Drilling Jig (Assembly Drawing) (01 sheet)

Machine vices (Assembly Drawing) (03 sheets)

Lathe Tool Holder (Assembly Drawing) Lathe tail stock (assembly drawing)

I.C. Engine Parts (03 sheets)

Piston

Connecting rod (Assembly Drawing) Crankshaft and flywheel (Assembly Drawing)

Boiler Parts (02 sheets)

Steam Stop Valve (Assembly Drawing) Blow off cock. (Assembly Drawing)

Mechanical Screw Jack (Assembled Drawing) (01 sheet)

Gears (02 sheets)

Gear, Types of gears, Nomenclature of gears and conventional representation

Draw the actual profile of involute teeth of spur gear by approximate method and base circle method.

RECOMMENDED BOOKS

1. P.S. Gill, “Machine Drawing”, S.K. Kataria and Sons, Ludhiana.
2. R.K. Dhawan, “A Text Book of Machine Drawing”, S. Chand and Co. Ltd New Delhi.
3. N.D. Bhatt, “Machine Drawing”, Charotar Book Depot, Anand.
4. Bhattacharya, “Machine Drawing”, Oxford Press, New Delhi.

INSTRUCTIONAL STRATEGY

The teachers should first demonstrate then assist the students to prepare drawing sheets. Teachers should pay special attention to following:

(1) First angle projection should be followed, 20% of drawings may be prepared in third angle projection.
(2) SP-46-1988 should be followed.
(3) The drawing should include discussion with tolerances, whenever necessary and material list as per BIS / ISO specifications.
(4) At least 18 sheets may be prepared covering all the topics.

3.4 THERMODYNAMICS - I

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RATIOANLE

A diploma holder in this course is supposed to maintain steam generators, turbines, compressors and other power plant equipment. Therefore, it is essential to impart him basic concepts of thermodynamics, steam generators, steam turbines, and compressors and about IC engines.

COURSE OUTCOMES

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

CO1: Apply thermodynamic laws.
CO2: Solve basic problems of gas equation using perfect gas laws.
CO3: Explain the working, construction and applications of steam boilers and steam generators
CO4: Determine various properties of Steam
CO5: Determine enthalpy, specific heat capacity of an ideal and real gas.
CO6: Explain the working, construction and application of air compressor.

DETAILED CONTENTS

UNIT I

Fundamental Concepts

Thermodynamic state and system, boundary, surrounding, universe, thermodynamic systems – closed, open, isolated, adiabatic, homogeneous and heterogeneous, macroscopic and microscopic, properties of system – intensive and extensive, thermodynamic equilibrium, quasi – static process, reversible and irreversible processes, Zeroth law of thermodynamics, definition of properties like pressure, volume, temperature, enthalpy and internal energy.

Laws of Perfect Gases

Definition of gases, explanation of perfect gas laws – Boyle's law, Charle's law, Avagadro's law, Regnault's law, Universal gas constant, Characteristic gas constants and its derivation.
Specific heat at constant pressure, specific heat at constant volume of a gas, derivation of an expression for specific heats with characteristics, simple numerical problems on gas equation.

UNIT II

Thermodynamic Processes

Types of thermodynamic processes – isochoric, isobaric, isothermal, adiabatic, isentropic, polytropic and throttling processes, equations representing the processes

Derivation of work done, change in internal energy, change in entropy, rate of heat transfer for the above processes

UNIT III

Laws of Thermodynamics

Laws of conservation of energy, first law of thermodynamics (Joule's experiment) and its limitations, Steady flow energy equation, Application of steady flow energy equation for turbines, pump, boilers, compressors, nozzles, and evaporators.

Heat source and sink, statements of second laws of thermodynamics: Kelvin Planck's statement, Classius statement, equivalency of statements, Perpetual motion Machine of first kind, second kind, Carnot engine, Introduction of third law of thermodynamics, concept of irreversibility and concept of entropy.

UNIT IV

Steam Generators

Uses of steam, classification of boilers, comparison of fire tube and water tube boilers. Construction and working of Nestler boiler, Babcock & Wilcox Boiler. function of various boiler mounting and accessories, Introduction to modern boilers – Benson boiler.

Properties of Steam

Formation of steam and related terms, thermodynamic properties of steam, steam tables, sensible heat, latent heat, internal energy of steam, entropy of water, entropy of steam, T- S diagrams, Mollier diagram (H – S Chart), Expansion of steam, Hyperbolic, reversible adiabatic and throttling processes, determination of quality of steam (dryness fraction),

UNIT V

Ideal and Real Gases

Concept of ideal gas, enthalpy and specific heat capacities of an ideal gas, P – V – T surface of an ideal gas, triple point, real gases, Vander-Wall's equation

Air Compressors

Functions of air compressor – uses of compressed air, type of air compressors

Single stage reciprocating air compressor, its construction and working, representation of processes involved on P – V diagram, calculation of work done.
Multistage compressors – advantages over single stage compressors, use of air cooler, condition of minimum work in two stage compressor (without proof).
Rotary compressors – types, working and construction of centrifugal compressor, axial flow compressor, vane type compressor

PRACTICAL EXERCISES

1. Determination of temperature by
   - 1.1 Thermocouple
   - 1.2 Pyrometer
   - 1.3 Infrared thermometer
2. Study the working of Nestler boiler.
3. Study of working of high pressure boiler.
4. Demonstration of mountings and accessories on a boiler.
5. Determination of dryness fraction of steam using calorimeter.
6. Demonstrate the working of air compressor.
7. Industrial visit may be planned to show working of boilers.

RECOMMENDED BOOKS

1. PK Nag, “Engineering Thermodynamics”, Tata McGraw Hill, Delhi.
2. Roy Chaudhary, “Basic Engineering Thermodynamics”, Tata McGraw Hill, Delhi.
3. CP Arora, “Engineering Thermodynamics”, Tata McGraw Hill, Delhi.
4. VP Vasandani and DS Kumar, “A Treatise on Heat Engineering”, Metropolitan Book Company.

INSTRUCTIONAL STRATEGY

This is hands-on practice based subject and topics taught in the class should be practiced in the lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

3.5 WORKSHOP TECHNOLOGY-II

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3	-

RATIOANLE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, knowledge about various manufacturing processes is required to be imparted. Hence the subject of workshop technology.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Demonstrate applications of various welding processes.
CO2: Explain the process of pattern making, moulding and casting
CO3: Explain procedure of various types of NDT for welding and casting.
CO4: Explain the working of various machining processes such as shaping, planning, milling and broaching
CO5: Understand functions and operations of various jigs and fixtures.

DETAILED CONTENTS

UNIT I

Welding

Resistance welding: Principle, advantages, limitations, working and applications of spot welding and seam welding

Other Welding Processes: Principle, advantages, limitations, working and applications of Shielded metal arc welding, submerged arc welding. Welding defects, methods of controlling welding defects and inspection of welded joints.

Modern Welding Methods: Methods, Principle of operation, advantages, disadvantages and applications of, Tungsten inert gas (TIG) welding, Metal inert gas (MIG) welding, Thermit welding, Electro slag welding, Electron beam welding, Ultrasonic welding, Laser beam welding, Robotic welding

UNIT II

Foundry Techniques

Pattern Making

Types of pattern, Pattern material, Pattern allowances, Pattern codes as per B.I.S., Introduction to cores, core boxes and core materials, Core making procedure, Core prints, positioning of cores

Moulding and Casting

Moulding Sand: Properties of moulding sand, their impact and control of properties viz. permeability, refractoriness, adhesiveness, cohesiveness, strength, flowability, collapsibility, Various types of moulding sand, Testing of moulding sand.

Mould Making: Types of moulds, Step involved in making a mould, Molding boxes, hand tools used for mould making, Molding processes: Bench molding, floor molding, pit molding and machine molding.

Casting Processes: Charging a furnace, melting and pouring both ferrous and non ferrous metals, cleaning of castings, Principle, working and applications of Die casting: hot chamber and cold chamber, Centrifugal casting

Gating and Risering System: Elements of gating system, Pouring basin, sprue, runner, gates, Types of risers, location of risers, Directional solidification.

Melting Furnaces: Construction and working of Pit furnace, Cupola furnace, Crucible furnace – tilting type, Electric furnace

Casting Defects: Different types of casting defects, Non destructive testing (NDT) of castings: die penetration test, radiography, magnetic particle inspection and ultrasonic inspection.

UNIT III

Shaping, Slotting and Planing

- Working principle and construction of shaper, slotter and planer
- Type of shapers and slotters
- Type of planers
- Quick return mechanism applied to shaper and planer machine.
- Work holding devices used on shaper and planer
- Types of tools used and their geometry.
- Specification of shaper and planer.

- Speeds and feeds in above processes.

Broaching

- Introduction to broaching
- Nomenclature of broach tools, types and material
- Types of broaching machines – single ram and duplex ram horizontal type, vertical type pull up, pull down and push down.

UNIT IV

Milling

- Milling methods - up milling and down milling
- Specification and working principle of milling machine
- Classification, brief description and applications of milling machines
- Details of column and knee type milling machine
- Milling machine accessories and attachment – Arbors, adaptors, collets, vices, circular table, indexing head and tail stock, vertical milling attachment, rotary table.
- Identification of different milling cutters and work mandrels
- Work holding devices
- Milling operations – face milling, angular milling, form milling, straddle milling and gang milling.
- Cutting parameters

UNIT V

Jigs and Fixtures

- Importance and use of jigs and fixtures, difference between jig and fixture.
- Principal of location
- Locating and clamping devices
- Types of jigs – drilling jig, template jig and plate jig
- Types of fixtures – Milling and welding fixture

RECOMMENDED BOOKS

1. BS Raghuvanshi, “Workshop Technology”, Dhanpat Rai and Sons Delhi.
2. SK Choudhry and Hajra, “Elements of Workshop Technology”, Asia Publishing House.
3. RL Aggarwal and T Manghnani,”Welding Engineering”, Khanna Publishers, Delhi.
4. PC Sharma, “A Text Book of Production Engineering”, S Chand and Company Ltd. Delhi.

5. PN Rao, "Manufacturing Technology, Vol I and II", Tata McGraw Hill, Delhi.
6. KP Sinha and DB Goel, "Foundry Technology", Roorkee Publishing House, Roorkee.

INSTRUCTIONAL STRATEGY

Teachers should lay special emphasis in making the students conversant with concepts, principles, procedures and practices related to various manufacturing processes. Use of audio-visual aids/video films should be made to show specialized operations. This subject contains five units of equal weightage.

3.6 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

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RATIONALE

The objective of this course is to impart fundamental knowledge and skills regarding basic electrical and electronics engineering, which diploma holders will come across in their professional life. This course will provide the students to understand the basic concepts and principles of a.c. fundamentals, electromagnetic induction, transformers, motors, distribution system, domestic installation, electrical safety etc. The students will also learn basic electronics along with their applications.

COURSE OUTCOMES:

After undergoing this course, the students will be able to:
CO1: Interpret various electrical quantities.
CO2: Improve power factor in a given circuit.
CO3: Explain construction, working principle, and applications of transformer.
CO4: Identify different wires of distribution system.
CO5: Describe the working of single phase and three phase motors.
CO6: Follow electrical safety measures.
CO7: List the applications of diodes and ICs.

DETAILED CONTENTS

UNIT I
Basic Electrical Quantities

Definition of voltage, current, power and energy with their units, name of instruments used for measuring above quantities, connection of these instruments in an electric circuit. Difference between ac and dc. Various applications of electricity.

AC Fundamentals

Electromagnetic induction-Faraday's Laws, Lenz's Law; Fleming's rules, Principles of a.c. Circuits; Alternating emf, Definition of cycle, frequency, amplitude and time period. Concept of electrical power, Concept of phase and phase difference. Concept of resistance, inductance and capacitance in simple a.c. circuit. Concept of three phase system; star and delta connections; voltage and current relationship (no derivation)

UNIT II

Transformer

Working principle and construction of single phase transformer, transformer ratio, emf equation, tapping of transformer, power transformer, auto transformer and distribution transformer (brief idea and difference between them), cooling of transformer, applications of various types of transformers.

Distribution System

Difference between high and low voltage distribution system, identification of three-phase wires, neutral wire and earth wire in a low voltage distribution system. Identification of voltages between phases and between one phase and neutral. Difference between three-phase and single-phase supply

UNIT III

Electric Motor

Description and applications of single-phase and three-phase motors. Introduction to DC motor and its applications, Difference between ac and dc motor, Connection and starting of three-phase induction motors by DOL and star-delta starter. Changing direction of rotation of a given 3 phase induction motor. Motors used for driving pump, compressor and e vehicles.

UNIT IV

Domestic Installation

Distinction between light-fan circuit and single phase power circuit, sub-circuits, various accessories and parts of domestic electrical installation. Different types of wires and their IS specification, Identification of wiring systems. Colour coding of electrical wires.

Electrical Safety

Electrical shock and precautions against shock, treatment of electric shock, concept of fuses and their classification, concept of earthing and various types of earthing, brief description of range of protective devices like MCB, ELCB, and RCB

UNIT V

Basic Electronics

Concept of semi conductor, types- P and N type. Diodes and their applications, Transistor – PNP and NPN. Their characteristics and uses. Introduction to integrated circuit (IC), Different types of ICs used in electric drives and their control circuit.

RECOMMENDED BOOKS

1. P.S. Dhogal, "Basic Electrical Engineering", Tata McGraw Hill Publishers, New Delhi.
2. B. L. Thareja, "A Text Book of Electrical Technology Vol. I and II", S Chand and Co., New Delhi.
3. J. B. Gupta, "Basic Electrical Engineering", S. Kataria and Sons, Delhi.
4. N.N. Bhargava and Kulshreshta, "Basic Electronics and Linear Circuits", Tata McGraw Hill, New Delhi.
5. S. K. Sahdev, "Electronic Principles", Dhanpat Rai and Sons, New Delhi.
6. V. K. Mehta, "Principles of Electrical and Electronics Engineering", S. Chand and Company Ltd.. New Delhi.

INSTRUCTIONAL STRATEGY

The teacher should give emphasis on understanding of concept and various terms used in the subject. This subject contains five units of equal weightage.

3.7 WORKSHOP PRACTICE - II

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RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, skills in operating various machines are required to be developed. Hence the subject of workshop practice.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Prepare jobs on lathe, shaper, planer and milling machines.

CO2: Carry out welding of parts.

CO3: Carry out pattern making, moulding and casting operations.

PRACTICAL EXERCISES

UNIT I

Advance Turning Shop

1. Exercise of boring with the help of boring bar
2. Exercises on internal threading on lathe machine
3. Preparing a composite job involving turning, taper turning, external thread cutting and knurling.
4. Eccentric turning job on a lathe using 4-Jaw chuck.
5. Resharpening of single point cutting tool with given geometry

UNIT II

Machine Shop

1 Prepare a V-Block up to ± 0.5 mm accuracy on shaper machine

2 Exercise on key way cutting and spline cutting on shaper machine.

3 Produce a rectangular slot on one face with a slotting cutter

4 Produce a rectangular face using a planer machine

5 Produce a rectangular block using a milling machine with a side and face cutter

6 Exercise on milling machine to produce a spur gear

UNIT II
Advance Welding Shop

1 Practice of electric arc welding/MIG/TIG welding on welding Simulator
2 Exercise on spot welding/seam welding (any utility item)
3 Prepare a lap joint on MIG welding
4 Prepare a butt joint on TIG welding
5 Exercise on Pipe/MS-Plate cutting by chop-saw & disk grinder.
6. Job on laser welding machine

UNIT IV
Pattern Making

1. Preparation of solid/single piece pattern.
2. Preparation of two piece/split pattern
3. Exercise on making of a pattern on wooden lathe
4. Preparation of a self cored pattern
5. Preparation of a core box.

UNIT V
Foundry Shop

1. Preparation of mould with solid pattern on floor.
2. Preparation of floor mould of solid pattern using cope.
3. Preparation of floor mould of split pattern in cope and drag of moulding box.
4. Practice on Moulding and casting of a solid pattern of aluminum
5. Preparing a mould of step pulley and also preparing core for the same.
6. Testing of moisture contents and strength of moulding sand.

RECOMMENDED BOOKS

1 BS Raghuvanshi, “Workshop Technology”, Dhanpat Rai and Sons, Delhi.
2 SK Choudhry and Hajra, “Elements of Workshop Technology”, Asia Publishing House.
3 RL Aggarwal and T Manghnani, “Welding Engineering”, Khanna Publishers, Delhi.
4 PC Sharma, “A Text Book of Production Engineering”, S Chand and Company Ltd., Delhi.
5 KP Sinha and DB Goel, “Foundry Technology”, Roorkee Publishng House, Roorkee.

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students.

3.8 OPEN ELECTIVE

L	P
2	-

RATIONALE

Open electives are very important and play major role in implementation of National Education Policy. These subjects provide greater autonomy to the students in the curriculum, giving them the opportunity to customize it to reflect their passions and interests. The system of open electives also encourages cross learning, as students pick and choose subjects from the different streams.

COURSE OUTCOMES

At the end of the open elective, the students will be able to:

CO1: State the basic concepts and principles about the subject of interest.
CO2: Perform in a better way in the professional world.
CO3: Select and learn the subject related to own interest.
CO4: Explore latest developments in the field of interest.
CO5: Develop the habit of self-learning through online courses.

LIST OF OPEN ELECTIVES

(The list is indicative and not exhaustive)

1. Computer Application in Business
2. Introduction to NGO Management
3. Basics of Event Management
4. Event Planning
5. Administrative Law
6. Introduction to Advertising
7. Moodle Learning Management System
8. Linux Operating System

9. E-Commerce Technologies
10. NCC
11. Marketing and Sales
12. Graphics and Animations
13. Digital Marketing
14. Human Resource Management
15. Supply Chain Management
16. TQM

GUIDELINES

Open Elective shall be offered preferably in online mode. Online mode open elective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL, Upgrad, Udemy, Khan Academy or any other online portal to promote self-learning. A flexible basket of large number of open electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online open electives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline open electives, a suitable relevant subject shall be offered by the respective department to the students with minimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs open elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students from time to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable open elective is available online, only then the course may be conducted in offline mode. The assessment of offline open elective shall be internal and external. The offline open elective internal assessment of 40 marks shall be based on internal sessional tests; assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

NOTE

The students enrolled under NCC will compulsorily undertake NCC as an open elective subject.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://www.udemy.com/
3. https://www.upgrad.com/
4. https://www.khanacademy.org/

FOURTH SEMESTER

4.1 ENGLISH AND COMMUNICATION SKILL - II

L	P
2	2

RATIONALE

Communication II moves a step further from Communication Skills I and is aimed at enhancing the linguistic competency of the students. Language as the most commonly used medium of self-expression remains indispensable in all spheres of human life – personal, social and professional. This course is intended to make fresh ground in teaching of Communicative English as per the requirements of National Skill Quality Framework.

COURSE OUTCOMES

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

CO1: Communicate effectively with an increased confidence; read, write and speak in English language fluently.

CO2: Comprehend special features of format and style of formal communication through various modes.

CO3: Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews

CO4: Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.

DETAILED CONTENTS

UNIT I

Reading

1.1 Portrait of a Lady - Khushwant Singh

1.2 The Doctor's Word by R K Narayan

1.3 Speech by Dr Kiran Bedi at IIM Indore2007 Leadership Concepts

1.4 The Bet - by Anton Chekov

UNIT II

Effective Communication Skills

2.1 Modern means of Communication (Video Conferencing, e- mail, Teleconferencing)

2.2 Effective Communication Skills: 7 C's of Communication

2.3 Non-verbal Communication – Significance, Types and Techniques for Effective Communication
2.4 Barriers and Effectiveness in Listening Skills
2.5 Barriers and Effectiveness in Speaking Skills

Unit III

Professional Writing

3.1 Correspondence: Enquiry letters, placing orders, complaint letters
3.2 Report Writing
3.3 Memos
3.4 Circulars
3.5 Press Release
3.6 Inspection Notes and tips for Note-taking
3.7 Corrigendum writing
3.8 Cover Letter

UNIT IV

Grammar and Vocabulary

4.1 Prepositions
4.2 Conjunctions
4.3 Punctuation
4.4 Idioms and Phrases: A bird of ill omen, A bird's eye view, A burning question, A child's play, A cat and dog life, A feather in one's cap, A fish out of water, A shark, A snail's pace, A snake in the grass, A wild goose chase, As busy as a bee, As faithful as dog, Apple of One's eye, Behind one's back, Breath one's last, Below the belt, Beat about the bush, Birds of a feather flock together, Black Sheep, Blue blood, By hook or crook, Chicken hearted, Cut a sorry figure ,Hand in glove, In black and white, In the twinkling, In full swing ,Is blind as a bat, No rose without a thorn, Once in a blue moon, Out of the frying pan in to the fire, know no bounds ,To back out, To bell the cat, To blow one's trumpet, To call a spade a spade, To cut one's coat according to one's cloth, To eat humble pie, To give ear to, To have a thing on one's finger tips, To have one's foot in the grave, To hold one's tongue, To kill two birds with one stone, To make an ass of oneself, To put two and two together, To the back bone, Turn coat, ups and downs.
4.5 Pairs of words commonly misused and confused: Accept-except, Access-excess, Affect-effect, Artificial- artful, Aspire-expire, Bail-bale, Bare-bear, Berth-birth, Beside-besides, Break-brake, Canvas-canvass, Course- coarse, Casual-causal, Council-counsel, Continual-continuous, Coma-comma, Cue- queue, Corpse- corps-core, Dairy-diary, Desert-dessert, Dual-duel, Dew- due, Die-dye, Draft- draught-drought, Device-devise, Doze-dose, Eligible-illegible, Emigrant-

immigrant, Envelop-envelope, Farther-further, Gate-gait, Goal-goal, Human-humane, Honorable-honorary, Hail-hale, Hair-heir-hare, Industrial-industrious, Impossible- impassable, Idle-idol-ideal, Lose-loose, Later-latter, Lesson-lessen, Main-Mane, Mental-mantle, Metal-mettle, Meter-metre, Oar-ore, Pray- prey, Plain-plan, Principal - principle, Personal- personnel, Roll- role, Route-rout- roote, Stationary-stationery, Union- unity, Urban- urbane, Vocation-vacation, Vain- vein-vane, Vary- very.

4.6 Translation of Administrative and Technical Terms in Hindi or Mother tongue: Academy, Abandon, Acting in official capacity, Administrator, Admission, Aforesaid, Affidavit, Agenda, Alma Master, Ambiguous, Appointing Authority, Apprentice, Additional, Advertisement, Assistant, Assumption of charge, Assurance, Attested copy, Bonafide, Bond, Cashier, Chief Minister, Chief Justice Clerical error, Commanding ,Officer, Consent, Contractor, corruption, Craftsman, Compensation, Code, Compensatory allowance, Compile, Confidential letter, Daily Wager, Data, Dearness allowance, Death - Cum Retirement, Dispatch, Dispatch Register, Disciplinary, Disciplinary Action, Disparity Department, Dictionary, Director, Director of Technical Education, Earned Leave, Efficiency Bar, Estate, Exemption, Executive Engineer, Extraordinary, Employment Exchange, Flying Squad, General Body, Head Clerk, Head Office, High Commission, Inconvenience, Income Tax, Indian Assembly Service, Justify, Legislative Assembly, Negligence, Officiating ,Office Record, Office Discipline, On Probation, Part Time, Performance, Polytechnic, Proof Reader Precautionary, Provisional, Qualified, Regret, Responsibility, Self-Sufficient, Senior, Simultaneous ,Staff, Stenography ,Superior, Slate, Takeover, Target Data Technical Approval, Tenure, Temporary, Timely Compliance, Under Investigation, Under Consideration, Verification, Viva-voce, Write off, Working Committee, Warning, Yours Faithfully , Zero Hour.

UNIT V

Employability Skills

5.1 Presentation Skills: How to prepare and deliver a good presentation

5.2 Telephone Etiquettes

5.3 Importance of developing employable and soft skills

5.4 Resume Writing: Definition, Kinds of Resume, Difference between Bio-data and Curriculum Vitae and Preparing a Resume for Job/ Internship

5.5 Group discussions: Concept and fundamentals of GD, and learning Group Dynamics.

5.6 Case Studies and Role Plays

PRACTICAL EXERCISES

1. Reading Practice of the above lessons in the Lab Activity classes.
2. Comprehension exercises of unseen passages along with the given lessons.

3. Vocabulary enrichment and grammar exercises based on the above selective readings.
4. Situational Conversation: Requesting and responding to requests; Expressing sympathy and condolence.
5. Warning; Asking and giving information.
6. Getting and giving permission.
7. Asking for and giving opinions.
8. A small formal and informal speech.
9. Seminar.
10. Debate.
11. Interview Skills: Preparing for the Interview and guidelines for success in the Interview and significance of acceptable body-language during the Interview.
12. Written Drills will be undertaken in the class to facilitate a holistic linguistic competency among learners.
13. Participation in a GD, Functional and Non-functional roles in GD, Case Studies and Role Plays
14. Presentations, using audio-visual aids (including power-point).
15. Telephonic interviews, face to face interviews.
16. Presentations as Mode of Communication: Persuasive Presentations using multi-media aids.
17. Practice of idioms and phrases on: Above board , Apple of One's eye , At sea, At random, At large, A burning question, A child's play, A wolf in sheep's clothing, A deal, Breath one's last, Bid fair to, Beat about the bush, Blue Blood, Big Gun, Bring to Book, Cut a sorry figure, Call names, Carry weight, Dark Horse, Eat Humble pie, Feel small, French leave, Grease the palm, Go against the grains, Get One's nerves, Hard and Fast, Hue and Cry, Head and ears, In full swing, Jack of all trades, know no bounds, kiss the dust, Keep an eye on, Lion's share, learn by rote, Null and void, on the cards, Pull a long face, Run amuck, Right and Left, Rain on Shine, Small talk, Take to one's heels, Tooth and nail, to take by storm, , Wet blanket, Yearn for.

RECOMMENDED BOOKS

1. Alvinder Dhillon and Parmod Kumar Singla, "Text Book of English and Communication Skills Vol – 1, 2", M/s Abhishek Publications, Chandigarh.
2. J Sethi, Kamlesh Sadanand & DV Jindal, "Course in English Pronunciation", PHI Learning Pvt. Ltd., New Delhi.
3. Wren and Martin, "High School English Grammar and Composition" .
4. NK Aggarwal and FT Wood, "English Grammar, Composition and Usage", Macmillan Publishers India Ltd., New Delhi.
5. RC Sharma, and Krishna Mohan, "Business Correspondence & Report Writing", (4th Edition), by Tata MC Graw Hills, New Delhi.

6. Varinder Kumar, Bodh Raj & NP Manocha, "Business Communication Skills", Kalyani Publisher, New Delhi.
7. Kavita Tyagi & Padma Misra, "Professional Communication", PHI Learning Pvt. Ltd., New Delhi.
8. Nira Konar, "Communication Skills for Professionals", PHI Learning Pvt. Ltd., New Delhi.
9. Krishna Mohan & Meera Banerji, "Developing Communication Skills", (2nd Edition), Macmillan Publishers India Ltd., New Delhi.
10. M. Ashraf Rizwi, "Effective Technical Communication", Tata MC Graw Hills, New Delhi.
11. Andrea J Rutherford, "Basic Communication Skills for Technology", Pearson Education, New Delhi.
12. "English and Communication Skills Vol-1,2" by Dr. Sangeeta, Jashanpreet Kaur; Anant Publications, Ambala City.

INSTRUCTIONAL STRATEGY

This is practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required communication skills in the students. Emphasis should be given on practicing of communication skills. This subject contains five unit of equal weight age.

4.2 MATERIALS AND METALLURGY

L	P
3	2

RATIONALE

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

COURSE OUTCOMES

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

CO1: Distinguish between metals and non metals and ferrous and non ferrous materials.
CO2: Analyze microstructure and changes in microstructure due to heat treatment.
CO3: Carryout various heat treatment processes.
CO4: Draw and interpret iron-carbon diagram.
CO5: Distinguish various grades of Stainless steel and the relative selection of fabrication process depending upon the metallurgy of SS
CO6: Classify various types of plastics and rubber.
CO7 Explain properties and applications of composites, ceramics and smart materials.
CO8 Select suitable material to be used for various engineering applications.

DETAILED CONTENTS

UNIT I

Introduction

Material: Engineering materials, Overview of different engineering materials and applications, Importance, Classification of materials, Difference between metals and non-metals, Overview of Biomaterials and semi-conducting materials

UNIT II

Crystallography

Fundamentals: Crystalline solid and amorphous solid, Unit Cell, Space Lattice, Arrangement of atoms in Simple Cubic Crystals, BCC, FCC and HCP Crystals, Number of atoms per unit Cell, Atomic Packing Factor, coordination number (without derivation), Defects/Imperfections, types and effects in Solid materials.

Deformation: Overview of deformation behaviour and its mechanisms, Elastic and Plastic deformation. Failure Mechanisms: Overview of failure modes, fracture, fatigue and creep.

Metallurgy

Introduction, Cooling curves of pure metals, dendritic solidification of metals, effect of grain size on mechanical properties, Binary alloys, Thermal equilibrium diagrams, Lever rule, Solid Solution alloys

UNIT III

Metals and Alloys

Ferrous Metals: Different iron ores, Flow diagram for production of iron ,steel and stainless steel, allotropic forms of iron- Alpha, Delta, Gamma. Basic process of manufacturing of pig iron and steel-making.

Cast Iron: Properties, types of Cast Iron, manufacture and their use.

Steels: Plain carbon Steels and alloy steel, Classification of plain carbon steels, Properties and application of different types of Plain Carbon Steels, Effect of various alloying elements on properties of steel, Uses of alloy steels (high speed steel, silicon steel, spring steel)

Stainless steel: Definition, importance and criticality (Life cycle cost, Corrosion impact; difference with Steel, Per Capita consumption; growth rate of SS vs other materials, World vs India). Various grades of SS and their nomenclature, Effect of alloying elements, Unique characteristics of various grades of SS

Manufacturing of SS: Process flow, Raw materials for SS manufacturing functions of each processing unit, Downstream facilities, Various finishes of SS.

Fabrication and testing of SS: Stud welding method, Weldability and effect of welding on various types of SS, Defects like Sensitization and microfissure, Relative observations and precautions while performing the processes: cutting , Buffing, Bending, Roll forming, Embossing, Polishing of Stainless steel. Chemical treatment like pickling and passivation for SS.

Applications of SS: Demand of SS in various segments, Overview of SS applications in Automobile, railway, and transport. Architectural, building construction applications and Process Industries.

Non Ferrous Materials: Properties and uses of Copper, Aluminium and their alloys

UNIT IV

Heat Treatment

Definition and objectives of heat treatment, Iron carbon equilibrium diagram, different microstructures of iron and steel. Formation and decomposition of Austenite, Martensitic Transformation. Various heat treatment processes- hardening, tempering, annealing, normalizing, surface hardening, carburizing, nitriding, cyaniding. Hardenability of Steels

Types of heat treatment furnaces (only basic idea), measurement of temperature of furnaces.
Physical metallurgy of Stainless Steel; Various phases in SS, Chromium-Nickel diagram, Schaeffler Diagram

UNIT V

Advanced Materials

Heat Insulating materials- Asbestos, glasswool, thermocole.
Refractory materials –Dolomite, porcelain.
Glass – Soda lime, borosil.
Materials for bearing metals Materials for Nuclear Energy
Smart materials- properties and applications.

PRACTICAL EXERCISES

1. Classification of about 25 specimens of materials/machine parts into
   (i) Metals and non metals
   (ii) Metals and alloys
   (iii) Ferrous and non ferrous metals
   (iv) Ferrous and non ferrous alloys
2. Given a set of specimen of metals and alloys (copper, brass, aluminium, cast iron, HSS, **SS**, Gun metal); identify and indicate the various properties possessed by them.
3. a) Study of heat treatment furnace.
   b) Study of a thermocouple/pyrometer.
4. Study of a metallurgical microscope and a specimen polishing machine.

5. To prepare specimens of following materials for microscopic examination and to Examine the microstructure of the specimens of following materials (At least any two): i) Brass ii) Copper iii) Cast Iron, iv) Mild Steel v) HSS, vi) Aluminium vii) Stainless steel
6. To anneal a given specimen and find out difference in hardness as a result of annealing.
7. To normalize a given specimen and to find out the difference in hardness as a result of normalizing.
8. To harden and temper a specimen and to find out the difference in hardness due to tempering.
9. Demo of welding defects like sensitization and micro fissure in stainless steel.

RECOMMENDED BOOKS

1. R.K. Rajput, "Text book of Material Science", Katson Publishers, Ludhiana.
2. V.K. Manchanda and GBS Narang, "Text book of Material Science", Khanna Publishers, New Delhi.
3. A.R. Gupta, "Introduction to Material Science", Satya Prakashan, New Delhi.
4. S. K. Hazra Chaudhary, "Material Science and Processes", India Book Distribution Co., Calcutta, First Edition, 1977.

INSTRUCTIONAL STRATEGY

While imparting instructions, teacher should show various types of engineering materials to the students. Visits to industry should be planned to demonstrate use of various types of materials or heat treatment processes in the industry. This is hands-on practice based subject and topics taught in the class should be practiced in the lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

4.3 HYDRAULICS AND PNEUMATICS

L	P
3	2

RATIONALE

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

COURSE OUTCOMES

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

CO1: Explain fluid properties, their units and conversion.
CO2: Measure pressure using appropriate pressure measuring devices.
CO3: Measure flow & discharge rate using appropriate flow measuring devices.
CO4: Describe the construction and working of turbines.
CO5: Describe the construction and working of pumps.
CO6: Explain the functions of various components used in hydraulic and pneumatic system.

DETAILED CONTENTS

UNIT I

Properties of fluid

Density, Specific gravity, Specific Weight, Specific Volume, Dynamic Viscosity, Kinematic Viscosity, Surface tension, Capillarity, Vapour Pressure, Compressibility. Fluid Pressure & Pressure Measurement: Fluid pressure, of Pascal's law and its applications Pressure head, Pressure intensity, Concept of vacuum and gauge pressures, atmospheric pressure, absolute pressure, Piezometer, Simple U- tube Manometer and differential manometers, Bourdan's pressure gauge, Concept of Total pressure on immersed bodies, center of pressure, Simple problems on fluid properties and Manometers.

UNIT II

Fluid Flow

Types of fluid flows, Path line and Stream line, Continuity equation, Bernoulli's theorem, Principle of operation of Venturimeter, Orifice meter and Pitot tube, Derivations for discharge, coefficient of discharge and numerical problems.

Flow Through Pipes: Laminar and turbulent flows; Darcy's equation and Chezy's equation for frictional losses, Minor losses in pipes, wetted perimeter, Hydraulic gradient and total gradient line, Reynold's number and its effect on pipe friction; Water hammer. Simple numerical problems to estimate major and minor losses

UNIT III

Hydraulic Turbines

Impact of jet on fixed vertical and moving vertical flat plates, Hydraulic Turbines:
Classification of hydraulic turbines, Selection of turbine on the basis of head and discharge available, Construction and working principle of Pelton wheel, Francis and Kaplan turbines.
other Machines working construction and applications of hydraulic press, hydraulic jack, hydraulic accumulator and hydraulic ram.

UNIT IV

Pumps

Centrifugal Pumps: Principle of working and applications, Types of casings and impellers, Concept of multistage, Priming and its methods, Cavitation, Manometric head, Work done, Manometric efficiency, Overall efficiency.

Reciprocating Pumps: Construction, working principle and applications of single and double acting reciprocating pumps, Concept of Slip, Negative slip, Cavitation and separation.

UNIT V

Hydraulic and Pneumatic systems

Introduction to oil power hydraulic and pneumatic system. Relative Merits and Demerits of oil power hydraulic and pneumatic system. Basic components of hydraulic system, function of each component in a hydraulic circuit such as Oil reservoirs, connectors, pipes, motors and pumps(power pack), Filters, etc.

Components of Pneumatic Systems : Basic components – function of each component such as Air compressors, Air cylinder and their types (single acting, double acting, piston type, diaphragm type, tandem cylinder, double ended cylinder). Air filter, regulator and lubricator – their necessity in pneumatic circuit. common faults in hydraulic system and pneumatic systems and remedial action.

PRACTICAL EXERCISES

1. Measurement of pressure head using
    i) Piezometer tube
    ii) Simple U-tube manometer
    iii) Bourdon.s tube pressure gauge
2. Verification of Bernoulli's theorem.
3. Determination of Coefficient of Discharge of venturimeter.
4. Determination of Coefficient of Discharge, coefficient of contraction and coefficient of velocity of Orifice meter.
5. Determination of coefficient of friction of flow through pipes((Darcy's equation)
6. Determination of minor losses of flow through pipes. (Chezy's Equation)
7. To determine overall efficiency of a single stage centrifugal pump.
8. Demo of working of Pelton wheel, Francis and Kaplan turbine with the help of working model.
9. Draw hydraulic circuit of any available machine or working model
10. Draw pneumatic circuit of any available machine or working model

RECOMMENDED BOOKS

1. S.S. Rattan, "Fluid Mechanics & Hydraulic Machines", Khanna Publishing House, New Delhi.
2. KL Kumar, "Fluid Mechanics", S Chand and Co Ltd., Ram Nagar, New Delhi.
3. P.N. Modi and S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House. New Delhi
4. R K Bansal, "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publication, New Delhi.
5. Andrew Parr, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide", Butterworth-Heinemann.
6. S. Majumdar, **"**Pneumatic Systems: Principles and Maintenance", McGraw Hill.

INSTRUCTIONAL STRATEGY

1. Use computer based learning aids for effective teaching-learning
2. Expose students to real life problems
3. Plan assignments so as to promote problem solving abilities and develop continued learning skills. This subject contains five units of equal weightage.

4.4 WORKSHOP TECHNOLOGY - III

L	P
3	-

RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, knowledge about various machining processes and modern machining methods is required to be imparted. Hence this subject.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: To understand the concept of gear manufacturing using different methods.
CO2: To understand grinding and finishing processes.
CO3: Explain the working and applications of modern machining practices.
CO4: Explain the working principle of metal forming.
CO5: Explain the working principle of metallic coating and finishing processes.

DETAILED CONTENTS

UNIT I

Gear Manufacturing

Gear materials and specifications, Gear manufacturing by Casting, Moulding, Stamping, Machining; Gear generating methods: Gear Shaping with pinion cutter & rack cutter; Gear hobbing; Description of gear hob; Operation of gear hobbing machine; Gear finishing processes;

UNIT II

Grinding

Principles of metal removal by Grinding; Abrasives – Natural & Artificial; Bonds and binding processes: Vitrified, silicate, shellac, rubber, bakelite; Factors affecting the selection of grind wheels: size and shape of wheel, kind of abrasive, grain size, grade and strength of bond, structure of grain, spacing, kinds of bind material; Standard marking systems: Meaning of letters & numbers sequence of marking, Grades of letters; Truing, dressing, balancing and mounting of wheel. Selection of grinding wheel. Grinding machines classification: Cylindrical, Surface, Tool

& Cutter grinding machines; Construction details; Principle of centreless grinding; Advantages & limitations of centreless grinding;

UNIT III

Modern Machining Processes

Introduction – comparison with traditional machining; Ultrasonic Machining: principle, Description of equipment, applications; Electric Discharge Machining (EDM): 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.

UNIT IV

Metal Forming Processes

Press Working - Types of presses, type of dies and punches, selection of press die, die material. Press Operations-Shearing, piercing, trimming, punching, notching, shaving, gearing, embossing, stamping.

Forging - Open die forging, closed die forging, Press forging, upset forging, swaging, up setters, roll forging, Cold and hot forging.

Rolling - Elementary theory of rolling, Types of rolling mills, Thread rolling, roll passes, Rolling defects and remedies.

Extrusion and Drawing - Type of extrusion- Hot and Cold, Direct and indirect. Pipe drawing, tube drawing, wire drawing

UNIT V

Metal Finishing Processes

Purpose of finishing surfaces. Surface roughness-Definition and units, Honing Process, its applications, Description of hones. Brief idea of honing machines. Lapping process, its applications. Description of lapping compounds and tools. Brief idea of lapping machines. Polishing, Buffing, Burnishing and super finishing

Metallic Coating Processes

Metal spraying – Wire process, powder coating process, applications, Electroplating: Basic principles, Plating metals, applications; Hot dipping: Galvanizing, Tin coating, Parkerising, Anodizing. Organic coatings: Oil base Paint, Lacquer base, Enamels, Bituminous paints, rubber base coating; Finishing specifications.

RECOMMENDED BOOKS

1. P N Rao, "Manufacturing Technology Vol.-I &II", Tata McGraw-Hill Publications.
2. S. K. Hajra Chaudhary, Bose and Roy, "Elements of Workshop Technology (Volume I and II)", Media Promoters and Publishers Limited.
3. O. P. Khanna & Lal, "Production Technology (Volume I & II)", Dhanpat Rai Publications.
4. BL Juneja, GS Sekhon and Nitin Seth, "Fundamental of Metal Cutting and Machine Tools", New Age International Limited.
5. R. K Jain, "Production Technology", Khanna Publication, New Delhi
7. Raghuwanshi, "Workshop Technology Vol.-II", Khanna Publishers, New Delhi.
8. B. L. Juneja, "Fundamental of Metal Forming", New Age International Limited, Delhi.

INSTRUCTIONAL STRATEGY

Teachers should lay special emphasis in making the students conversant with concepts, principles, procedures and practices related to various manufacturing processes. Use of audio-visual aids/video films should be made to show specialized operations. This subject contains five units of equal weightage.

4.5 MACHINE DESIGN

L	P
3	-

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

At the end of this course, students will be able to:

CO1: Explain the terms related to design.
CO2: Design shaft on the basis of strength and rigidity.
CO3: Design keys and couplings
CO4: Design temporary and permanent joints
CO5: Design screw jack and helical spring.

DETAILED CONTENTS

UNIT I

Introduction

- Design – Definition, Type of design, necessity of design, Comparison of designed and undesigned work, Design procedure, Characteristics of a good designer
- Design terminology: stress, strain, factor of safety, factors affecting factor of safety, stress concentration, methods to reduce stress concentration, fatigue, creep and tenacity, endurance limit. SN Curve and its significance
- General design consideration, Selection of materials, criteria of material selection, Codes and Standards (BIS standards)
- Various design failures- maximum normal stress theory, maximum stress theory, maximum strain theory

UNIT II

Design of Shaft

- Type of shaft, shaft materials, Type of loading on shaft, standard sizes of shaft available
- Shaft subjected to torsion only, determination of shaft diameter (hollow and solid shaft) on the basis of :
  - Strength criterion
  - Rigidity criterion
- Determination of shaft diameter (hollow and solid shaft) subjected to bending
- Determination of shaft diameter (hollow and solid shaft) subjected to combined torsion and bending.

UNIT III

Design of Key

- Types of key, materials of key, functions of key
- Failure of key (by Shearing and Crushing).
- Design of key (Determination of key dimension)
- Effect of keyway on shaft strength. (Figures and problems).

Design of Coupling

Necessity of a coupling, advantages of a coupling, types of couplings, design of muff coupling, design of flange coupling. (Both protected type and unprotected type).

UNIT IV

Design of Joints

Types of joints - Temporary and permanent joints, utility of various joints

- Design of Temporary Joints:
  Knuckle Joints – Different parts of the joint, material used for the joint, type of knuckle Joint, design of the knuckle joint. (Figures and problems).
  Cotter Joint – Different parts of the spigot and socket joints, Design of spigot and socket joint.
- Design of Permanent Joint:
  Riveted Joints. : Rivet materials, Rivet heads, leak proofing of riveted joint – caulking and fullering.
  Different modes of rivet joint failure.
  Design of riveted joint – Lap and butt, single and multi riveted joint.
  Welded Joint - Welding symbols. Type of welded joint, strength of parallel and transverse fillet welds.
  Strength of combined parallel and transverse weld.

UNIT V

Design of Screwed Joints and Springs

- Design of screw: Introduction, Advantages and Disadvantages of screw joints, location of screw joints. Important terms used in screw threads, designation of screw threads, Initial stresses due to screw up forces, stresses due to combined forces, Design of Screw jack
- Design of Spring: Classification and applications of sprigs, spring terminology, Stresses in springs, Wahl's correction factor, design of open coil helical spring subjected to uniform applied load under tension and compression.

RECOMMENDED BOOKS

1. R.S. Khurmi and JK Gupta, "Machine Design", Eurasia Publishing House (Pvt.) Limited, New Delhi.
2. V.B. Bhandari, "Machine Design", Tata McGraw Hill, New Delhi.
3. George Dieter, "Engineering Design", Tata McGraw Hill Publishers, New Delhi.
4. Joseph Edward Shigley, "Mechanical Engineering Design", McGraw Hill, Delhi.
5. Sharma and Agrawal, "Machine Design", Katson Publishing House, Ludhiana.
6. D.P. Mandali, "Design Data Handbook", SK Kataria and Sons, Delhi.
7. A.P.Verma, "Machine Design", SK Kataria and Sons, Delhi.
8. AR Gupta and BK Gupta, "Machine Design", Satya Parkashan, New Delhi.

INSTRUCTIONAL STRATEGY

While teaching, teacher should use models of various parts/components. This subject contains five units of equal weightage. Teacher should observe following:

a) Use of design data book during the examination is allowed.

b) The paper setter should normally provide all the relevant data for the machine design in the question paper.

4.6 THERMODYNAMICS-II

L	P
3	2

RATIOANLE

A diploma holder in this course is supposed to know about working and testing of IC Engines, fuel supply, ignition system, cooling and lubrication of engines and working of steam turbine and gas turbine. Hence this subject.

COURSE OUTCOMES

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

CO1: Explain the working of IC engine and functioning of various parts of IC engine.
CO2: Explain the working of fuel supply and ignition system in petrol engine.
CO3: Explain the functioning of different components of fuel supply of diesel engine.
CO4: Explain the working of lubrication and cooling system in IC engine.
CO5: Assist in testing an IC engine and understand pollution norms in India.
CO6: Explain the functioning of steam turbine, gas turbine and jet propulsion.

DETAILED CONTENTS

UNIT I

IC Engines

- Introduction and classification of IC engine
- Description of Carnot cycle, Otto cycle, diesel cycle with PV and TS diagram
- Working principle of two stroke and four stroke cycle, SI engines and CI engines
- Location and functions of various parts of IC engines and materials used for them
- Basic terms such as bore, TDC, BDC, Stroke, Crank throw, piston speed and compression ratio
- Valve timing diagram for four stroke CI and SI engines
- Comparison between SI and CI engines, comparison between two stroke and four stroke engines

Fuel Supply and Ignition System in Petrol Engine

- Concept of carburetion
- Air fuel ratio, mixture required at different conditions and loads on engine.
- Simple carburetor and its limitations and application. Working of Solex carburetor.
- Description of petrol injection system (MPFI)
- Description of battery coil and electronic ignition system

UNIT II

Fuel System of Diesel Engine

- Components of fuel supply system of Diesel engine
- Description and working of fuel feed pump, Fuel injection pump, fuel injectors and fuel filters
- Types of Fuel injection systems in diesel engine

Cooling and Lubrication

- Function of cooling system in IC engine
- Air cooling and water cooling system, use of thermostat and radiator.
- Function and types of coolant
- Function of lubrication
- Lubrication system of IC engine

UNIT III

Testing of IC Engines

- Engine power - indicated and brake power
- Efficiency - mechanical, thermal. relative and volumetric
- Methods of finding indicated and brake power
- Morse test for petrol engine
- Heat balance sheet, simple numerical problems
- Concept of pollutants in SI and CI engines, pollution control, norms for two or four wheelers. Bharat stage emission standards (BS Norms), Methods of reducing pollution in IC engines

UNIT IV

Steam Turbines and Steam Condensers

- Introduction, main parts, uses and classification of steam turbine
- Construction and working principle of impulse and reaction steam turbines and comparison

- Governing of steam turbines
- Steam nozzles - types and applications
- Function of a steam condenser, elements of condensing plant and types of steam condenser (Jet and surface).
- Comparison between jet condenser and surface condenser
- Cooling pond and cooling towers

UNIT V

Gas Turbines and Jet Propulsion

- Classification, open cycle gas turbine and closed cycle gas turbine, comparison of gas turbines with reciprocating IC engines, applications and limitations of gas turbine
- Open cycle constant pressure gas turbines - general layout, PV and TS diagram and working of gas turbine
- Closed cycle gas turbines, PV and TS diagram and working
- Principle of operation of ram-jet engine and turbo jet engine - application of jet engines
- Supercharger and turbocharger engine

PRACTICAL EXERCISES

1. Dismantle an IC engine and note down the condition of various parts, removal and fitting of piston, rings, measuring of bore size, crank shaft ovality and assemble it.
2. Servicing of petrol engine.
3. Demonstration of electronic ignition system
4. Valve servicing, grinding, lapping and fitting mechanism and tappet adjustment.
5. Determination of BHP by dynamometer.
6. Morse test on multi-cylinder petrol engine.
7. Testing of engine pollution.
8. Demonstration and study of lubrication system of a multi cylinder IC engine
9. Draw heat balance sheet of a 4 stroke IC engine.

Note : Visit to a thermal power plant may be arranged.

RECOMMENDED BOOKS

1. Pandey and Shah, “Elements of Heat Engines”, Charotar Publishing House, Anand.
2. PL. Ballaney, “Thermal Engineering”, Khanna Publishers, New Delhi.
3. Francis F Huang, “Engineering Thermodynamics”, McMillan Publishing Company,

Delhi.
4. CP. Arora, “Engineering Thermodynamics”, Tata McGraw Hill Publishers, New Delhi.
5. RK Purohit, “Thermal Engineering”, Standard Publishers Distributors, New Delhi.
6. V Ganeshan, “Internal Combustion Engine and Gas Turbine”, Tata McGraw Hill.

INSTRUCTIONAL STRATEGY

This is hands-on practice based subject and topics taught in the class should be practiced in the lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

4.7 WORKSHOP PRACTICE - III

L	P
-	6

RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, skills in operating various machines are required to be developed. Hence the subject of workshop practice.

COURSE OUTCOMES:

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

CO1: Prepare jobs using various conventional and advance machines.

CO2: Carry out metal coating and finishing operations.

CO3: Undertake advance fitting operations.

PRACTICAL EXERCISES

UNIT 1
GRINDING SHOP

1. Job on grinding machine using a surface grinder.
2. Prepare a job on cylindrical grinding machine.
3. Grinding a drill-bit on tool and cutter grinder.
4. Prepare a job on centerless grinding machine.
5. Exercise on dressing a grinding wheel.

UNIT II
ADVANCE MACHINE SHOP

1. Prepare a slot on one face using milling machine
2. Prepare a T slot on vertical milling machine.
3. Prepare a job on milling machine by using a form cutter
4. Exercise of cutting a spur gear on a hobbing machine
5. Perform machining operation on EDM/wire cut machine.
6. Demonstration of modern machining processes such as ECM/USM/LBM etc. through industrial visit.

7. Demo of metal forming operations such as Forging, Extrusion, Rolling, Press Working etc. through industrial visit.

UNIT III
METAL COATING AND FINISHING SHOP

1. Prepare a job by using metal finishing operations such as lapping, buffing, polishing, burnishing on a workpiece.
2. Prepare a job to finish an internal surface using honing process.
3. Carry out electroplating on a job.
4. Finishing a metal surface using a metal spray
5. Finishing a metal surface using powder Coating

UNIT IV
ADVANCE FITTING SHOP

1. Prepare a composite job of drilling, reaming, counter boring, counter sinking and tapping operations.
2. Prepare dove tail fitting on mild steel specimen. or
   Prepare radius fitting on mild steel specimen
3. Perform pipe threading operation using die and assembly of the same with pipe fittings.

RECOMMENDED BOOKS

1. B.S. Raghuwanshi, "Workshop Technology", Dhanpat Rai and Sons, Delhi.
2. S.K. Choudhry and Hajra, "Elements of Workshop Technology", Asia Publishing House.
3 PC Sharma, "A Textbook of Production Engineering", S. Chand and Company Ltd. Delhi.

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students. Instructor should conduct classes of each Workshop explaining use of tools, jobs to be made and safety precautions related to each workshop prior to students being exposed to actual practicals.

4.8 CAD/ CAM

L	P
-	4

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, are the part of Computer Integrated Manufacturing which help to achieve the desired goals in manufacturing. After completing 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:

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

CO1: Draw 2D drawings of various parts using drafting software.

CO2: Draw 3D drawings using any part modelling software.

CO3: Generate part programs using CAM software.

PRACTICAL EXERCISES

UNIT I

Computer Aided Design (CAD) **(03 Sheets)**

- Introduction to Computer Aided Drafting (2D) commands of any one software (Auto CAD, ProE, Solid works, Unigraphics etc.)
- Introduction to CAD Software, Installing CAD Software, Familiarization with software, coordinate system (Absolute, Relative and Polar), snap, grid, and ortho mode and setting of units and layout.
- Exercises on preparing drawings of some machine elements using: Drawing commands – point, line, arc, circle, ellipse, Editing commands – scale, erase, copy, stretch, lengthen and explode.
- Dimensioning and placing text in drawing area, sectioning and hatching, Inquiry for different parameters of drawing entity, Create layers within a drawing,
- Some exercise on simple drawings.

UNIT II

Prepare assembly drawing of the following using Drafting Software (2D) (3 sheets)

- Plummer Block
- Stepped pulley, V-belt pulley
- Machine tool Holder
- Wall Bracket

UNIT III

Isometric Drawing by CAD using any part modeling Software (3D) (2 sheets)

Introduction: Part modelling: Datum Plane; constraint; sketch; dimensioning; extrude; revolve; sweep; blend; protrusion; extrusion; rib; shell; hole; round; chamfer; copy; mirror; assembly; align; orient. Exercises for 3D Drawings:

- Flanged coupling
- Bearing Block
- Bushed bearing

UNIT IV

Computer Aided Manufacturing (CAM)

- Introduction to CAM software, steps in using CAM software
- Generate part program using CAM software (MasterCAM/EdgeCAM or any other CAM software) for turning jobs
- Generate part program using CAM software (MasterCAM/EdgeCAM or any other CAM software) for milling jobs

RECOMMENDED BOOKS

1. P. Radhakrishnan, S. Subramaniyan and V. Raju, "CAD/CAM/CIM", New Age International Pvt. Ltd., New Delhi.
2. P.S. Gill, "Machine Drawing", S. K. Kataria & Sons, Delhi.
3. T. Jeyapooran, "Engineering Drawing with AutoCAD 2000", Vikas Publishing House, Delhi.
4. Instruction Manual of the Software (AutoCAD, ProE, Solidworks, Unigraphic etc.).

INSTRUCTIONAL STRATEGY

Emphasis should be laid on hands-on practice for development of required skills in the students.

THIRD YEAR

NSQF LEVEL - 5

18. STUDY AND EVALUATION SCHEME

FIFTH SEMESTER :

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
5.1	Industrial Training-II	-	2	0+1=1	-	40	40	-	60	60	100
5.2	Refrigeration and Air Conditioning	3	2	3+1=4	40	40	80	60	60	120	200
5.3	**CNC Machines and Automation	3	2	3+1=4	40	40	80	60	60	120	200
5.4	Programme Elective I	3	-	3+0=3	40	-	40	60	-	60	100
5.5	Theory of Machines	2	2	2+1=3	40	40	80	60	60	120	200
5.6	Multi- disciplinary Elective (MOOCs/offline)	2	-	2+0=2	40	-	40	60	-	60	100
5.7	Workshop Practice – IV	-	4	0+2=2	-	40	40	-	60	60	100
5.8	Minor Project	-	4	0+2=2	-	40	40	-	60	60	100
# Student Centered Activities(SCA)		-	6	-	-	-	-	-	-	-	-
	Total	**13**	**22**	**21**	**200**	**240**	**440**	**300**	**360**	**660**	**1100**

** Common with other Diplomas

Programme Elective I: 5.4.1. Industrial Engineering **5.4.2.** Plant Maintenance & Material Handing **5.4.3.** Stainless Steel Technology

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

SIXTH SEMESTER :

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
6.1	Automobile Engineering	3	2	3+1=4	40	40	80	60	60	120	200
6.2	Metrology and Quality Control	3	2	3+1=4	40	40	80	60	60	120	200
6.3	*Entrepreneurship Development and Management	3	-	3+0=3	40	-	40	60	-	60	100
6.4	Programme Elective II	3	-	3+0=3	40	-	40	60	-	60	100
6.5	Major Project / Industrial Training	-	12	0+6=6	-	40	40	-	60	60	100
# Student Centered Activities (SCA)		-	7	-	-	-	-	-	-	-	-
	Total	**12**	**23**	**20**	**160**	**120**	**280**	**240**	**180**	**420**	**700**

* Common with other Diploma Courses

Programme Elective II: 6.4.1. Renewable Sources of Energy **6.4.2.** Estimating and Costing in Mechanical Engineering
6.4.3. Power Plant Engineering

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

19. HORIZONTAL AND VERTICAL SUBJECTS ORGANISATION

Sr. No.	Subjects/Areas	Hours Per Week	
		Fifth Semester	Sixth Semester
1.	Industrial Training-II	2	-
2.	Refrigeration and Air Conditioning	5	-
3.	CNC Machines and Automation	5	-
4.	Programme Elective I	3	-
5.	Theory of Machines	4	-
6.	Multi- disciplinary Elective	2	-
7.	Workshop Practice – IV	4	-
8.	Minor Project	4	-
9.	Automobile Engineering	-	5
10.	Metrology and Quality Control	-	5
11.	Entrepreneurship Development and Management	-	3
12.	Programme Elective II		3
13.	Major Project / Industrial Training		12
14.	Student Centred Activities	6	7
	Total	**35**	**35**

20. COMPETENCY PROFILE AND EMPLOYMENT OPPORTUNITIES

Government and private sectors related to **Mechanical Engineering** require **supervisors and technician engineers,** having well developed skills with clear choice of procedures. They are expected to have complete knowledge and practical skills related to mechanical engineering. They shall be able to communicate clearly with others. Diploma holders after passing level 5 shall have understanding of desired mathematical skills and understanding of social and natural environment. They are expected to collect, organize and communicate information effectively.

Work requiring knowledge, skills and aptitudes at level 5 will also be carried out in familiar situations, but also ones where problems may arise. Job holders will be able to make choices about the best procedures to adopt to address problems where the choices are clear. Individuals in jobs which require level 5 qualifications will normally be responsible for the completion of their own work and expected to learn and improve their performance on the job. They will require well developed practical and cognitive skills to complete their work. They may also have some responsibility for others' work and learning.

Individuals employed to carry out these jobs will be expected to be able to communicate clearly in speech and writing and may be required to apply mathematical processes. They should also be able to collect and organise information to communicate about the work. They will solve problems by selecting and applying methods, tools, materials and information. They will be expected to have previous knowledge and skills in the occupation, and to know and apply facts, principles, processes and general concepts in the occupation. They will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their work. They will be expected to operate hygienically and in ways which show an understanding of environmental issues. They will take account of health and safety issues as they affect the work they carry out or supervise. In working with others, they will be expected to conduct themselves in ways which show an understanding of the social and political environment.

They are expected have the knowledge of Refrigeration and Air Conditioning, CNC Machines, Automobile Engineering, Metrology and Quality Control and Renewable Sources of Energy. They might find work with a manufacturing company and spend time maintaining, or even designing, the machines that perform much of the automations. They might also work in relevant laboratories for any institute, university or even a private companies. They are expected to have good exposure of

humanities, life skills, entrepreneur development and management to establish small start-ups in the area of Marketing, Sales, Repair and Maintenance etc**.**

They have wide scope to work as supervisory technical employee on wage basis in following organizations:

- In manufacturing industries primarily in private sector and to some extent in public sector
- In Railways, Hospitals, Military Engineering Services, Boards and Corporations, Construction Companies, Transportation Departments, Telecommunication, PWD and Rural Development Agencies.

They have wide scope in establishing small start-ups in the area of Marketing and Sales, Manufacturing Units and Repair and Maintenance units etc.

21. PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 5 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

PO1: Perform task that require well developed skills with clear choice of procedures.

PO2: Acquire knowledge of facts, principles and processes related to Mechanical Engineering.

PO3: Demonstrate cognitive and practical skills to complete tasks and solve problems.

PO4: Develop skills to collect, organize and communicate information.

PO5: Accomplish own work and supervise others work.

PO6: Select online multidisciplinary electives of own interest to promote self-learning.

22. ASSESSMENT OF PROGRAM AND COURSE OUTCOMES

Programme Outcomes to be assessed	Assessment criteria for the Course Outcomes
PO1: Perform task that require well developed skills with clear choice of procedures.	• Explain the working and construction features of refrigeration and air conditioning systems • Explain latest developments in the field of refrigeration and air conditioning. • Describe the construction and features of air compressor and working on different air compressors. • Explain the construction and tooling of CNC machine. • Prepare simple part programme. • Demonstrate and Operate a CNC lathe and milling machine. • Explain the trends in the field of automation. • Use industrial engineering concepts to improve productivity • Explain various incentive plans • Explain the concept of testing, repair and maintenance. • Comprehend the procedure for erection and commissioning of machines • Work on shop floor for the Production of stainless steels. • Describe different machine elements, mechanisms and inversion of mechanism • Describe different types of cams and their motions and also draw cam profiles for various Motions. • Identify and explain the function of different chassis components and drive types. • Explain the use of different business tools (TQM / ISO-Standards) and QC tools in manufacturing environment. • Explain different types of Transducers and

	measure displacement, vibration, pressure and temperature. • Describe various renewable and non-renewable sources of energy • Explain the fundamentals of estimation. • Explain the elements of costing. • Describe the fundamentals of cost accounting. • Explain the Social and Economic issues of power plants.
PO2: Acquire knowledge of facts, principles and processes related to mechanical engineering	• Classify, draw and interpret various refrigeration cycles with their applications. • Make basic calculation of psychometric properties and processes. • Calculate heating and cooling load requirements of a room. • Calculate the properties of air by using psychometric chart. • Assess the part program, edit and execute in CNC turning and machining centre • Develop the part program and tool path generation using simulation software for Lathe and Milling machines • Use Advanced programming structures. • Use resources optimally and economically. • Apply work study techniques to eliminate unproductive activities • Comprehend the procedure for testing of machines • Explain various lubrication systems • Undertake processing, fabrication, property evaluation, structure - property correlation of steel. • Undertake Phase Transformations and Heat treatments • Select Suitable Drives and Mechanisms for a

	particular application • Explain the design of Brakes, Dynamometers, Bearings and Clutches. • Prepare jobs using gear hobbing EDM and grinding machine. • Carry out metal finishing operations. • Carry out powder coating, honing and scraping operations. • Explain working principle of various solar energy systems • Describe concepts of power generation with the wind energy, ocean energy, hydro, geothermal energy, tidal energy, fuel cell. • Work on a bio gas plant. • Describe different energy storage devices used in renewable energy resources. • Estimate the material cost. • Estimate machining time. • Estimate foundry cost, forging cost and welding cost. • Analyse economics of power plants and list factors affecting the power plants and interpret the performance of power plants based on load variations. • Identify elements and their functions of, hydro power plants. • Identify elements and their functions and operations of steam power plants. • Identify elements and their functions and operations of nuclear and gas turbine power plants. • Identify elements and their functions and operations of solar, wind and diesel power plants.

PO3: Demonstrate cognitive and practical skills to complete tasks and solve problems.	• Carry out charging of air conditioner. • Detect faults and trouble shooting in an air-conditioner/refrigerator. • Diagnose common problems in CNC machines. • Solve planning, scheduling and sequencing problems for shop floor • Interpret different kinds of production systems • Prepare break-even analysis and Gantt chart. • Locate suitable plant location and draw plant layout for different production system. • Maintain inventory optimally and classify different types of inventory • Comprehend the procedure of repair and maintenance • Explain the means to maintain various Material Handling systems • Select grades for large scale applications • Solve problems on power transmission. • Solve problems on balancing and Vibration • Maintain transmission system. • Carry out balancing of wheels to maintain steering geometry. • Carry out routine servicing of brake system and bleeding of hydraulic brakes • Carry out testing and charging of Lead-acid battery. • Interpret Bharat norms of exhaust emissions. • Electric, Hybrid vehicles, running, charging and maintenance issues • Apply different inspection techniques to improve quality of products and processes. • Select and use suitable measurement tools / gauges to measure product dimensions.

	• Measure geometrical parameters such as Straightness, Flatness and Parallelism. • Use different quality charts to control products quality and interpret different quality control charts. • Apply the concept of Process costing, and types of Budget, and familiarize with accounting terminology.
PO4: Develop skills to collect, organize and communicate information.	• Understand the working environment of industries • Learn about present and future requirement of industries. • Develop writing, speaking and presentations skills. • Observe technological developments as per present and future needs of industries. • Collect, communicate and manage the data from connected devices. • Comprehend the importance of entrepreneurship and its role in nation's development. • Classify the various types of business and business organizations. • Identify the various resources / sources and / or schemes for starting a new venture. • Explain the principles of management including its functions in an organisation. • Conduct market survey and prepare project report. • Define the problem statement of the Industrial training / Major project according to the need of industry. • Write the Internship / Major project report effectively. • Present the Internship / Major project report using PPT.
PO5: Accomplish own work and supervise others work.	• Take necessary safety precautions and measures. • Work in team for solving industrial problems

	• Develop competencies and skills required by relevant industries. • Define the problem statement of the Major project/Industrial training according to the need of industry. • Work as a team member for successful completion of Industrial training / Major project. • Write the Internship / Major project report effectively. • Present the Internship / Major project report using PPT.
PO6: Select online open elective of own interest to promote self-learning.	• State the basic concepts and principles about the subject of interest. • Perform in a better way in the professional world. • Select and learn the subject related to own interest. • Explore latest developments in the field of interest. • Develop the habit of self-learning through online courses.

23. SUBJECTS & CONTENTS

(THIRD YEAR)

FIFTH SEMESTER

5.1 INDUSTRIAL TRAINING-II

L	P
-	2

RATIONALE

Industrial training will help the students to understand the working environmentof relevant industries. The student will learn to work in team to solve the industrial problems. It willalso give exposure about the present and future requirements of the relevant industries. This trainingis very important for development of required competencies and skills for employment and start– ups.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1: Explain the working environment of industries
CO2: Take necessary safety precautions and measures.
CO3: Describe present and future requirement of industries.
CO4: Work in team for solving industrial problems
CO5: Develop competencies and skills required by relevant industries.
CO6: Develop writing, speaking and presentations skills.

PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.

GUIDELINES

Students will be evaluated based on Industrial training report and their presentation using Power Point about the knowledge and skills gained during the training. The Headof the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation. The following performance parameters are to be considered for assessment of the students out of 100 marks:

	Parameter	**Weightage**
i	Industrial assessment of the candidate by the trainer	40%
ii	Report Writing	20%
iii	Power Point Presentation	20%
iv	Viva-voce	20%

5.2 REFRIGERATION AND AIR CONDITIONING

L	P
3	2

RATIONALE

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

COURSE OUTCOMES

After undergoing the training, the students will be able to:

- CO1 Explain the working and construction features of refrigeration and air conditioning systems
- CO2 Classify, draw and interpret various refrigeration cycles with their applications.
- CO3 Make basic calculation of psychometric properties and processes.
- CO4 Calculate heating and cooling load requirements of a room.
- CO5 Explain latest developments in the field of refrigeration and air conditioning.
- CO6 Calculate the properties of air by using psychometric chart.
- CO7 Detect faults and trouble shooting in an air-conditioner/refrigerator.
- CO8 Carry out charging of air conditioner.
- CO9 Describe the construction and features of air compressor and working on different air compressors.

DETAILED CONTENTS

UNIT-I

Introduction to Refrigeration

Definition of Refrigeration; Refrigerating effect-unit of refrigeration, Types of Refrigeration-Ice, dry ice, Steam jet, Throttling, Liquid nitrogen refrigeration, Basic Air Refrigeration; Difference Between a

Heat Engine, Refrigerator and Heat Pump, Coefficient of performance;

Difference between COP and efficiency, Reversed Carnot Cycle(P-V, T-S diagrams & efficiency), Simple Numerical problems based on calculation of efficiency and COP , Refrigeration effect, etc.

Refrigeration Systems

Vapour compression Refrigeration cycle: Basic Components(compressor, condenser, throttling devices and evaporator), Working of Vapour compression cycle; Representation of the vapour compression cycle on T-S & P-V Diagram; Introduction to Dry Saturated Vapour after Compression, Wet Vapour after Compression, Superheated Vapour after Compression, with Superheated Vapour after Compression; Effects of super heating and under cooling, its advantages and disadvantages.

UNIT-II
REFRIGERATION COMPONENT AND DEVICES:

Compressor - types of compressors; Hermetically sealed and Semi hermetically sealed compressor; Relative advantages
Condensers - Air Cooled, water cooled, natural and forced cooling system; Advantages and disadvantages of air cooled and water cooled condensers;
Evaporators -natural, convection, forced convection types.
Refrigerant flow controls devices: Capillary tube; Automatic Expansion valve; Thermo static expansion valve; High side and low side float valve; Solenoid valve; Evaporator pressure regulator, application of various expansion valves.

Safety Devices-Thermostat, overload protector, L, HP cutout switch, Strainer and accumulator.

UNIT III
REFRIGERANTs: Introduction to refrigerants, Functions of refrigerants; Primary and secondary refrigerants, Properties of ideal refrigerants; Classification of refrigerants by group number and commonly used refrigerants in practice; Selection of refrigerant.
Properties of R - 717, R – 22, R–134 (a), R744 (CO_2), R-454B as an alternate to R410A, Detection of refrigerants leakage and safety measures; charging the system with refrigerant. Lubricants used in refrigeration and their properties.

UNIT IV

AIR CONDITIONING: Introduction to Air conditioning; Factors affecting Air conditioning, Psychrometry, Definition and importance of specific humidity, relative humidity, degree of saturation, DBT, WBT, DPT, sensible heat, latent heat, Total enthalpy of air. Psychometric process-sensible heating and cooling, Humidifying and dehumidifying; Psychometric chart and its use, various lines, psychometric process, Psychometric process-sensible heating and cooling, Humidifying and dehumidifying; By-pass factor, room sensible heat factor(Concept only).

UNIT V

REFRIGERATION AND AIR-CONDITIONING TOOLS: Tools used in refrigeration and Air conditioner installation; Installation procedure; Faults in refrigeration and air conditioning system; Servicing procedure.

LATEST DEVELOPMENT IN REFRIGERATION AND AIR CONDITIONING:- Inverter technology, auto-defrosting, blast cooling, star rating; Window and Split air conditioning, Year-round Air-Conditioning system; Industrial Air conditioning. Dairy refrigeration, Cold Storage, Introduction to Solar Refrigeration.

PRACTICALS EXERCISES

1. Identify various tools of refrigeration kit.
2. Practice in cutting, bending, flaring, swaging and brazing of tubes.
3. Study of thermostatic switch, LP/HP cut out overload protector filters, strainers and filter driers.
4. Identify various parts of a refrigerator and window air conditioner.
5. Charging of a refrigerator/ air conditioner (demonstration only).
6. To detect faults in a refrigerator/ air conditioner
7. Leak detection of refrigeration equipment
8. Conduct performance test on A/C test rig to determine COP of the refrigerator
9. Visit to an ice plant or cold storage plant or central air conditioning plant

RECOMMENDED BOOKS

1. Refrigeration and Air Conditioning – Sadhu Singh, Khanna Book Publishing Co., New Delhi

2. Refrigeration and Air Conditioning – S. Domakundawar, Dhanpat Rai publications.
3. Refrigeration and Air Conditioning – A.S. Sarao & G.S. Gabi, 6th edition, Satya Prakashan Publications, New Delhi, 2004.
4. Principles of Refrigeration – Roy J. Dossat, 5th edition, Pearson Publications, 2001.
5. Refrigeration and Air Conditioning – M. Zakria Baig, Premier/ Radiant Publishing House.
6. Refrigeration and Air Conditioning – C.P Arora, Tata McGraw Hill Education, 2000.

RECOMMENDED WEBSITES

1. https://www.vedantu.com/jee-main/physics-difference-between-air-conditioning-and-refrigeration
2. https://www.geeksforgeeks.org/refrigeration-and-air-conditioning/
3. https://www.sciencedirect.com/book/9780750685191/refrigeration-and-air-conditioning

INSTRUCTIONAL STRATEGY

This is hands on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills among the students. This subject contains five units of equal weightage. Teaches should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components. While imparting instructions, focus should be on conceptual understanding. Training slides of "Carrier Fundamentals of Refrigeration Air Conditioning" to be shown to students.

5.3 CNC MACHINES AND AUTOMATION

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RATIONALE

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

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1 Explain the construction and tooling of CNC machine.
CO2 Prepare simple part programme.
CO3 Demonstrate and Operate a CNC lathe and milling machine.
CO4 Assess the part program, edit and execute in CNC turning and machining centre
CO5 Diagnose common problems in CNC machines.
CO6 Explain the trends in the field of automation.
CO7 Use Advanced programming structures.
CO8 Develop the part program and tool path generation using simulation software for Lathe and Milling machines

DETAILED CONTENTS

UNIT-I

Introduction

Introduction to NC, Basic Components of NC, binary coding, MCU, input devices, advantages / disadvantages of NC machines over conventional machines, CNC & DNC, their types, their relative advantages, disadvantages, Adaptive control systems, selection of parts to be machined on CNC machines, Problems with conventional NC, PLC Control and its purpose, types and applications.

Classification Of NC Systems

According to Feedback, motion, positioning.

UNIT-II

Part Programming

Part programming and basic procedure of part programming, Rules for Axis identification, NC words, Blocks, part programming formats, simple programming for rational components (Point to point, Straight line, curved surface), tool off sets, cutter radius compensation and wear compensation. Comparative study of Fanuc Controller and Sinumerik codes.

Advanced Structures in Part Programming

Advantages of using advanced structures, part programming using canned cycles, subroutines and do loops, mirror image.

UNIT III

Construction and Tooling

Need of Special mechanical design features for CNC, specification Chart of CNC machines, types of slideways, balls, rollers, motor- servo/stepper , recirculating ball screw and nut assembly, swarf removal, safety and guarding devices,

Various cutting tools for CNC machines, overview of tool holder, different pallet systems and automatic tool changer-ATC system, tool change cycle, types of tool magazines, specialized work done in CNC tool room.

UNIT IV

System devices

Control System, Transducers and Sensors, characteristics of sensors, Tachometer, LVDT, opto-interrupters, potentiometers for linear and angular position, encoder, Actuators, axis drives.

Problems in CNC Machines

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

UNIT V

Automation System

Automation, suitability of production system to automation , types, automatic assembly, manufacture of printed circuit boards(PCB), manufacture of integrated Circuits, Overview of FMS, AGV-types, ASRS, Group technology, CAD/CAM and CIM, Automated Identification system ,

Automated inspection: Off-line, On-line, Contact, Non-contact; Coordinate Measuring machines; Machine vision, concept of AI and its applications in manufacturing, Robotics, nomenclature of joints, motion.

PRACTICAL EXERCISES

1. Comparative Study of the constructional details of CNC lathe and CNC milling Machine.
2. Comparative Study of international standard codes:
   -G-Codes and M-Codes; for major operations.
3. Study the constructional details of following components of CNC machine installed in lab for:
   - Automatic tool changer and tool setter
   - Multiple pallets
   - Swarf removal
   - Safety devices
4. Develop a part programme for following lathe operations and make the job on CNC lathe and CNC turning center.(for finish pass only) – (At least two) Calculating coordinate points for a cylindrical job by considering sign convention for lathe (Material: Aluminium/Acrylic/Plastic rod)
   - Plain turning and facing operations
   - Taper turning operations
   - Operation along contour using circular interpolation.
5. Develop a part programme for the following milling operations and make the job on CNC milling (for finish pass only)- At least two (Material: Aluminium/Acrylic/Plastic rod)
   - Plain milling
   - Slot milling
   - Contouring
   - Pocket milling
6. Calculate coordinate points for a zig zag job by considering sign convention for milling
7. Using canned cycle - Create a part program for drilling, tapping, counter sinking and produce component in the Machine

8. Demonstration through industrial visit for awareness of actual working of FMS in production.
9. Use of software for any one of turning or milling operations on CNC turning center. Program writing – Turning simulator for generation of tool path.
10. Demo of 3-D Printing.

RECOMMENDED BOOKS

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

RECOMMENDED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is hands on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills among the students. This subject contains five units of equal weightage. Efforts should be made to develop programming skills amongst the students. During practice work, it should be ensured that students get opportunity to individually perform practical tasks.

5.4 PROGRAMME ELECTIVE-I
5.4.1 INDUSTRIAL ENGINEERING

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RATIONALE

In the competitive production houses, it is required that a diploma holder at supervision level have knowledge of time and motion study procedures to improve the methods/system. For this, knowledge and related skills in method study and work measurement are essential. In addition, knowledge of production planning and control is required for the optimized control on production process.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1 Use industrial engineering concepts to improve productivity
CO2 Use resources optimally and economically.
CO3 Apply work study techniques to eliminate unproductive activities
CO4 Explain various incentive plans
CO5 Solve planning, scheduling and sequencing problems for shop floor
CO6 Interpret different kinds of production systems
CO7 Prepare break-even analysis and Gantt chart.
CO8 Locate suitable plant location and draw plant layout for different production system.
CO9 Maintain inventory optimally and classify different types of inventory

DETAILED CONTENTS

UNIT-I

Productivity

Introduction to productivity, Standard of living, factors affecting productivity, practical measurement of productivity, difference between production and productivity, causes of low productivity and methods

to improve productivity, contribution of standardization in improving productivity. Importance of good working conditions.

Work Study

Definition and scope of work study; factors for selection of work study job, uses and limitations of work study, Inter-relation between method study and work measurement; Human aspects of work study; Role of work study in improving productivity. Method Study - Objectives and procedure for Method study analysis

UNIT-II

Motion Analysis

Principles of Motion analysis; Therbligs and SIMO charts; Normal work area (Principle of motion economy), Arrangement of work place with motion economy. Ergonomics, ergonomic aspect in design of machine tools and equipment.

Work measurement

Objectives; work measurement techniques, Time study, Basic procedure in making a time study;
Employees rating factor;
Application of time allowances: Rest, Personal, Process, Special and Policy allowances; Calculation of standard time; Simple Numerical Problems; Techniques of Work Measurement; standard data and its usage.; Pre determined Motion Time System (PMTS)., work sampling,

UNIT III

Wages and Incentive Schemes

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

Plant Layout

Location, layout of machines in Plant Layout, Principles of Plant layout, types of plant layout and positioning of machines

UNIT IV

Production Planning and Control

Production and its types- job order, batch type and continuous type of productions.
Objectives and components (functions) of P.P.C, Advantages of production planning and Production Control, stages of P.P.C, process planning, routing, scheduling, dispatching and follow up, routing

purpose, route sheets, scheduling – purpose, machine loading chart, dispatching – purpose, and procedure, follow up – purpose and procedure. GANTT charts-types. CPM/PERT technique.

Stores Management

Different Layout and structures of stores, Inventory control, Types of inventory, Various terms of inventory like: reorder quantity, etc. ABC Analysis, calculation of EOQ, Bin cards and various forms required in stores for documentation. Purchase procedures.

UNIT V

Miscellaneous

Value Engg: Value engineering concepts, advantages, applications, problem recognition, and role in productivity, criteria for comparison, and element of choice. VE activity, use, esteem and exchange values, basic vs. secondary vs. unnecessary functions. Approach of function, Evaluation of function, determining function, classifying function, evaluation of costs, Monte Carlo method for make or buy.

Break –Even Analysis.

PRACTICAL EXERCISES

1. Stop watch time study on any machine like lathe, drilling machine or milling machine
2. Method improvement - Assembly of bolt, nut and 3 washers
3. Determination of standard time for assembly of electrical switch
4. Preparation of flow process chart
5. Preparation of SIMO chart
6. Preparation of flow diagram

RECOMMENDED BOOKS

1. Production and costing by GBS Narang; Khanna Publishers, New Delhi.
2. Production Management by MS Sehrawat and JS Narang, Dhanpat Rai and Sons, New Delhi.
3. Industrial Engineering and Management by O.P. Khanna, Dhanpat Rai and Sons, Delhi.
4. Work Study and Ergonomics by S Dalela and Sourabh
5. Industrial Engineering and Management by M. Mahajan; Dhanpat Rai and Sons, New Delhi.
6. Introduction to Work Study, ILO Publication

7. Anil Kumar Mukhopadhyaya, “Value Engineering: Concepts Techniques and applications”, SAGE Publications 2010.

8. Miles, L.D., “Techniques of Value Analysis and Engineering”, McGraw Hill second Edition, 1989

RECOMMENDED WEBSITES

1. https://www.shiksha.com/engineering/industrial-engineering-chp

2. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. Teacher should use models and encourage students to develop some other suitable model. The teacher should observe and redress the difficulties faced by students in performing the work while working on ergonomically good and poorly designed workstation. The teacher should show them real forms to be filled from stores and record keeping.

5.4.2 PLANT MAINTENANCE AND MATERIAL HANDLING

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RATIONALE

A diploma holder is involved in supervision and maintenance related jobs. He must know the various processes carried out during maintenance, material handling and documentation of the same. The students should understand the concepts of testing, erection and commissioning of machines, periodical repair and maintenance.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Explain the concept of testing, repair and maintenance.
CO2: Explain the procedure for erection and commissioning of machines
CO3: Explain the procedure for testing of machines
CO4: Explain various lubrication systems
CO5: Describe the procedure of repair and maintenance
CO6: Explain the means to maintain various Material Handling systems

DETAILED CONTENTS

UNIT-1

Introduction

Necessity and advantages of testing, repair and maintenance, Significance of work content of testing, repair and maintenance. Common instruments required for testing, significance of B-T curve in life span of machine tool, Acceptance test for machine tools, Economic aspects, manpower planning and materials management

Plant Layout, Erection and Commissioning of Machines (Installation)

Location, layout of machines in Plant Layout, Principles of Plant layout, types of plant layout and method of positioning of machines, grouping of machines.

Foundation – types of foundation, various considerations for machine foundations, foundation plan, types of foundation bolts, erection and leveling, grouting Vibration, damping, vibration isolation – methods of isolation, anti-vibration mounts.

UNIT-II

Testing Of Machines

Testing equipment – dial gauge, mandrel, spirit level, straight edge, auto collimator, Recalibration of measuring instruments like vernier calliper

Testing methods – geometrical/alignment test, performance test, testing under load, run test, vibrations, noise

Testing of appliances (for safety and operational efficiency)-ACs, Lifts.

Maintenance

Definition, advantages, limitations, functions and types of maintenance organisation. Types of maintenance viz. emergency, preventive, breakdown/corrective, predictive

Introduction to computerized maintenance record like facility register, maintenance request.

Introduction to machine history card – purpose and advantages.

Preparation of scheduled yearly plan for preventive maintenance, difference of work, content of servicing, repairs and overhauling. MTBF and MTTR. Maintainability, Reliability

UNIT-III

Spare Part Provisioning

Spare parts- types of spare parts, need of frequently needed spare parts inventory, Make provision of spares for parts not available in market, Cannibalism.

Repairing

Repair cycle, analysis, Repair complexity, Common parts which are prone to failure, reasons of failure Repair schedule Parts that commonly need repair such as belts, couplings, nuts, and bolts repairing the engines, compressors and boilers. Maintenance manual, Maintenance records, Housekeeping. Introduction to Total Productive Maintenance (TPM). Concept of periodic maintenance schedule of items like air conditioner, industrial vehicle & other machines.

UNIT-IV

Lubrication Systems

Lubrication methods and periodical lubrication chart for various machines (daily, weekly, monthly)

Handling and storage of lubricants, Lubricants conditioning and disposal

Lubricant and their grades needed for specific components such as gears, bearings, and chains

Purpose and procedure of changing oil periodically (like gear box oil).

Functional additives –

surface, performance enhancing, lubricant protective, Lubricants applications – tribological components and industrial machinery, Lubricants testing and test methods, Organization and management of lubrication, lubricant storage and handling.

UNIT-V

Material Handling Systems

Basic principles of material handling, Basic types of material handling equipments and its characteristic, Types of load to be handled, Uses and limitations, Methods of stacking, Unit load: pallet sizing and loading. Forklift trucks, Conveyor models, Working & Maintenance of Traction type conveyors such as Belt conveyors, Chain conveyors, Bucket elevators, Escalators, AGV Systems, Automated Storage & Retrieval System (ASRS), Carousels, Load handling attachments: a) Various types of hooks-Forged, Triangular eye hooks, Appliances for suspending hooks b) Crane grab for unit & piece loads c) Electric lifting magnet, vacuum lifter. d) Grabbing attachment for loose materials e) Crane attachment for handling liquids/molten metals. Load conditions & Economics of material handling system.

RECOMMENDED BOOKS

1. Installation, Testing and Maintenance by JS Narang, Dhanpat Rai & Sons, New Delhi.
2. Industrial Maintenance by HP Garg; S. Chand and Company, Delhi.
3. Plant Maintenance Engineering by RK Jain; Khanna Publishers, Delhi.
4. Installation, Servicing and Maintenance by SN Bhattacharya; S Chand and Company, Delhi.
5. Maintenance Engineering and Management by RC Mishra and K Pathak; Prentice Hall of India Pvt. Ltd., New Delhi.
6. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

RECOMMENDED WEBSITES

1. http://swayam.gov.in
2. https://www.plantengineering.com/articles/material-handling-maintenance-needs-cloud-based-efficiency/

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. The Teacher should lay emphasis on following:

- Lay greater emphasis on practical aspects of maintenance.
- Make use of PPTs and video films
- Expose the students to real life situation.
- Promote continued learning through properly planned assignments.
- Demonstrate sample of all types of gear and bearings.

5.4.3 STAINLESS STEEL TECHNOLOGY

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RATIONALE

Many students of Mechanical Engineering find employment in the industries related to stainless steel. They should be having basic understanding of shop floor practices in the production of stainless steel. They should be made aware about transformations and heat treatment operations in the fabrication and manufacture of stainless steel.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Work on shop floor for the Production of stainless steels.
CO2: Undertake processing, fabrication, property evaluation, structure - property correlation of steel.
CO3: Undertake Phase Transformations and Heat treatments
CO4: Select grades for large scale applications

DETAILED CONTENTS

UNIT-1

Introduction

Definition, Alloying elements in Stainless Steels and their functions. Effect of alloying elements on properties of Stainless Steels. Classification of Stainless Steels.Cost implications of alloy additions and substitutes. Comparison of Stainless steel production in India and in the world.

Making And Processing

Raw materials, Electric Arc Furnace, Induction furnace, plasma furnace, Argon oxygen decarburisation, Ladle Refining, Vacuum Oxygen Decarburisation, Vacuum degassing, Ingot casting vis-a-vis Continuous casting, casting defects, inclusion control. Hot Rolling, Hot Forging, Annealing & Pickling, Cold Rolling, Final Annealing and Pickling, Skin Pass Mill, Strip Grinding Line. Finishing of Stainless Steels. Colour Coating of Stainless Steels, Powder Coating process, thermal spray Eutalloy

process for wear resistant.

UNIT-II

Phase Transformations and Heat Treatments

Relevance of Nickel equivalent and Chromium equivalent, Inadequacy Fe-Fe3C diagram for stainless steels, Role of alloying elements in ferrite and austenite stabilization, Role of deformation on phase transformation. Heat treatment of stainless steels-ferrite, martensite, austenitic, duplex, precipitation hard enable grade stainless steels. Precipitation reaction in stainless steels.

Mechanical Behaviour and Properties

Deformation behavior of stainless steel. Role of precipitates on mechanical properties. Mechanical properties of different grades of stainless steels- tensile, hardness, impact, fatigue.

UNIT-III

Fabrication of Steels I

Cold roll forming(CRF) processes, Forging, Extrusion, Deep Drawing, Coin blanking, machining, Cutting of Stainless Steels, Welding of Stainless Steels- Welding, Brazing, Soldering and Overlaying, Common welding techniques, welding consumables and precautions required. Fusion Welding processes- Shielded Metal Arc Welding (SMAW), Gas Tungsten AW, Gas Metal AW (Inert/active gas), Flux-cored AW, Plasma AW, Submerged AW, Electro-slag Welding, EBW, LBW. Solid State Welding – All variations of Resistance welding e.g. Spot, Seam, Projection, Flash, Upset, High frequency, Percussion. Friction stir welding.

UNIT-IV

Fabrication of Steels II

Specific difficulties associated with welding of–Martensitic-, Ferritic, Austenitic-, Duplex, Precipitation Hardened-,Martensitic, Semiaustenitic-,Austenitic-precipitation hardened stainless steels. Welding of dissimilar metal combinations with stainless steels. Sensitization/Weld decay: Causes, mechanisms, remedies, High temperature sensitization, 475oC embrittlement, α' phase transformation, Distortion-Causes, mechanisms, remedies, Effect of alloying elements on weldability of Stainless Steels, Schrieffer De Long diagram interpretations. Tools and Equipment. Issues faced during fabrication of stainless steels and their solutions.

Testing, Handling and Storage of Stainless Steel

PMI technique, XRF, Ultrasonic testing, Magnetic Particle testing, Dye penetrate, Portable hardness, Surface roughness measurement, Surface Reflectivity measurement, Recommended procedures for storage

UNIT-V

Corrosion

Types of corrosion, Galvanic corrosion-Mechanism and prevention, Pitting Corrosion- Mechanism and prevention, Interpretation of PREN, Crack propagation mechanisms-Inter-granular, Trans-granular, Crevice Corrosion, Stress Corrosion Cracking(SCC),Microbiologically Induced Corrosion (MIC), Erosion Corrosion. High temperature corrosion, Different corrosion testing procedures. Role of precipitates on corrosion, Corrosion resistance of stainless steels

Applications

Automotive, Railways & Transport, Architecture Building & Construction, Reinforcement bars, Roofing sheets, utensils, Furniture's, Material Handling applications, Process Industries, Biomedical applications. Life Cycle Cost Analysis.

RECOMMENDED BOOKS

1. Corrosion Engineering, MG Fontana, 3rd Edition, McGraw-Hill Book Company, New York,1987
2. Phase Transformation in Metals and Alloys, David A Porter, K.E. Esterling, CRC press, Taylor and francisgroup,3rdEdition, 2009,.
3. Alloys: Preparation, Properties, Applications, Fathi Hubashi, *Wiley*VCH;1 edition,2008
4. Fundamental of Steelmaking by E.T. Turkdogan, The InstituteofMaterials,London,1996,
5. Fundamental of Steelmaking Metallurgy by Brahma *Deo*; Rob *Boom*, Prentice Hall International, 1993.
6. Steel Making by V.Kudrin, Moscow : Mir Publishers ; Boca Raton : CRC Press,1985
7. Steel and its Heat Treatment by K.E.Thieling, Butterworth-Heinemann,1967
8. The Physical Metallurgy of Steels by William C. Leslie, Hempisphere Pub.Corp.,1981
9. Stainless Steel and Their Properties by Bela Lafler
10. Physical metallurgy of Stainless Steel Development, FB Pickering, International Materials Reviews, Volume21, 1976, ASM international
11. 100 years of Stainless Steel by BSSA(UK),2013
12. Handbook of Stainless Steel: Donald Peckner, Irving Melvin Bernstein, Macgraw-hill books,1977

13. Alloy Digest Source Book: Stainless Steel, Joseph R. Davis, ASM international, 1994
14. ASM specialty handbook stainless steel, Joseph R. Davis, ASM international6.OutokompuStainlessSteelHandbooks, 2009
15. Technical Hand book of Stainless steel: The Atlas Steels, 2013.

RECOMMENDED WEBSITES

1. https://stainlesssteeltech.com/
2. https://www.steel-technology.com/articles/stainless-steel-overview-types-buying-guide-and-global-suppliers
3. http://www.stainlesstech.com/

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. The teachers should use teaching aids for classroom teaching and give assignments for solving numerical problems. Arrange industry visits to augment classroom teaching-learning process. Arrange expert lectures from the industry experts.

5.5 THEORY OF MACHINES

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RATIONALE

In industries, the diploma engineers/technicians are supposed to manage functioning of equipment with proper planning, operation and maintenance of equipment and assist in the Design and Development of Prototype and other components. It is essential that he is made conversant with the principles related to use and design of machine components. He needs knowledge and skills of various motion and force transforming mechanisms and devices, such as four bar mechanism, belt pulley, clutches, flywheel, etc. This course is included in the curriculum to provide such necessary knowledge and skills in the area of mechanical equipment and devices to help in understanding of kinematics & dynamics of different equipment being used in industry.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Describe different machine elements, mechanisms and inversion of mechanism
CO2: Describe different types of cams and their motions and also draw cam profiles for various Motions.
CO3: Select Suitable Drives and Mechanisms for a particular application
CO4: Solve problems on power transmission.
CO5: Explain the design of Brakes, Dynamometers, Bearings and Clutches.
CO6: Solve problems on balancing and Vibration

DETAILED CONTENTS

UNIT-1
SIMPLE MECHANISMS

1.1 Introduction to Machines and Theory of Machines

1.2 Kinematics of Machines: - Definition of Kinematics, Dynamics, Statics, Kinetics, Kinematic link, Kinematic Pair and its types, constrained motion and its types, Kinematic chain and its types, Mechanism, inversion, machine and structure.

1.2 Inversions of Kinematic Chain: Inversion of four bar chain, coupled wheels of Locomotive &

Pantograph. Inversion of Single Slider Crank chain- Rotary I.C. Engines mechanism, Crank and Slotted lever quick return mechanism. Inversion of Double Slider Crank Chain- Scotch Yoke Mechanism & Oldham's coupling.

UNIT-II

CAMS & FOLLOWERS

2.1 Definition and function of cam. Different types of cams and followers and their specific applications.

2.2 Terminology of cam profile.

2.3 Displacement diagram for uniform velocity, S.H.M. and uniform acceleration and deceleration.

2.4 Drawing of profile of radial cam with knife-edge and roller follower with and without offset with reciprocating motion.

UNIT-III

FLYWHEEL

3.1 Flywheel - Concept, function and applications of flywheel. Types of flywheel: (i) Disc type (ii) Rim type (Specific application of these two).

3.2 Turning moment diagram for single cylinder 4-Stroke I.C. Engine and Steam Engine (Single Acting & Double Acting).

3.3 Coefficient of fluctuation of energy, Coefficient of fluctuation of speed and its significance. (Numerical).

GOVERNORS

Concept, function and applications of Governors.

Comparison between Flywheel and Governor

Terminology used in Governors.

Types of centrifugal Governor: Construction and working of Simple Watt governor, Porter Governor and Hartnell Governor.

UNIT-IV

MECHANICAL POWER TRANSMISSION

4.1 Introduction to Mechanical Power, Need of Power Transmission, Methods of Power Transmission.

4.2 Introduction to belt drives. Flat belt drive and V -belt drive, Relative advantages and disadvantages,

4.3 Types and application of belt drives- Open belt drive, Closed or crossed belt drive, Fast and loose pulley, Stepped cone pulley, Jockey pulley drive, Quarter turn belt drive, Compound belt drive. Length of belt.

4.4 Concept of velocity ratio, slip and creep; crowning of pulleys,

4.5 Ratio of driving tensions, power transmitted, centrifugal tension, and condition for maximum horse power (simple numerical)

4.6 Introduction to Chain Drive, Different types of chains and their applications. Advantages disadvantages of chain drive relative to belt drive.

4.7 Gear Drive -Different types of gears and their applications.

4.8 Gear train, Types and application of different gear trains: Simple, compound, reverted and epicyclic gear trains(simple numerical)

4.9 Relative advantages and disadvantages of Gear drive over other belt drives.

UNIT-V

VIBRATIONS & BALANCING

5.1 Concept and terminology used in vibrations, Causes of vibrations in machines; their harmful effects and remedies. Types of vibrations-Free, forced and damped. Damping of vibrations. Resonance.

5.2 Concept of balancing, static and dynamic balancing, Need of balancing of machine parts.

5.3 Balancing of rotating masses in the same plane and different planes.

PRACTICAL EXERCISES

1. To study inversion of Four Bar Mechanism, Single Slider Crank Chain and Double Slider Crank Chain Mechanism with the help of working models.
2. To construct radial cam profile for uniform velocity with knife edge and roller follower on drawing sheet.
3. To construct radial cam profile for SHM with knife edge and roller follower on drawing sheet.
4. To construct radial cam profile for uniform acceleration and retardation with knife edge and roller follower on drawing sheet.
5. To find the moment of inertia of a flywheel.
6. To Study the different types of centrifugal governors & plot graph between R.P.M & Displacement of sleeve.
7. To study various types of belts drives and to calculate velocity ratio.
8. To study different types of gear trains with the help of working models and to calculate Velocity ratio.
9. To perform the experiment of Balancing of rotating parts and find the unbalanced couple and forces.

RECOMMENDED BOOKS

1. Theory of machines – S.S .Rattan,Tata McGraw-Hill publications.
2. Theory of machines – R.K.Bansa , 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.
5. Theory of machines – Jagdish Lal, Bombay Metro – Politan book Ltd.
6. Theory of machines – P.L. Ballaney, Khanna Publications.

RECOMMENDED WEBSITES

1. https://www.researchgate.net/publication/278026450_Introduction_to_Theory_of_Machines
2. https://www.maritimeknowledge.in/course-details.php?course_id=80&course_name=Mechanics%20of%20Machines-1#
3. https://www.slideshare.net/akhudaiwala/introduction-to-theory-of-machines

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. 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.

5.6 MULTIDISCIPLINARY ELECTIVE

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RATIONALE

Multidisciplinary electives are very important and play major role in implementation of National Education Policy. Multidisciplinary is a subject which is useful for two or more disciplines in which students are asked to understand the concept of multidisciplinary or interdisciplinary. It will help the students to gain an arsenal of skills that are easily transferable across work environments.

COURSE OUTCOMES

At the end of the open elective, the students will be able to:
CO1: Apply critical thinking problem solving.
CO2: Demonstrate self and time management.
CO3: Display analytical and research abilities.
CO4: Integrate multiple knowledge domains.
CO5: Enhance the scope and depth of learning.

LIST OF MULTIDISCIPLINARY ELECTIVES
(The list is indicative and not exhaustive)

1. Introduction to Internet of Things
2. Introduction to Robotics
3. Introduction to Embedded System Design
4. Fundamentals of Artificial Intelligence
5. Digital Image Processing
6. Introduction to Machine Learning
7. Fundamentals of Artificial Intelligence
8. The Joy of Computing Using Python
9. Cloud Computing
10. Introduction to Industry 4.0

11. Industrial Internet of Things

12. Object Oriented System Development using UML, Java and Patterns

GUIDELINES

Multidisciplinary Elective shall be offered preferably in online mode. Online mode multidisciplinary elective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL, Upgrad, Udemy, Khan Academy or any other online portal to promote self-learning. A flexible basket of large number of multidisciplinary electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online multidisciplinary electives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline multidisciplinary electives, a suitable relevant subject shall be offered by the respective department to the students with minimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs multidisciplinary elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students from time to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable multidisciplinary elective is available online, only then the course may be conducted in offlinemode. The assessment of offline multidisciplinary elective shall be internal and external. The offlinemultidisciplinary elective internal assessment of 40 marks shall be based on internal sessional tests, assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://www.udemy.com/
3. https://www.upgrad.com/
4. https://www.khanacademy.org/

5.7 WORKSHOP PRACTICE-IV

L	P
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RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, skills in operating various machines are required to be developed among the students.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1: Prepare jobs using gear hobbing EDM and grinding machine.
CO2: Carry out metal finishing operations.
CO3: Carry out powder coating, honing and scraping operations.

PRACTICAL EXERCISES

UNIT I
MODERN MACHINE SHOP-I

- Prepare a cavity/hole on EDM machine.
- Exercise of cutting a helical gear on gear hobbing machine

UNIT II
MODERN MACHINE SHOP-II

- Prepare a job on centre less grinding machine.
- Demonstration of 3-D printing Machine through industrial visit.

UNIT III
ADVANCE FINISHING SHOP-I

- Prepare a job on powder coating machine.

- Prepare a job to finish an external surface using honing process.

UNIT-IV

ADVANCE FINISHING SHOP-II

- To perform a scraping operation on flat surface.
- Demonstration of advance finishing processes through industrial visit.

RECOMMENDED WEBSITES

1. B.S. Raghuwanshi, "Workshop Technology", Dhanpat Rai and Sons, Delhi.
2. S.K. Choudhry and Hajra, "Elements of Workshop Technology", Asia Publishing House.
3 PC Sharma, "A Textbook of Production Engineering", S. Chand and Company Ltd.Delhi.

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students. Instructor should conduct classes of each Workshop explaining use of tools, jobs to be made and safety precautions related to each workshop prior to students being exposed to actual. Industrial visits may be arranged for demonstration of above shops, wherever in –house infrastructure is not available.

5.8 MINOR PROJECT

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RATIONALE

Minor project work will help in developing the relevant skills among the students as per National Skill Qualification Framework. It aims at exposing the students to the present and future needs of various relevant industries. It is expected from the students to get acquainted with desiredattributes for industrial environment. For this purpose, students are required to be involved in Minor Project Work by apply the knowledge and skills gained through course work.

COURSE OUTCOMES

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

CO1: Define the problem statement of the minor project according to the need of industry.

CO2: Work as a team member for successful completion of minor project.

CO3: Write the minor project report effectively.

CO4: Present the minor project report using PPT.

CO5: Presentation Skills development.

GUIDELINES

Depending upon the interest of the students, they can develop minor projects as per present and future demand of the industry. The supervisors may guide the students to identify their minor project work and prepare their plan of action well in advance. As a minor project activity each student is supposed to study the operations and prepare a detailed project report of the operations/processes/activities. The supervisor may create a group of 5-6 students as per their interest to work as a team for successful completion of the minor project. Necessary infrastructure and facilities of workshop and other labs will be provided for executing the minor projects.

The supervisor shall evaluate the students along with one external expert by considering the following parameters:

	Parameter	**Weightage**
I	Selection of minor project	20%
ii	Innovation / creativity	20%
iii	Performance, responsibility	20%
iv	Report Writing	20%
v	Viva -voce / presentation	20%

SIXTH SEMESTER

6.1 AUTOMOBILE ENGINEERING

L	P
3	2

RATIONALE

These days, automobile has become a necessity instead of luxury. The diploma holders in this course are required to supervise production, repair and maintenance of vehicles. For this purpose, knowledge and skills are required to be imparted, so that they are able to work efficiently in the automobile industry. This subject aims at developing required knowledge and skills in this area.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1 Identify and explain the function of different chassis components and drive types.
CO2 Maintain transmission system.
CO3 Carry out balancing of wheels to maintain steering geometry.
CO4 Carry out routine servicing of brake system and bleeding of hydraulic brakes
CO5 Carry out testing and charging of Lead-acid battery.
CO6 Interpret Bharat norms of exhaust emissions.
CO7 Resolve Electric, Hybrid vehicles, running, charging and maintenance issues.

DETAILED CONTENTS

UNIT-I

Introduction

Automobile and its development
Various types of automobiles manufactured, their manufacturer and location of their manufacturing unit.
Classification of automobiles
Layout of chassis
Types of drives-front wheel, rear wheel, four wheels.

Electric and Other Modern Vehicles

Introduction; History of Hybrid and Electric Vehicles; Social and Environmental importance of Hybrid and Electric Vehicles; Components, Vehicle mechanics: Roadway fundamentals, Vehicle kinetics, Dynamics of vehicle motion; Propulsion System Design, Motor sizing, Introduction of CNG/PNG in Automobiles, Introduction to self-driven cars.

UNIT-II

Transmission System

Clutch - Functions, Constructional details of single plate and multi plate friction clutches, Cone clutch, Hydraulic clutch

Gear Box - Functions, 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 (CVT).

Propeller shaft and rear axle - Functions, Universal joint, Differential, Different types of rear axles and rear axle drives.

Wheels and Tyres-Types of wheels, Types and specifications of tyres used in Indian vehicles, Toe in, Toe out, camber, caster, kingpin inclination, Wheel balancing and alignment, Factors affecting tyre life.

UNIT III

Steering System

Function and principle of steering system, steering geometry, Types of steering mechanism-Ackerman and Davis Steering Mechanism. Types of steering gears - worm and wheel, rack and pinion, Power steering-Hydraulic and Electrical.

Braking System

Function of braking system, Constructional details and working of mechanical, hydraulic, air and vacuum brake, Power 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 (ABS) Electronic Brake-force Distribution (EBD) and its working, Regenerative braking.

UNIT IV

Suspension System

Function of suspension system and types of Coil spring, leaf spring, Air suspension, Shock Absorber (Telescopic type) –Function, construction and working.

Battery

Functions and types, Constructional details of Lithium ion batteries, Specification of battery-capacity, rating , number of plates, selection of battery for particular use, Battery charging, chemical reactions during charge and discharge, Maintenance of batteries, Checking of batteries for voltage and specific gravity. Batteries for electric and hybrid vehicles. Battery pack Design, Properties of Batteries

UNIT V

Dynamo and Alternator

Dynamo- Function and details, Regulators - voltage current and compensated type, Cutout- construction, working and their adjustment,

Alternator- Construction and working, charging of battery by alternator. Introduction to Integrated starter-alternator, wiring Diagram of an Automobile.

Safety Measures

Road safety symbols & rules. Various safety star rating systems tests of vehicles. Air bags and other safety equipments such as bull guard, cameras, sensors.

Advance Driver Assistance Systems (ADAS).

PRACTICAL EXERCISES

1. Fault and their remedies in Battery Ignition system
2. Adjustment of Head Light Beam (ii) Wiper and Indicators.
3. Dismantling and inspection of (i) AC Pump (ii) SU Pump
4. Dismantle (i) rear axle (ii) differential and find out the gear ratio of crown wheel & driven sun gear and planet pinion.
5. Fault finding practices on an automobile - four wheelers (petrol/ diesel vehicles).
6. Servicing/Tuning of a 2 wheeler/4 wheeler.
7. Servicing of hydraulic brakes :
   a) adjustment of brakes
   b) bleeding of brakes
   c) fitting of leather pads
8. Learning Driving Practice
9. Testing and Charging of an automobile battery and measuring cell voltage and
   a) Specific gravity of electrolyte.

10. Rotation of tyres inflation of tyres and balancing of wheels.

RECOMMENDED BOOKS

1. Automobile Engineering by GBS Narang; Khanna Publishers, Delhi.
2. Automobile Engineering by Dr. Kirpal Singh; Standard Publishers and Distributors, Delhi.
3. Automotive Mechanics, by W.Crouse and Anglin; Tata McGraw Hill, Delhi.
4. Automobile Engineering by G. S. Aulakh; Eagle Prakashan, Jalandhar.
5. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

RECOMMENDED WEBSITES

1. https://www.shiksha.com/engineering/automobile-engineering-chp
2. https://onlinecourses.nptel.ac.in/noc20_de06/preview
3. https://swayam.gov.in/explorer

INSTRUCTIONAL STRATEGY

This is hands on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills among the students. This subject contains five units of equal weightage. Teaches should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components. While imparting instructions, focus should be on conceptual understanding.

6.2 METROLOGY AND QUALITY CONTROL

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RATIONALE

Diploma holders are required to measure and inspect for ensuring quality of product in the industries. For this purpose, knowledge and skills about standards of measurement, limits, fits and tolerances, types of inspection and various measuring instruments, SQC & quality standards are necessary.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

- CO1 Apply different inspection techniques to improve quality of products and processes.
- CO2 Select and use suitable measurement tools / gauges to measure product dimensions.
- CO3 Measure geometrical parameters such as Straightness, Flatness and Parallelism.
- CO4 Use different quality charts to control products quality and interpret different quality control charts.
- CO5 Explain the use of different business tools (TQM / ISO-Standards) and QC tools in manufacturing environment.
- CO6 Explain different types of Transducers and measure displacement, vibration, pressure and temperature.

DETAILED CONTENTS

UNIT-I

Inspection

Introduction to inspection, Planning of inspection: W^5H principle

Types of inspection: remedial, preventive and operative inspection, incoming, in-process and final inspection

Standards of Measurement - International, national and company standard, line and wavelength standards.

Factors influencing the quality of manufacture.

Metrology: Measurement and Gauging-I

Introduction, Definition, Basic principles used in measurement and gauging, mechanical, optical, electrical and electronic, Slip gauges, Sine bar, clinometer, comparators – mechanical, electrical and pneumatic.

UNIT-II

Metrology: Measurement and Gauging-II

Types of gauges, Limit gauges: plug, ring, snap, taper, thread, height, depth, form, feeler, wire and their applications for linear, angular, surface, thread and gear measurements, gauge tolerances.
Tool room microscope, profile projector.

Errors in Measurement

Geometrical parameters and errors: Errors & their effect on quality, concept of errors, measurement of geometrical parameter such as straightness, flatness and parallelism.

UNIT III

Statistical Quality Control -I

Sampling Plans, Basic statistical concepts, empirical distribution and histograms, Central tendency measures-frequency, mean, mode, standard deviation, normal distribution, binomial and Poisson, Simple- examples.

Statistical Quality Control-II

Introduction to control charts, variable and attribute charts - namely, X and R, X bar and nP, P, C charts and their applications.

UNIT IV

Sampling Plans

Sampling plans, selection of sample size, method of taking samples, frequency of samples. Acceptance Sampling, Inspection plan format and test reports

Modern Quality Concepts

Concept of total quality management (TQM)
National and International Codes.
ISO-9000, concept and its evolution

UNIT V

Quality Control Tools

QC tools- Fish Bone diagram, Cause and Effect Diagram, scatter Diagram, Histogram Introduction to Kaizen, 5S and Quality Circle

Instrumentation

Transducers – Its different types.

Measurement of mechanical quantities such as displacement, vibration, frequency, pressure temperature by electro mechanical transducers of resistance, capacitance & inductance type.

PRACTICAL EXERCISES

1. Use of dial indicator for measuring taper.
2. Use of combination set, bevel protector and sine bar for measuring taper.
3. Measurement of thread characteristic using vernier and gauges.
4. Use of slip gauge in measurement of center distance between two pins.
5. Use of tool maker's microscope and comparator.
6. Plot frequency distribution for 50 turned components.
7. With the help of given data, plot X and R, P and C charts

RECOMMENDED BOOKS

1. Inspection and Quality Control by J.S. Narang & A. Gupta, Dhanpat Rai & Sons,Delhi.
2. Statistical Quality Control by M.Mahajan: Dhanpat Rai and Sons, Delhi
3. Engineering Metrology by RK Jain
4. Engineering Metrology by RK Rajput; SK Kataria and Sons
5. Production Planning Control and Management by KC Jain & Aggarwal

RECOMMENDED WEBSITES

1. https://swayam.gov.in/explorer
2. https://www.engineering.com/story/an-introduction-to-metrology-and-quality-in-manufacturing

INSTRUCTIONAL STRATEGY

This is hands on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills among the students. This subject contains five units of equal weightage. Teaches should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components. While imparting instructions, focus should be on conceptual understanding.

6.3 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT

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3	-

RATIONALE

In the present day scenario, it has become imperative to impart entrepreneurship and management concepts to students so that a significant percentage of them can be directed towards setting up and managing their own small enterprises. This subject focuses on imparting the necessary competencies and skills of enterprise set up and its management.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Explain the importance of entrepreneurship and its role in nation's development.
CO2: Classify the various types of business and business organizations.
CO3: Identify the various resources / sources and / or schemes for starting a new venture.
CO4: Explain the principles of management including its functions in an organisation.
CO5: Conduct market survey and prepare project report.

DETAILED CONTENTS

UNIT I

Entrepreneurship: Concept and definitions, classification and types of entrepreneurs, entrepreneurial competencies, Traits / Qualities of entrepreneurs, manager v/s entrepreneur, role of Entrepreneur, barriers in entrepreneurship, Sole proprietorship and partnership forms of business organisations, small business vs startup, critical components for establishing a start-up, Leadership: Definition and Need, Manager Vs leader, Types of leadership

UNIT II

Definition of MSME (micro, small and medium enterprises), significant provisions of MSME Act, importance of feasibility studies, technical, marketing and finance related problems faced by new enterprises, major labor issues in MSMEs and its related laws, Obtaining financial assistance through various government schemes like Prime Minister Employment Generation Program (PMEGP) Pradhan Mantri Mudra Yogna (PMMY) , Make in India, Start up India, Stand up India , National Urban Livelihood Mission (NULM); Schemes of assistance by entrepreneurial support agencies at National,

State, District level: NSIC, NRDC, DC:MSME, SIDBI, NABARD, Commercial Banks, SFC's TCO, KVIB, DIC, Technology Business Incubator (TBI) and Science and Technology Entrepreneur Parks (STEP).

UNIT III

NATURE AND FUNCTIONS OF MANAGEMENT: Definition, Nature of Management, Management as a Process, Management as Science and Art, Management Functions, Management and Administration, Managerial Skills, Levels of Management; Leadership.

PLANNING AND DECISION MAKING: Planning and Forecasting - Meaning and definition, Features, Steps in Planning Process, Approaches, Principles, Importance, Advantages and Disadvantages of Planning, Types of Plans, Types of Planning, Management by Objective. Decision Making-Meaning, Characteristics.

UNIT IV

ORGANISING AND ORGANISATION STRUCTURE: Organising Process - Meaning and Definition, Characteristics Process, Need and Importance, Principles, Span of Management, Organisational Chart - Types, Contents, Uses, Limitations, Factors Affecting Organisational Chart.

STAFFING: Meaning, Nature, Importance, Staffing process. Manpower Planning, Recruitment, Selection, Orientation and Placement, Training, Remuneration.

CONTROLLING AND CO-ORDINATION Controlling - Meaning, Features, Importance, Control Process, Characteristics of an effective control system, Types of Control. Co-ordination - characteristics, essentials.

UNIT V

Market Survey and Opportunity Identification, Scanning of business environment, Assessment of demand and supply in potential areas of growth, Project report Preparation, Detailed project report including technical, economic and market feasibility, Common errors in project report preparations, Exercises on preparation of project report.

RECOMMENDED BOOKS

1. Entrepreneurship Development and Management by Dr. Ranjana Verma, Dr. Sangeeta, Dr. Pooja Sharma; Anant Publications, Ambala City.
2. BS Rathore and Dr JS Saini, "A Handbook of Entrepreneurship", Aapga Publications, Panchkula (Haryana).

3. Entrepreneurship Development, Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. CB Gupta and P Srinivasan, “Entrepreneurship Development in India”, Sultan Chand and Sons, New Delhi.
5. Poornima M Charantimath, “Entrepreneurship Development - Small Business Enterprises”, Pearson Education, New Delhi.
6. David H Holt, “Entrepreneurship: New Venture Creation”, Prentice Hall of India Pvt. Ltd., New Delhi.
7. PM Bhandari, “Handbook of Small Scale Industry”.
8. L M Prasad, “Principles and Practice of Management”, Sultan Chand & Sons, New Delhi.

RECOMMENDED WEBSITES

1. https://ipindia.gov.in/

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method. The teacher will discuss stories and case studies with students, which in turn will develop appropriate managerial and entrepreneurial qualities in the students. In addition, expert lecturers may also be arranged from outside experts and students may be taken to nearby industrial organisations on visit. Approach extracted reading and handouts may be provided. In addition, different activities like conduct of entrepreneurship awareness camp extension lecturers by outside experts, interactions sessions with entrepreneurs and industrial visits may also be organised. This subject contains five units of equal weightage.

6.4 PROGRAMME ELECTIVE-II
6.4.1 RENEWABLE SOURCES OF ENERGY

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RATIONALE

Since the conventional energy resources are fast depleting, it is high time to tap the renewable and non-conventional energy sources. The Diploma holder must be aware about the renewable energy resources like solar energy, wind energy, geothermal energy, ocean energy, hydro energy which is used for number of applications such as power generation, heating, cooling etc. This subject aim is to develop the skill required for renewable energy resource, so that they help the society for fulfilling the energy demand which is increasing day by day.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Describe various renewable and non-renewable sources of energy
CO2: Explain working principle of various solar energy systems
CO3: Describe concepts of power generation with the wind energy, ocean energy, hydro, geothermal energy, tidal energy, fuel cell.
CO4: Work on a bio gas plant.
CO5: Describe different energy storage devices used in renewable energy resources.

DETAILED CONTENTS

UNIT I
Introduction to Energy and Solar Energy

1.1 **Classification of Energy Resources:** Conventional Energy Resources, Non-conventional Energy Resources, Roles and responsibility of Ministry of New and Renewable Energy Sources. Needs of renewable energy. Targets and Present Status of Renewable Energy Sources in India.

1.2 **Solar Energy:** Introduction, potential of solar energy in India, Solar Radiation, Principle of conversion of solar radiation into heat, construction and working principle of photo-voltaic cell. Solar cell materials, Difference between solar cell, panel, array, module, Characteristics, important terms related to solar energy, Efficiency of Solar Cells. Applications of solar energy like solar PV system (standalone and grid connected), solar water heating system, solar furnaces, solar cookers, solar lighting, solar water pumping system, solar still. Government schemes and policies.

UNIT II

Bio-Energy and Hydro Energy

2.1 **Bio-Energy:** Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Biomass Gasification, Types and application of gasifier, Types of biogas plants, Factors affecting biogas generation, Environmental impacts and benefits, Future role of biomass , Biomass potential and programs in India.

2.2 **Hydro Energy:** Introduction, Capacity and Potential, Hydro Power Plant (mini and micro), Environmental and social impacts.

UNIT III

Wind Energy and Geothermal Energy

3.1 **Wind Energy:** Introduction, Wind energy conversion system, windmills, types of wind mills, selection of site, electricity generation from wind energy, Wind Energy potential and Scenario in India.

3.2 **Geothermal Energy:** Introduction , Geothermal Resource Utilization like hydrothermal, Geo-pressured hot dry rock, magma, Geothermal based Electric Power Generation, Associated Problems, environmental Effects, prospects of geothermal energy in India.

UNIT IV

Tidal Energy and Mhd

4.1 **Tidal Energy:** Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants.

4.2 **Ocean Energy:** Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation, prospects of OTEC in India.

4.3 **MHD power generation**: Principle of working of Magneto Hydro Dynamic (MHD) Power Generation, materials for MHD generators and future prospects, performance and limitations.

UNIT V

Fuel Cell and Energy Storage Devices

5.1 **Fuel Cells:** Fuel cell definition, difference between batteries and fuel cells, Principle of working of fuel cells ,types of fuel cell, power generation by fuel cell ,conversion efficiency, applications, advantages and disadvantages of fuel cell .

5.2 **Energy Storage:** Need of energy storage, Different modes of energy storage, Flywheel storage, Superconducting Magnet Energy Storage (SMES) systems, Capacitor, battery, Super capacitor. Comparison and application.

RECOMMENDED BOOKS

1. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. B. H. Khan, "Non-Conventional Energy Resources", The McGraw Hill.
3. J. W. Twidell & A. Weir, "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.
4. S. P. Sukhatme and J.K. Nayak, "Solar Energy – Principles of Thermal Collection and Storage", Tata McGraw-Hill, New Delhi.
5. Garg, Prakash, "Solar Energy, Fundamentals and Applications", Tata McGraw Hill.
6. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publications, New Delhi, 2011.
7. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
8. K. C. Khandelwal & S. S. Mahdi, "Biogas Technology – A Practical Handbook", Tata Mc Graw Hill.
9. G. N. Tiwari, "Solar Energy – Fundamentals Design, Modeling & Applications", Narosa Publishing House, New Delhi, 2002.
10. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
11. Frank Krieth & John F Kreider, "Principles of Solar Energy", John Wiley, New York.
12. N. K. Bansal, "Renewable Energy Sources and Conversion Technology", Manfred Kleemann, Michael Meliss, Tata McGraw Hill Publishing Co. Ltd New Delhi.

RECOMMENDED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

Topics taught in the class should be demonstrated in the field/industries. This subject contains five units of equal weightage. The teacher should make the students aware about the depletion of energy sources and the availability of alternate sources of energy their feasibility and limitations. The need for adopting renewable and non-conventional energy sources should be made clear to students. Teacher must discuss application of these energy sources in nearby surrounding areas. Visit nearby renewable energy source plants to enhance the real time practical skill in the students.

6.4.2 ESTIMATING AND COSTING IN MECHANICAL ENGINEERING

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RATIONALE

Diploma holders are also engaged in purchasing of raw materials and production. For this purpose, they must know the basics of estimating and costing to work out the cost and budget of the job for the customers. They are also involved in tendering and preparing the quotes.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Explain the fundamentals of estimation.
CO2: Explain elements of costing.
CO3: Describe the fundamentals of cost accounting.
CO4: Estimate the material cost.
CO5: Estimate machining time.
CO6: Estimate foundry cost, forging cost and welding cost.
CO7: Apply the concept of process costing, and types of budget, and familiarize with accounting terminology.

DETAILED CONTENTS

UNIT-1

Introduction

Cost estimation-definition, Importance, purpose, elements for estimation, cost estimation procedure. Case study of any utility item, cost accounting, purposes of cost accounting, Comparison of estimating and costing.

Fundamentals of Estimating

Organization of estimating department, cost estimator- his essential qualifications, types of estimates, constituents of job estimates, cost of production, selling price, capital investment, rate of return (ROR) on investment , principal factors in estimating, miscellaneous allowances,

UNIT-II

Elements of Costing

Definitions, objectives, elements of costs, components of costs, ladder of cost, overhead expenses: factory expenses, depreciation cost-causes; methods of calculation of depreciation, obsolescence, interest on capital, idleness costs, repairs and maintenance cost, selling and distribution overheads and methods of allocation of overhead charges, procedure for costing

Methods of costing with example; unit costing, batch costing, departmental costing, process costing, multiple and composite costing

UNIT-III

Estimation of Material Cost

Estimation of volumes, weights and cost of material for items like pulley, spindle, lathe centre, fly wheel, crank shaft and similar items. Simple numerical on the above, Provision of budgets based on estimates.

UNIT-IV

Estimation of Machine Shop

Set-up time, operation time, handling time, machining time, tear down time, allowances; personal, fatigue, tool checking/sharpening/changing, unit operation time, cycle time and total time, full depth of cut, cutting speeds for various operations for different tool materials and product materials, estimation of time for various machining operations - turning, drilling, boring, tapping, shaping, planning, milling and grinding.

Estimation of Welding and Plastic Moulding

Estimation of cost of different products produced in welding- gas and electric welding,
Estimating in injection and plastic moulding

UNIT-V

Estimation of Forging and Foundry Shops

Estimating in forging and foundry shops, various losses.
Die Cost Estimation: Basic approach to cost estimation – pricing history, work intensity history, additional costs, machinability of materials, cost of materials, evaluation. Die building estimates.

Process and Job Costing

Characteristics -Principles -Procedure for Process costing, Accounting terminology like -book value-Net Present Value-Work in progress- Gross Domestic Product (GDP)-balance sheet, Introduction to

tendering process.

RECOMMENDED BOOKS

1. Production and Costing by GBS Narang and V. Kumar, Khanna Publishers, New Delhi.
2. Mechanical Estimating and Costing by Sinha BP; Tata McGraw Hill, New Delhi.
3. Production Engineering, Estimating and Costing by M Adithan and BS Pabla; Konark Publishers, New Delhi.
4. Mechanical Estimating and Costing by T.T.T.I, Madras: Tata McGraw Hill, New Delhi.
5. e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.
6. Process planning & cost estimation M.Adithan New age International.

RECOMMENDED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. Teaches should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components. While imparting instructions, focus should be on conceptual understanding. Use computer based learning aids for effective teaching learning. Expose the students to real life problems. Plan assignments so as to promote problem-solving abilities and develop continued learning skills. Motivate students to bring calculators in class from the very first day.

6.4.3 POWER PLANT ENGINEERING

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RATIONALE

The students of mechanical engineering should have the knowledge and skills pertaining to power generation systems, their control and economics in different type of power plants for their operation and maintenance. The students should also be able to analyze economics of power plants alongwith the factors affecting the performance of power plants.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Analyse economics of power plants, list factors affecting the efficiency of power plants and interpret the performance of power plants based on load variations.
CO2: Identify elements and their functions of, hydro power plants.
CO3: Identify elements and their functions and operations of steam power plants.
CO4: Identify elements and their functions and operations of nuclear and gas turbine power plants.
CO5: Identify elements and their functions and operations of solar, wind and diesel power plants.
CO6: Explain the Social and Economic issues of power plants.

DETAILED CONTENTS

UNIT-1

Introduction & Economics of Power Plant

Power plant- Introduction, Classification-Location of power plant-Choice of Power plant Terminology used in power plant: Peak load, Base load, Load factor, Load curve, demand factor-Various factor affecting the operation of power plant-Load sharing- power tariff methods-factors involved in fixing of a tariff.

Hydro Power Plant

Hydro-electric power plant- Introduction, storage and poundage, General layout and essential elements of Hydro-electric power plant and its working-Classification of the plant-base load plant, peak load

plant, Run off river plant, storage river plant, pumped storage plant, mini and micro hydel plants, governing of hydraulic turbines-impulse turbine- reaction turbine, selection of turbines, Advantages and disadvantages-limitations of hydro-electric power plant.

UNIT-II

Thermal Power Plant

Thermal power plant -General layout –working-Site Selection–materials required for thermal power plants, coal handling and its methods, stages in coal storage, Fuel burning-Stoker firing-overfeed stoker –under feed stokers-chain grate stoker, Pulverized fuel handling system-unit and central system, Pulverization of coal-Ball mill, Ash handling system-Gravity system-electrostatic precipitation (ESP) system-Feed water treatment-Mechanical method, Advantages and disadvantages-limitations of Thermal power plant.

UNIT-III

Nuclear Power Plant & Gas Turbine Power Plants

Nuclear power plant-Introduction-nuclear fuels, nuclear fission and fusion, working of a nuclear power plant, types of reactors- pressurized water reactor- boiling water reactor, effects of nuclear radiation, different methods for nuclear waste disposal-low, medium and high-level waste disposal, Advantages-disadvantages-limitations.

Gas turbine power plant-Schematic diagram & working of open and closed cycle gas turbine power plant, Components of Gas turbine–compressor, combustion chamber, gas turbine, vortex blading , gas turbine fuels, Advantages -disadvantages-limitations of Gas turbine power plant.

UNIT-IV

SOLAR, WIND AND DIESEL POWER PLANTS

Solar power plant-Introduction-layout, Solar cell fundamentals & classification –maximum power point tracker (MPPT) and solar panel. Comparison with conventional Power plants.

Wind power plant: Introduction, -Factors affecting distribution of Wind energy, Variation of wind speed with height and time-Horizontal axis wind turbine (HAWT)-types of rotors, Vertical axis wind turbine- types of rotors, Wind energy conversion system (WECS) advantages and disadvantages, limitations of Wind power plant.

Diesel power plant- layout -Components and the working- Advantages -disadvantages limitations.

UNIT-V

PLANT SAFETY AND ENVIRONMENTAL IMPACT OF POWER PLANTS

Social and Economic issues of power plant-Issues related to health- Oxides of sulphur, oxides of carbon, oxides of nitrogen, Acid precipitation, Acid rain, acid snow, Dry deposition, acid fog, smog,

greenhouse effect, air and water pollution from thermal power plants and its control, Thermal pollution from thermal power plants, noise pollution and its control, natural and artificial radio activity nuclear power and environment- radiations from nuclear power plant effluents-high level wastes-methods to reduce pollution, global warming-its effects and control, standardization for environmental pollution.

RECOMMENDED BOOKS

1. Power plant engineering Arora and Domkundwar, Dhanpat rai & CO (P) LTD
2. Power plant engineering P.K .Nag McGraw Hill
3. Power plant engineering G.R. Nagpal Khanna publishers
4. Power Plant Engineering. Dr. P.C.Sharma S. K. Kataria
5. A Text Book of Power Plant Engineering. R K Rajput Laxmi Publications,
6. Power plant technology M.M. EL-Wakil McGraw Hill
7. Power Plant Engineering. C. Elanchezhian, L. Saravanakumar, B. Vijaya Ramnath I.K. International Publishing House
8. Power Station Engineering and Economy. Bernhardt G A Sarotzki, William A Vopat Tata Mc Graw Hill

RECOMMENDED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. Teaches should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components. While imparting instructions, focus should be on conceptual understanding. Use computer based learning aids for effective teaching learning. Expose the students to real life problems. Plan assignments so as to promote problem-solving abilities and develop continued learning skills. Motivate students to bring calculators in class from the very first day.

6.5 MAJOR PROJECT/INDUSTRIAL TRAINING

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RATIONALE

Major project / Industrial training work will help in developing the relevant skills among the students as per National Skill Qualification Framework. It aims at exposing the students to the present and future needs of various relevant industries. It is expected from the students to get acquainted with desired attributes for industrial environment. For this purpose, students are required to be involved in industrial training / Major Project Work in different establishments.

COURSE OUTCOMES

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

CO1: Define the problem statement of the Industrial training / Major project according to the need of industry.

CO2: Work as a team member for successful completion of Industrial training / Major project.

CO3: Write the major project/industrial training report effectively.

CO4: Present the major project/industrial training project report using PPT.

GUIDELINES

Depending upon the interest of the students, they can go for Industrial training / Major project as per present and future demand of the industry. The supervisors may guide the students to identify their project work and chalk out their plan of action well in advance. As an Industrial training / Major project activity each student is supposed to study the operations at site and prepare a detailed project report of the observations/processes/activities. The supervisor may create a group of 4-5 students as per their interest to work as a team for successful completion of the Industrial training / Major Project.

The supervisor shall evaluate the students along with one external industry / academic expert by considering the following parameters:

	Parameter	**Weightage**
I	Defining problem statement, focus and approach	20%
ii	Innovation / creativity	20%
iii	Report Writing	20%
iv	Power Point Presentation	20%
v	Viva - voce	20%

24. ASSESMENT TOOLS & CRITERION

The assessment is carried out by conducting:

1. Formative assessments
2. Summative assessments

1. FORMATIVE ASSESSEMENT

The **formative assessment** will be evaluated on the basis of the internal assessments for theory subjects and practical by the concerned teachers for evaluating the knowledge and skill acquired by students and the behavioral transformation of the students. This **internal assessment** is primarily carried out by collecting evidence of competence gained by the students by evaluating them at work based on assessment criteria, asking questions and initiating formative discussions to assess understanding and by evaluating records and reports, and sessional marks are awarded to them.

2. SUMMATIVE ASSESSMENT

The **summative assessment** will include end semester examination for theory part for each candidate and practical examination with viva voice. Each Performance Criteria will be assigned marks proportional to its importance and proportion of marks for Theory and Skills Practical for each subject should be laid down.

The following assessment tools are used for effective student evaluation:

1. Theory Examinations
2. Practical Work
3. Internships
4. Professional Industrial Training
5. Project Work (Minor & Major)
6. Massive Open Online Courses (MOOCs)
7. Viva Voce
8. Case Studies

1. 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

i. Sessional /class-tests,
ii. Quizzes,
iii. Assignments,
iv. Seminars/ Presentations
v. Attendance
vi. Case Studies

For **Summative evaluation** of theory, the question paper may comprise of three sections.

i. It should contain objective type question and multiple choice questions. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.
ii. It should contain short answer questions.
iii. Descriptive type questions , with some internal choice of the questions set may be given in this section

2. Practical Assessment

Evaluation of students performance in practical work (Laboratory experiments, Workshop practical /field exercises) aims at assessing students ability to apply or practice the concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. This will comprise of a creation of mock environment, wherever applicable in the skill lab which is equipped with all required equipment for development of desired skills. Candidate's soft skills, communication, aptitude, safety consciousness, quality consciousness etc. will be ascertained by observation and will be marked in observation checklist along with the assessment of Job carried out in labs and maintenance of Lab Record files.

Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behavior and it should be followed by viva-voce of the relevant subject. The end product will be measured against the specified dimensions and standards to gauge the level of his skill achievements

3. Internship

The two mandatory internships after I Year and II Year of the programme are to be assessed in 3rd and 5th semester subsequently. The internships should be preferably done in the field/ in the industry, can be in house depending upon the stream and availability of resources in and around the institute.

Every faculty should be assigned the students and made responsible for the evaluation and assessment of the internship. Formative assessment should be taken from the industry/institute/ department on the basis of performance, behavior and learning capabilities. Summative evaluation may comprise of weightages on the basis of report submission/ presentation followed by viva-voce of the relevant subject.

4. Professional Industrial Training

Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of 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. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behavior and it should be followed by viva-voce of the relevant subject.

The formative assessment should include the evaluation from the employer where the student is doing his training or Project work in the ratio of 40:60. The final assessment will be the combination of the employer assessment and evaluation by the faculty of the institute which shall include report submission/ presentation/ seminar followed by viva-voce of the relevant subject.

5. Project Work Assessment

The purpose of evaluation of project work is to assess student's ability to apply, in an integrated manner, knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The project work assigned should be of

relevance to the core skill, state of the art topics and the project areas that are pertaining to enhance job skill and enhance occupational opportunities. For both, minor and major project, Formative and summative evaluation may comprise of weightages to performance on task, quality of product, nature and relevance of project and general behavior.
The formative assessment should include the continuous assessment based on the work allocated and mid semester viva voice or presentation. The final assessment will be the combination of the project undertaken, report submission and should be followed by viva-voce of the relevant subject.

In case of the assessment of this component, the team of examiners should be constituted on 50 – 50 % basis. i.e. half of the examiners in the team should be invited from outside the institute conducting examination.

6. MOOC COURSES (Open Elective and Multi-Disciplinary Elective)

Massive Open Online Courses (MOOCs) platforms promise open, online courses to massive numbers of students as they are free to join, they provide a wide range of courses, they allow for space and time flexibility and their participants can benefit from various online communication tools and access to quality content.

The coordinating Department/Centre/Office shall monitor every student to adopt the courses online of their choice and preference on Swayam portal. The duration of courses will vary depending on the level and credit points. Courses offered in the duration of 4-10 weeks for 2 to 3 credits at diploma level are to be opted. Students, after they have registered, can get a certificate after attending the classes and submitting the assignments/quizzes and qualifying nationwide exam conducted written exam at the institute close to the one where the student is enrolled.

On successful completion of each course, the institution offering the MOOCs course would issue the certificate, along with the number of credits and grades, through which the student can get credits transferred into his marks certificate issued by his parent institution. Guidelines for credit sharing will be issued by concerned Regulators such as UGC, AICTE, etc. for consideration by various Institutes. There may be standard norms for the host Institution to conduct the course that may include continuous evaluation through assignments, online quizzes, case studies, online writing exercises, term examinations, student feedback, online forum management, etc.

The coordinating Department/Centre/Office of the respective department shall monitor every student and submit to the Office of Examinations, a score sheet (marks card) during the last 10 days prior to the close of the even semester.

7. Viva Voce

This tool will be used to assess the conceptual understanding and the behavioral aspects as regards the job role and the specific task at hand. It will also include questions on safety, quality, environment and equipment's etc. Ask questions on non-prescribed tasks to ensure that the learners have complete knowledge on the assessment

Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits with the marks scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

$$SGPA\ (Si) = \sum(Ci \times Gi) / \sum Ci$$

where Ci is the number of credits of the ith course and Gi is the marks scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

25. TEACHING LEARNING TOOLS FOR EFFECTIVE IMPLEMENTATION

For effective implementation of curriculum, the faculty and staff of institutions 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 only a proper mix of different teaching methods in all these places of instruction can bring the changes in students behavior as stipulated in the curriculum document. It is important to understand curriculum document holistically and further be aware of intricacies of Teaching-Learning Tools for achieving curriculum objectives. Given below are certain recommendations which may help in carrying out teaching-learning effectively:

PROGRAMME LEVEL RECOMMENDATIONS

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 at institute level. The Head of the institute have a great role to play in its dissemination and percolation up to grass-root level.

3. Head of Department are required to prepare academic plan at department level referring to institutional academic plan.

COURSE LEVEL RECOMMENDATIONS

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. 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 which is made available to them in the academic plan at Board level. With the amount of time to their credit, it is essential for them to use it judiciously by planning all above activities properly and ensure execution of

the plan effectively. Following is the gist of suggestions for subject teachers for effective utilization of Teaching Learning Tools to achieve the course objectives:

1. Teachers need to ensure attainment of course outcomes so as to help the students achieve program outcomes and also meet the desired learning outcomes in five domains of NSQF i.e. Process, Professional knowledge, Professional skills, Core skills and Responsibility.

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

3. 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.

4. Teachers are required to plan for expert lectures from field/industry. For this, necessary steps need to be taken such as planning in advance, identifying field experts, making correspondence to invite them, taking necessary budgetary approval etc.

5. 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.

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

7. Lot of focus needs to be laid on skill development. There is need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem based learning and experiential learning effectively. The development and use of lab manuals will enable the institutes to provide lab experiences effectively.

8. Emphasis should to lay on developing soft skills like communication skills, personality Development, self-learning, inter personal skills, problem solving, and creativity etc.

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

extensive use of audio visual aids such as video films, power point presentations and IT tools.

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 f for wastage of energy and other resources etc.

12. To enhance digital learning, open electives and multi-disciplinary electives have been provided in the curriculum to be taken up in the form of MOOCs. For Open electives, some courses may be identified out of the prescribed list given in the curriculum keeping in mind the interest of students. Similarly, for multi-disciplinary electives, courses to be o offered may be identified by considering their relevance and utility. Every year SWAYAM is notifying the list of courses which are going to be offered in forthcoming even and odd semester. The institute needs to select the courses that are offered on SWAYAM platform or any other online platform.

13. For effective implementation of Massive Open Online Courses (MOOCs), a faculty member in the department may be identified and given the responsibility to coordinate various activities related to MOOCs. The concerned faculty member will facilitate in registration of students for MOOCs. The faculty member will also be responsible for compiling the result of students on the completion of MOOCs and pass on the information to the concerned authority.

14. Flexibility has been provided in the curriculum for the students to choose a course related to the discipline as per their interest. For effective implementation of discipline-specific electives, the institute should identify some courses from the list of courses prescribed in the curriculum. The courses should be selected and offered keeping in mind the interest of students, infrastructure and expertise available in and around the institute related to the courses. Option for discipline-specific elective may be taken from students through a form and a course, with more than 10 students opting for it, may be run.

15. Where ever possible, it is essential to use activity based learning rather than relying on delivery based conventional teaching all the time. While teaching, the teacher should make extensive use of audio visual aids such as video films, power point presentations and IT tools.

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

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

18. To enhance digital learning, open electives and multi-disciplinary electives have been provided in the curriculum to be taken up in the form of MOOCs. For Open electives, some courses may be identified out of the prescribed list given in the curriculum keeping in mind the interest of students. Similarly, for multi-disciplinary electives, courses to be offered may be identified by considering their relevance and utility. Every year SWAYAM is notifying the list of courses which are going to be offered in forthcoming even and odd semester. The institute needs to select the courses that are offered on SWAYAM platform or any other online platform.

26. LIST OF EXPERTS

1. Controller of Examination, Haryana State Board of Technical Education, Panchkula.
2. Controller of Admn. & Finance, Haryana State Board of Technical Education, Panchkula.
3. Joint Secretary, Haryana State Board of Technical Education, Panchkula.
4. Deputy Secretary, Training & Placement, Haryana State Board of Technical Education, Panchkula.
5. Deputy Secretary, Examination, Haryana State Board of Technical Education, Panchkula.
6. Deputy Secretary, Academic, Haryana State Board of Technical Education, Panchkula.
7. Assistant Secretary, Academic, Haryana State Board of Technical Education, Panchkula.
8. Sh. Sudhansu, Hero Moto Corp., Haryana.
9. Sh. Veer Daman Singh, Regional Manager, Lincoln Electric India Company Pvt Ltd.
10. Sh. Vinod Kumar Pandey, Manager Engineering, Labotron Instruments Pvt. Ltd., Ambala, Haryana.
11. Dr. Jatinder Madan, Professor & Head, Mechanical Engineering, CCET, Chandigarh
12. Sh. Narinder, CSIO, Chandigarh
13. Sh. NS Jassal, Principal, Indo Swiss Training Centre, Chandigarh.
14. Sh. Jagjit Singh Narang, HOD, Mechanical Engineering Department,Government Polytechnic, Ambala, Haryana.
15. Sh. Subhash Chandra Bhoria, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Hisar, Haryana.
16. Sh. Harvinder Singh Saini, Senior Lecturer, Mechanical Engineering Department, Senior Lecturer, Government Polytechnic, Ambala, Haryana.
17. Subhash Bhardwaj, HOD, Mechanical Engineering Department,Government Polytechnic, Ambala, Haryana.

18. Sh. Pardeep Kumar, HOD, Mechanical Engineering Department,Government Polytechnic, Nilokheri, Haryana.
19. Sh. Vikas Sharma, HOD, Mechanical Engineering Department,Government Polytechnic, Nilokheri, Haryana.
20. Sh. Rajiv Verma, HOD, Mechanical Engineering Department,Government Polytechnic, Adampur, Haryana.
21. Sh. Parveen Saini, Lecturer, Mechanical Engineering Department, Government Polytechnic, Nilokheri, Haryana.
22. Sh. Baljit Siwach, Lecturer, Mechanical Engineering Department, Government Polytechnic, Sonepat, Haryana.
23. Sh. Kapil Sharma, HOD, Mechanical Engineering Department, Seth JaiParkash Polytechnic, Damla, Haryana.
24. Sh, Baltar Singh, Workshop Superintendent, Mechanical Engineering Department, Government Polytechnic, Ambala, Haryana.
25. Sh. Dinesh Mor, Workshop Superintendent, Workshop Department, Government Polytechnic, Sonipat, Haryana.
26. Sh. Manmohan Singh, Workshop Superintendent, Mechanical Engineering Department, Government Polytechnic, Damla, Haryana.
27. Sh. Balwan Singh, Workshop In-charge, Mechanical Engineering Department, Aryabhatt Institute of Technology, Delhi.
28. Sh. Gulab Singh, Workshop Instructor, Mechanical Engineering Department, SethJai Parkash Polytechnic, Damla, Haryana.
29. Sh. Ashwani Kumar, Workshop Instructor, Electrical Engineering Department, Government Polytechnic, Damla, Haryana.
30. Sh. Rajneesh Rana, Workshop Instructor, Electronics Engineering Department, Government Polytechnic, Damla, Haryana.
31. Sh. Ankush Aggarwal, Lecturer, Mechanical Engineering Department, Seth Jai Parkash Polytechnic, Damla, Haryana.
32. Ms. Amita, Deputy Director (Acd), Directorate of Technical Education.
33. Dr. Bhajan Lal, Lecturer, Applied Science Department, Government Polytechnic for Women, Sirsa, Haryana.

34. Sh. Anil Nain, Lecturer, Applied Science Department, Government Polytechnic, Hisar, Haryana.
35. Dr. Sarita Mann, Lecturer, Applied Science Department, Government Polytechnic, Ambala, Haryana.
36. Smt. Bindu Verma, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.
37. Dr. Pankaj Sharma, Professor, Applied Science Department, NITTTR, Chandigarh.
38. Dr. Ashok Kumar, Associate Professor, Applied Science Department, NITTTR, Chandigarh.
39. Smt. Pushpa Rani, Senior Lecturer, Applied Science Department, Government Polytechnic, Sonipat, Haryana.
40. Smt. Krishna Bhoria, Lecturer, Applied Science Department, Government Polytechnic, Ambala, Haryana.
41. Smt. Preetpal Kaur, Guest Faculty, Applied Science Department, Government Polytechnic, Ambala, Haryana.
42. Ms. Monika, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.
43. Dr. Neena Sharma, English Department, MCM College, Chandigarh.
44. Er. Hanish Saini, Lecturer, Department of Mechanical Engineering, Government Polytechnic, Ambala, Haryana.
45. Sh. Satyawan Dhaka, Senior Lecturer, Applied Science Department, Government Polytechnic, Nilokheri.
46. Mrs. Sapna Sang, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.
47. Sh. Ravi Bansal, Lecturer, Applied Science Department, Government Polytechnic, Manesar, Haryana.
48. Mrs. Kiran, Lecturer, Applied Science Department, Government Polytechnic, Sonepat, Haryana.
49. Dr. Naveen Jha, Assistant Professor, Department of Mathematics, Government Engineering College, Bharatpur.

50. Dr. KC Lachhwani, Assistant Professor, Applied Science, NITTTR,Chandigarh
51. Sh. KG Srinivasa, Professor CSE, IIIT-Naya Raipur.
52. Dr. Vidhi Grover, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.
53. Sh. Tavinder Singh, Lecturer, Applied Science Department, Government Polytechnic, Sirsa, Haryana.
54. Ms. Sunita Rani, Lecturer, Applied Science Department, Government Polytechnic, Ambala, Haryana.
55. Sh. Deepak Punia, Sr. Lecturer, Government Polytechnic,Shergarh, Kaithal.
56. Sh. Dev Suman Verma, Sr. Lecturer, Government Polytechnic, Rajpur Sadhaura, Yamuna Nagar.
57. Sh. Amit, Lecturer, Government Polytechnic, Hisar
58. Sh. Bachu Singh Kadam, Lecturer, Government Polytechnic, Manesar.
59. Er. Sunil Jassal, Associate Professor, Department of Mechanical Engineering, NITTTR, Chandigarh.
60. Dr. Rajesh Mehra, Professor and Head, Curriculum Development Centre, NITTTR, Chandigarh.
61. Dr. AB Gupta, Professor and Head, Education & Educational Management Department, NITTTR, Chandigarh.
62. Er. P.K. Singla, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh.
63. Dr. SK Gupta, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh.
64. Dr. Meenakshi Sood, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh.

27. APPENDIX

Sr. No.	LIST OF EQUIPMENTS
1.	Work benches fitted with carpenter vices
2.	Circular saw grinder
3.	Wood cutting band saw-vertical
4.	Bench grinder
5.	Drilling machine
6.	Wood turning lathe
7.	Wood Planner
8.	Tool accessories measuring and marking Instruments
9.	Band saw blade brazing unit
10.	Work benches with vices (4 vices on each bench)
11.	Marking tables with scribers
12.	Surface plates
13.	Bench grinders
14.	Drilling machine
15.	Power Hacksaw
16.	Sheet Bending Machine
17.	Tool kits – taps, dies, drills
18.	Tool kits – chiesels, hammers, files, hacksaw
19.	Accessories like calipers, V blocks, height, gauges steel rules and scribers
20.	Pipe vice
21.	Chain wrenches
22.	Ring spanner set
23.	Pipe die set 2”
24.	Pipe bending device
25.	Various pluming fitting
26.	Moulding boxes
27.	Ladles
28.	Tool Kits
29.	Quenching tanks
30.	Portable grinder
31.	Pit furnace with blower
32.	Spray gun with hose pipe
33.	Paint brushes

34.	Paint/Varnish
35.	Air Compressor with 2 hp motor
36.	Miscellaneous
37.	Black smithy forge (with open hearths, accessories to match the forge)
38.	Wrought iron anvils
39.	Swage blocks
40.	Blower with accessories, motor switch etc
41.	Work benches with vices
42.	Power hammer
43.	Tools and accessories – hammers, swages, tongs, pokers, pullers etc
44.	Electrical welding transformer set with accessories
45.	Gas Cutting Unit
46.	Work benches with vices
47.	Welding generator set
48.	Oxy acetylene welding set with accessories
49.	Acetylene generating set
50.	Electric welder tool kit
51.	Projection welding machine
52.	Brazing equipment with accessories
53.	Soldering irons
54.	Pedestal grinder
55.	Metal spraying gun
56.	Spot welder
57.	TIG welding set
58.	MIG welding set
59.	Welding Partition Screen
60.	Salt bath oil fired furnace
61.	Salt bath electric resistance furnace
62.	Electric furnace muffle type
63.	Forced circulation tempering furnace
64.	Quenching tank
65.	Pyrometers
66.	Pot for bailing out the salt
67.	Metallurgical microscope
68.	Abrasive cut off machine

69.	Polygon of forces apparatus
70.	Apparatus for reaction at supports
71.	Jib crane
72.	Screw jack
73.	Inclined plane and friction apparatus
74.	Worm and worm wheel
75.	Brinell and Rockwell hardness tester
76.	Impact testing machine (Izod and Charpy)
77.	Microprocessor based universal testing machine
78.	Torsion testing machine (fully computerized)
79.	Spring Deflection Apparatus
80.	Beam Deflection Appatus
81.	Wattmeter
82.	Ammeter
83.	Voltmeter
84.	DC shunt motor
85.	Single phase variac
86.	Single phase transformer
87.	Resistive load
88.	Multimeter
89.	CRO
90.	Regulated supply
91.	Signal generator
92.	3-phase inductor motor
93.	3-phase variac
94.	DC shunt generator coupled with motor and starter
95.	Rheostat
96.	Tachometer
97.	Centre lathes
98.	Tool room lathe
99.	Lathe with copy turning attachment and other attachments
100.	Universal milling machine
101.	Vertical milling machine
102.	Shapers
103.	Radial drilling machine

104.	Upright drilling machine
105.	Gear Shaper
106.	Centreless grinder
107.	Universal cylindrical grinder
108.	Hydraulic surface grinder
109.	Tool and Cutter grinder
110.	Power hacksaw
111.	Pedestal grinder
112.	Electro discharge machine
113.	Work bench
114.	Precision instruments
115.	Surface plates
116.	Hand tools and accessories
117.	CNC trainer lathe
118.	CNC trainer milling machine
119.	PC Computer
120.	Computer based NC Programming Software
121.	CNC Simulation software
122.	CNC Milling machine accessories and holding devices
123.	3 D Printer
124.	Piezometer tube
125.	U tube differential manometer
126.	Inclined manometer
127.	Bourdan pressure gauge
128.	Hydraulic jack
129.	Hydraulic press
130.	Bernoulli’s apparatus
131.	Venturimeter apparatus with differential manometer
132.	Pipe friction apparatus
133.	Reciprocating pump
134.	Centrifugal pump
135.	Model of pelton wheel
136.	Model of Francis turbine
137.	Throttling Calorimeter
138.	Bomb Calorimeter

139.	Junker's Gas Calorimeter
140.	Gravimetric Analysis
141.	Orsat Apparatus
142.	Mechanical Types Co_2 Recorder
143.	Single Stage Reciprocating
144.	Rotary Compressor
145.	Flash Point Apparatus
146.	Pyrometer
147.	Lancashire boiler model
148.	Model of impulse turbine
149.	Model of reaction turbine
150.	Model of surface condenser
151.	Spring loaded safety valve
152.	Single cylinder 2 stroke petrol engine
153.	Single cylinder 4 stroke petrol engine
154.	Multicylinder petrol engine test ring
155.	Digital vernier calliper
156.	Digital micrometer
157.	Height gauge
158.	Depth gauge
159.	Combination set
160.	Bevel protractor
161.	Sine bar
162.	Precision balls and rollers
163.	Surface plate
164.	Slip gauges set
165.	Comparator – Mechanical , Pneumatic
166.	Gear tooth vernier
167.	Snap and ring gauges
168.	Feeler gauge, radius gauge
169.	Angle plate
170.	Tool makers microscope
171.	Profile projector
172.	Surface roughness tester
173.	IDEAS

174.	AutoCAD
175.	Computer Systems of latest configuration
176.	Mechanical Desk Top
177.	Catia
178.	Digitiser
179.	Plotter
180.	Scanner
181.	Printer (Laser, DMP)
182.	Refrigeration trainer
183.	Air conditioner trainer
184.	Water cooler
185.	Experimental Ice plant
186.	Refrigeration compressor
187.	Safety controls (HP, LP Cut outs, oil pressure controls), solenoid valve, expansion valves, thermostats, charging board
188.	Gas charging equipment
189.	Vacuum pump
190.	Compressor
191.	Pumps
192.	Drier
193.	Pulley block
194.	Mobile Crane
195.	Fork Lift
196.	Hydraulic Jack
197.	Winch
198.	Cut Section model of old Vehicle Chassis
199.	Tyre inflation apparatus
200.	Battery Charging System and its Specific gravity Test
201.	Hydraulic Brake arrangement
202.	Head Light and Tail Light and Horn wiring apparatus
203.	Vehicle for driving practice
204.	Battery Ignition System
205.	Model of Wiper


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