GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN CE/EE/ET/ME/MT/CM/IT/DDGM**
PROGRAMME CODE	**01/02/03/04/05/06/07/08**
COURSE TITLE	**SOCIAL AND LIFE SKILLS**
COURSE CODE	**HU21204**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS DECLARATION COURSE	**NO**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme												
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory					Based on LL & TSL				Based on SL		Total Marks
															Practical						
			CL	TL	LL					FA-TH	SA-TH	Total			FA-PR		SA-PR		SLA		
										Max	Max	Max	Min		Max	Min	Max	Min	Max	Min	
HU21204	SOCIAL AND LIFE SKILLS	VEC	1	--	2	1	4	2	--	--	--	--	--		25	10	--	--	25	10	50

Total IKS Hrs for Term: 0 Hrs

Abbreviations: CL-Classroom Learning, **TL**-Tutorial Learning, **LL**-Laboratory Learning, **SLH**-Self Learning Hours, **NLH**-Notional Learning Hours, **FA** - Formative Assessment**, SA** -Summative assessment, **IKS** – Indian Knowledge System, **SLA**- Self Learning Assessment

Legends: @-Internal Assessment, # - External Assessment,***#** - Online Examination,**@$** - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

1. If a candidate is not securing minimum passing marks in **FA-PR** (Formative Assessment - Practical) of any course, then the candidate shall be declared as **'Detained'** in that course.
2. If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as **'fail'** and will have to repeat and resubmit SLA work.
1. **Notional learning hours** for the semester are **(CL + LL + TL + SL) hrs. * 15 Weeks**
3. **1 credit** is equivalent to **30 Notional hours**.
4. * Self-learning hours shall not be reflected in the Timetable.

6.* Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

The introduction of a social and life skills course for diploma engineers is indeed a significant step forward in shaping well-rounded professionals. By integrating soft skills training with technical education, this curriculum addresses the growing need for engineers who are not only experts in their field but also adept in interpersonal communication, collaboration, and leadership. Such skills are crucial for success in the modern workforce, where the ability to navigate complex social dynamics can be just as important as technical know-how. Moreover, the emphasis on ethical decision-making prepares engineers to approach their work with integrity and responsibility. As these professionals progress in their careers, the benefits of this comprehensive education will manifest in their ability to innovate, lead, and contribute positively to their communities and the broader society. This forward-thinking approach ensures that the engineers of tomorrow are equipped not just with the tools to excel in their careers, but also with the vision to drive societal progress.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1: Achieve shared goals through effective teamwork in executing sustainable community development projects.

CO2: Improve cooperation and understanding through refined communication skills.

CO3: Encourage ethical choices and compassionate behaviour by nurturing moral values.

CO4: Foster ethical judgment, honesty, and societal accountability to shape principled and conscientious professionals.

CO5: Equip students with practical financial literacy skills for efficient financial management.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT:

Sr. No	TheoryLearning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I ENGAGEMENTS WITHIN UNNAT MAHARASHTRA ABHIYAN (UMA) (CL Hrs-03, Marks-NIL)				
1.	**TLO1.1:** Recognize the importance of addressing societal needs and involving relevant stakeholders in problem-solving efforts. **TLO1.2:** Integrate academia, society, and technology to devise comprehensive solutions for complex societal issues. **TLO1.3:**Enhance communication and negotiation skills to effectively engage stakeholders, ensuring diverse perspectives and productive collaboration in problem-solving. **TLO1.4:** Utilize critical data sources such as economic surveys, and environmental data to guide decision-making and solution development in problem-solving endeavours. **TLO1.5:** Identify key stakeholders and delineate their roles and interests in addressing societal challenges. **TLO1.6:** Identify essential attributes for measurement in the problem-solving process. **TLO1.7:** Explore diverse	**1.1 Identifying Regional Societal Challenges:** Recognizing Community Needs Requiring Engineering Solutions. **1.2Integrating Multidisciplinary Approaches:** Linking Academia, Society, and Technology **1.3 Involving Diverse Stakeholders:** Engaging Various Actors in the Problem-Solving Process **1.4Accessing Secondary Data Sources:** Utilizing Resources like Census and Economic Surveys **1.5Mapping Problems and Stakeholders:** Understanding Activities' Relevance to System Components and Key Stakeholders **1.6Defining Measurement Metrics:** Identifying Essential Attributes for Evaluation **1.7 Employing Data Collection Tools:** Exploring Surveys and Measurement Equipment **1.8Establishing Measurement Standards:** Developing Survey Forms and Piloting Processes **1.9Conducting Field Surveys:** Quantifying Local Systems such as Agriculture and Transportation **1.10Analyzing Data and Creating Reports:** Summarizing Data and	Considering the unit design, it's vital to consider the following factors during the implementation of the unit: i) Organize students into smaller groups of 5-6 members to carry out fieldwork within the larger cohort. ii) Allocate multiple student groups evenly among all faculty members involved in the course. iii) A team of course faculty will visit local governing bodies like Municipal Corporations, Villages, Panchayats, Zilla Parishads, and Panchayat Samitis to assess small-scale technological or engineering needs within their jurisdiction. iv) The team of course instructors will conduct initial field visits to explore various scenarios and options	**CO1**

	tools and templates for data collection, including surveys and measurement equipment. **TLO1.8:** Establish a structured framework for measuring identified attributes, including the development of survey forms and piloting the measurement process. **TLO1.9:** Gain practical experience in conducting fieldwork to gather primary data, such as agricultural output, rainfall, and transportation networks. **TLO1.10:** Develop proficiency in data analysis to draw meaningful conclusions, informing decision-making and solution development processes.	Reflections in Reports, Utilizing Various Formats like Tables and Graphs	for student-led fieldwork to assess and quantify different parameters and characteristics. **a) Session I** will introduce the development approach, fieldwork methodology, and the utilization of case studies as instructional tools. **b) Sessions II** - VII will cover topics such as societal dynamics, stakeholder engagement, value creation, establishing metrics, basic analysis, and preliminary reporting. **c) Session VIII** will wrap up the program with feedback collection and assessment. **d) Field Work:** **1. Pilot Visit** - Testing the survey instrument **2. Survey Visit 1** - Gathering data/information Survey. **3**. **Visit 2-** Further data collection. **4.SummaryVisit-** Concluding activities post-analysis.	
UNIT - II NATIONAL SERVICE SCHEME (NSS) (CL Hrs-03, Marks- NIL)				
2	**TLO2.1:** Enhance communication and leadership abilities to effectively interact with local leaders. **TLO2.2:** Develop proficiency in conducting socio-economic surveys using appropriate data collection techniques and analysis methods to understand community needs. **TLO2.3:** Identify suitable villages and devise activity plans based on community	2.1 Engaging with Village/Area 2.2 Conducting initial socio-economic surveys in nearby villages. 2.3 Selecting villages for adoption and initiating project activities. 2.4 Conducting thorough socio-economic surveys in the adopted village or area. 2.5 Identifying key issues and challenges within the community. 2.6 Raising awareness about advancements in agriculture, watershed management, wasteland reclamation, renewable energy, affordable housing, sanitation,	Considering the unit design, it's vital to consider the following factors during the implementation of the unit: i) Organize students into smaller groups of 5-6 members to carry out fieldwork within the larger cohort. ii) Allocate multiple student groups evenly among all faculty members involved in the course.	**CO2**

	needs and available resources. **TLO2.4:** Analyze survey findings to discern socio-economic patterns, obstacles, and potential avenues for progress. **TLO2.5:**Prioritize community issues according to their significance and impact on community welfare. **TLO2.6:** Communicate information on agriculture, watershed management, renewable energy, housing, sanitation, nutrition, and hygiene effectively. **TLO2.7:** Cultivate networking and advocacy skills to foster collaboration among government agencies, development organizations, and the community.	nutrition, and personal hygiene. Also, informing about skill enhancement programs, income generation opportunities, government initiatives, legal aid, consumer rights, and related topics. 2.7 Facilitating collaboration between the government and development agencies to implement various schemes in the adopted village or slum.	iii) Before selecting a village or slum for NSS activities, it's advisable for teachers to conduct an initial visit. iv)The selected area should have a dense population. iv)Community members should exhibit a willingness to improve their living conditions and actively engage in projects initiated by the NSS for their benefit. vi) NSS units should avoid areas with a history of political conflicts. vii) The chosen area should be conveniently accessible for NSS volunteers to conduct regular visits to the slums.	
UNIT - III UNIVERSAL HUMAN VALUES (CL Hrs-03, Marks- NIL)				
3	**TL03.1:** Apply love and compassion to promote harmony and well-being. **TL03.2:** Demonstrate honesty and transparency to build trust and authenticity. **TL03.3:** Utilize non-violent approaches to resolve conflicts and enhance empathy. **TL03.4:** Align actions with moral principles to promote justice and fairness. **TL03.5:** Employ peace-building strategies for harmony and reconciliation. **TL03.6:** Engage in acts of service to cultivate empathy and social responsibility. **TL03.7:** Prioritize others' needs to foster altruism and generosity.	**4.1 Exploring Love and Compassion (Prem and Karuna):** Learning about and embodying the principles of love and compassion in daily life. **4.2 Embracing Truth (Satya):** Understanding the significance of truthfulness and integrating it into one's actions and interactions. **4.3 Embracing Non-Violence (Ahimsa):** Understanding the importance of non-violence and applying it in personal and societal contexts. **4.4 Upholding Righteousness (Dharma):** Exploring the concept of righteousness and practising it through ethical conduct and moral values. **4.5 Cultivating Peace (Shanti):** Reflecting on the essence of peace and cultivating	Proposed Learning Approaches for: i) Lecture Delivery ii) Demonstrations iii) Case Studies iv)Role-playing exercises v)Observational Learning vi)Portfolio Development vii) Simulations viii) Inspirational Talks from Industry Professionals ix) On-site Visits to sites or Industries	**CO3**

	TL03.8: Exhibit behaviours that uphold gender equality and respect for diversity to create an inclusive	inner tranquillity while promoting harmony in relationships and communities. **4.6 Embracing Service (Seva):** Understanding the value of selfless service and actively engaging in acts of kindness and support for others. **4.7 Embracing Renunciation (Sacrifice) Tyaga**: Understanding the concept of renunciation and willingly **letting go of self-interest for the greater good. and attitudes.** **4.8 Promoting Gender Equality and Sensitivity:** Recognizing the importance of gender equality and fostering an environment of inclusivity and respect for all genders through actions and attitudes.		
UNIT - IV VALUE EDUCATION (UNNATI FOUNDATION) (CL Hrs-03, Marks- NIL)				
4	**TLO4.1:** Display comprehension of one's own identity, values, and beliefs. **TLO4.2**: Recognize and express personal strengths and weaknesses effectively. **TLO4.3:**Demonstrate adeptness in active listening by providing feedback and demonstrating empathy. **TLO4.4:**Acquire strategies for handling conflicts constructively and respectfully. **TLO4.5:** Assess and reflect on moral values and principles that influence personal actions and choices. **TLO4.6:** Analyze and assess the moral values and principles guiding individual actions and decisions.	**4.1. Self-awareness and Personal Development** Self-understanding, Identification of strengths and weaknesses, Setting goals and devising plans, Building self-esteem and confidence **4.2.Interpersonal Skills and Effective Communication** Engaging in active listening, Resolving conflicts, Cultivating healthy relationships **4.3. Ethics and Morality** Grasping ethical concepts, Upholding moral values and principles, Making ethical decisions, Demonstrating integrity and honesty **4.4. Social Values and Responsibility** Being punctual and initiating conversation, Managing emotions effectively, Introducing oneself and others, Maintaining a positive attitude Valuing family bonds, Creating favourable impressions,	i)Video Demonstrations ii)Flipped Learning Environment iii) Case Studies iv)Role-playing Activities v)Group-based Learning vi)Team-based Learning vii)Utilization of Chalkboard	**CO4**

		Communicating effectively, Emphasizing cleanliness, hygiene, and organization, Expressing preferences, Fostering confidence Enhancing listening skills, Demonstrating appropriate greetings, Promoting gender equality and sensitivity, Exercising responsibility, Integrating visual and verbal learning, Establishing and pursuing goals, Observing social media etiquette, Efficiently managing time and daily routines		
UNIT - V FINANCIAL LITERACY(CL Hrs-03, Marks- NIL)				
5	**TLO5.1:**Comprehending Savings and Investment Practices. **TLO5.2:**Cultivating Proficiency in Financial Planning. **TLO 5.3:**Developing Competence in Transaction Handling. **TLO5.4:**Achieving Proficiency in Income, Spending, and Budget Management. **TLO 5.5:**Attaining Understanding of Inflation Concepts. **TLO 5.6:** Fostering Competence in Loan Administration. **TLO5.7:** Acknowledging the Significance of Insurance.	**5.1. Fundamentals of Finances:** Grasping concepts of income, expenses, and savings, Employing budgeting techniques, Understanding assets and liabilities, and Recognizing the significance of emergency funds. **5.2. Banking Essentials** Initiating and managing bank accounts, Familiarizing oneself with various account types (savings, checking, etc.), Comprehending interest rates, and Safely utilizing ATMs. **5.3. Management of Credit and Debt** Interpreting credit scores and reports, Identifying different credit types (credit cards, loans, etc.), Responsible debt management, and Preventing involvement in predatory lending. **5.4. Foundations of Investment** Understanding investment types (stocks, bonds, mutual funds, etc.), Assessing risk and return, Implementing diversification strategies, and Formulating investment approaches. **5.5. Financial Planning and Goal Establishment** Establishing financial objectives, Crafting a personalized financial blueprint, Continuously monitoring and adjusting financial goals, and Engaging in long-term financial	i) Video Demonstrations ii) Presentations iii) Case Studies iv) Chalkboard Utilization v) Collaborative Learning	**CO5**

		strategizing. **5.6. Consumer Rights and Duties** Familiarizing oneself with consumer entitlements, Safeguarding against financial scams and fraudulent activities Exercising responsible borrowing and spending practices, Upholding financial privacy and security measures. **5.7. Essentials of Insurance** Exploring different insurance categories (health, life, auto, home, etc.), Understanding insurance policy specifics, Recognizing the importance of insurance coverage, and Navigating the insurance claims process. **5.8. Economic Literacy** Grasping fundamental economic principles, Understanding the concepts of inflation and deflation, Analyzing market trends, and Interpreting economic indicators.		

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/ TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment/ Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	**LLOI.I.1:** Communicating and interacting with residents or children with compassion and empathy, demonstrating an understanding of their needs and emotions.	1.1 Encouraging empathy and kindness through volunteer work at: i) a nearby nursing home ii)a care centre for children from disadvantaged families or similar types of facilities.	2	CO3
2	**LLO 2.1** Enhance goal-setting abilities by engaging in collaborative planning, analyzing obstacles, and reflecting on personal aspirations to align them with broader academic or career goals.	2.1 Pathway to Success: Goal-Setting Exercise	2	CO4
3	**LLO3.1:** Develop effective communication skills by demonstrating compassion, empathy, and understanding towards residents or children, while acknowledging and addressing their needs and emotions.	3.1 Exploring Your Inner World: Self-Reflection Activity	2	CO4
4	**LLO4.1:** Laboratory Learning Outcome: Cultivate structured self-reflection skills to assess personal	4.1 Strengths and Weaknesses Identification and Analysis Exercise	2	CO4

	strengths and weaknesses.			
5	**LLO 5.1:** Display proficiency in time management through the creation and adherence to structured timelines for task coordination.	5.1 Time Management Simulation for Coordinating Industrial Visits	2	CO4
6	**LLO 6.1**: Demonstrate competency in social media etiquette through engaging in activities and adhering to established norms and guidelines.	6.1 Activity on Social Media Etiquette	2	CO4
7	**LLO 7.1:** Develop skills in mapping and analyzing family income and expenses through structured exercises.	7.1. Exercise on Mapping and Analyzing Family Income and Expenses	2	CO5
8	**LLO 8.1**: Apply their knowledge of interest rate calculation to real-world financial situations, improving decision-making skills.	8.1 Exploring Simple and Compound Interest: A Hands-On Exercise on Interest Rate Calculation and Its Impact on Savings and Loans.	2	CO5
9	**LLO9.1:** Enhance comprehension of interest rates and their impact on financial dealings, encompassing savings accounts, Fixed Deposits (FDs), and loans.	9.1 Interest Rate Comparison Exercise: Analyzing Rates for Savings, Fixed Deposits, and Loans.	2	CO5
10	**LLO10.1:** Mastering and implementing safety protocols for ensuring secure ATM transactions.	10.1 Safety Precautions for ATM Usage: Exploring Tips for Secure Transactions	2	CO5

Note: Out of the above suggestive LLOs –

1. A judicial mix of LLOs is to be performed to achieve the desired outcomes

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

SELF-LEARNING - MICRO PROJECT/ASSIGNMENT/ACTIVITIES (ANY ONE)

The following list provides examples of activities that can be pursued under the program. Each group has the flexibility to choose from these options or undertake any other activity deemed suitable based on local requirements. The group focuses on the holistic development of the selected area, whether it is a village or a slum.

a) Community clean-up drives

Group tasks for community clean-up drives are,

1. Site Survey and Planning: Identify areas needing attention and plan tasks.
2. Logistics Management: Coordinate supply distribution to volunteers.
3. Volunteer Coordination: Welcome, register, and assign tasks to volunteers.
4. Trash Collection and Segregation: Collect and sort waste into categories.
5. Street Sweeping and Cleaning: Sweep and clean streets, sidewalks, and public areas.
6. Beautification and Landscaping: Enhance aesthetics by planting and trimming.

7. Safety and First Aid: Ensure volunteer safety and manage emergencies.
8. Documentation and Reporting: Capture progress through photos and reports.
9. Community Engagement: Educate and raise awareness among residents.
10. Post-Clean-up Evaluation: Review success and plan future initiatives.

b) Tree plantation initiatives

Group tasks for Tree plantation initiatives,

1. Community Awareness: Workshops to educate on tree benefits.
2. Community Participation: Engage locals in all planting
3. Team Building: Group activities to strengthen community bonds.
4. Leadership Development: Empower individuals to lead initiatives.
5. Communication Workshops: Enhance effective messaging.
6. Problem-solving Discussions: Address planting challenges.
7. Environmental Responsibility: Foster care for green spaces.
8. Cultural Integration: Incorporate local traditions into initiatives.
9. Sustainability Education: Teach sustainable planting practices.
10. Monitoring and Evaluation: Assess impact and plan improvements.

c) Environmental conservation awareness

Group tasks for Environmental conservation awareness

1. Educational Workshops: Teach about conservation methods.
2. Art Competitions: Promote environmental themes through art.
3. Street Plays: Perform interactive skits in public spaces.
4. Awareness Walks: Organize marches with environmental messages.
5. Tree Plantation: Plant trees to enhance green spaces.
6. Clean-up Campaigns: Remove litter from local areas.
7. Guest Lectures: Invite experts to discuss environmental issues.
8. Film Screenings: Show documentaries on conservation topics.
9. Social Media Campaigns: Spread awareness through online platforms.
10. Community Workshops: Educate on waste management and sustainability.

d) Health and sanitation programs

1. Health Education Sessions: Conduct informative sessions on hygiene, disease prevention, and nutrition.
2. Sanitation Infrastructure Evaluation: Assess the effectiveness of existing sanitation facilities and propose improvements.
3. Community Clean-up Events: Organize collective efforts to clean and maintain public spaces for better health outcomes.
4. Distribution of Hygiene Kits: Provide essential hygiene items such as soap, toothpaste, and sanitary products to community members.
5. Vaccination Drives: Coordinate vaccination campaigns to protect against prevalent diseases and promote community health.
6. Water Quality Testing: Conduct regular testing of water sources to ensure safe drinking water for residents.
8. Personal Hygiene Workshops: Offer workshops focusing on personal grooming, handwashing techniques, and menstrual hygiene.
9. First Aid Training: Provide basic first aid training to community members to equip them with life-saving

skills.

10. Community Health Surveys: Conduct surveys to assess health needs and gather feedback for future program planning.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No.	Equipment Name with Broad Specifications	Relevant LLO Number
1	Basic engineering measurement instruments, GPS data collection devices, and open-sour GIS software like Google Earth and QGIS, along with the Microsoft Office suite.	ALL

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

NOT APPLICABLE

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
Formative assessment (Assessment for Learning) Report and presentation of fieldwork activities, Self- Learning (Assignment)	--

X. SUGGESTED COS- POS MATRIX FORM

NOT APPLICABLE

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	Mark Stafford Smith and Pamela Matson	Sustainable Development: Principles, Frameworks, and Case Studies	Oxford University Press, ISBN: 9780199588952
2	Katar Singh	Rural Development: Principles, Policies and Management	SAGE Publications Pvt. Ltd, ISBN:978-9351502867.
3	Anand Kumar, Asim Kumar Mandal, and R. Venkata Rao	Maharashtra: Governance and Development"	Routledge India, ISBN: 978-0367709133
4	Dalai Lama and Howard C. Cutler	The Art of Happiness	Riverhead Books, and the ISBN: 978-1594488894.
5	Stephen R. Covey	The 7 Habits of Highly Effective People	Simon & Schuster, ISBN : 978-1982137274.
6	Local college students, UMA staff	Sample Case Studies on the UMA website	IITB-UMA team

XI. LEARNING WEBSITES & PORTALS

Sr.No.	Link/Portal	Description
1	https://www.ugc.gov.in/pdfnews/4371304_LifeSKill_JeevanKaush al_2023.pdf	UHV: UGC Course on life skills. Unit 4 i.e. Course 4 is to be referred
2	https://nss.gov.in/	The National Service Scheme (NSS) website provides information about the NSS program in India. It includes details about the objectives, history, and structure of NSS. Additionally, the website offers resources for NSS volunteers and coordinators, such as program guidelines, training materials, and reports.
3	https://gr.maharashtra.gov.in/Site/Upload/Government%20Resolutions/English/20160113150152380 8.pdf	Government Resolution of Government of Maharashtra regarding Unnat Maharashtra Abhiyan
4	https://gr.maharashtra.gov.in/Site/Upload/Government%20Resolutions/English/20160615145407370 8.pdf	Government Resolution of Government of Maharashtra regarding Unnat Maharashtra Abhiyan Guidelines
5	https://www.humanvaluesfoundation.com/.	The Human Values Foundation website offers educators resources for teaching human values and social-emotional learning to children and youth. It provides curriculum-based programs, lesson plans, and activities to foster character development, resilience, and positive behaviour. Additionally, the website shares insights into the foundation's mission, values, and the global impact of its programs in schools.

Name & Signature: **Mr. S.B.Kulkarni** Lecturer in Mechanical Engineering **(Course Experts)**	
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GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**MATERIAL TESTING & QUALITY ASSURANCE**
COURSE CODE	**MT31202**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT31202	MATERIAL TESTING & QUALITY ASSURANCE	SEC	04	--	04	--	08	4	3	30	70	100	40	25	10	25#	10	--	--	150

Total IKS Hrs for Term: 0 Hrs

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4. **1 credit** is equivalent to **30 Notional hours**.
5. * Self-learning hours shall not be reflected in the Timetable.

6.* Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

Engineers use different materials for various engineering purposes. These materials and solid objects are subjected to various kinds of forces and stresses during service and often involve the risk of breaking in service and in that situation, they cannot be welded or molded instantly. It may take a long to further rework the same to give them shape or they may not be re-shaped at all. Hence, it is necessary to make the material and objects strong enough. To ensure this, these solid objects require various types of destructive and non-destructive testing during the manufacturing process so that the risk factor is reduced, facilitating durability and long-lasting capacity (or endurance).

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1 – Perform tensile and compression test on materials.

CO2 – Perform fatigue and creep test on materials.

CO3 – Perform impact test on different materials.

CO4 – Conduct different types of hardness tests on materials.

CO5 – Explain principle of various NDT methods.
CO6 – Explain various components of quality standards.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I MECHANICAL PROPERTIES OF METALS (CL Hrs-08 Marks-12)				
1	TLO 1.1 Compare the salient features TLO 1.2 Understand various loading conditions TLO 1.3 Compare elastic & plastic deformation TLO 1.4 Explain terms e.g. stress-strain, yield point etc. TLO 1.5 Explain Hooks law or modulus of elasticity TLO 1.6 Explain or compare the shear & torsion test TLO 1.7 Explain fracture mechanism & its type TLO 1.8 Explain the procedure for conducting a tensile test	1.1 A brief introduction to bonding arrangement in materials and especially in metals and alloys i.e. metallic bond 1.2 Deformation of metals under various loading conditions i.e. tensile, compressive and shear. 1.3 Elastic and plastic deformation, various terms used i.e. stress, strain, elasticity, plasticity, toughness, resilience. Stress-Strain curves, Yield point and yielding phenomenon, percentage elongation and reduction in area, proof stress. Hook's law, Modulus of elasticity, Young's modulus 1.4 Shear and torsion tests. 1.5 Fracture and its mechanism. Fracture of ductile and brittle materials. Operations with tensile testing machines, universal testing machines etc. for tensile, compressive, shear or bending strength.	Improved Lecture Tutorial Assignment Demonstration	**CO1**
UNIT-II FATIGUE TEST (CL Hrs-08, Marks-08)				
2	TLO2.1: Explain fatigue TLO 2.2:. Define repeated loading and state its types. TLO2.3: Explain fatigue strength and endurance limit. TLO2.4:. Explain the fatigue testing procedure. TLO 2.5:. Explain factors to improve fatigue properties. TLO2.6: Explain the effect of composition /surface condition/stress concentration /size on the strength of fatigue.	2.1 Concept of fatigue. Repeated loadings, and their types. 2.2 Fatigue test, fatigue strength, and endurance limit. Orowan's and Wood's theories explain fatigue failure. Effect of composition, stress concentration, size and surface conditions on fatigue strength. 2.3. Measures to be taken to improve fatigue life	Improved Lecture Tutorial Assignment Demonstration	**CO2**

UNIT III CREEP TEST (CL Hrs-08 Marks-08)				
3	TLO3.1: Explain the creep concept TLO 3.2: Explain the procedure for to creep test. TLO 3.3: Explain stages in the creep curve. TLO 3.4: Describe factors that affect on creep. TLO 3.5 Explain the relationship between creep rate, stress and temperature.	3.1 Concept of creep. Creep Test. Standard creep curve with the explanation of various stages. Effect of temperature on creep test, equi-cohesive temperature 3.2 Factors affecting creep such as composition, grain size, method of steel making and heat treatment 3.3 Relation between creep rate, stress and temperature	Improved Lecture Tutorial Assignment Demonstration	**CO2**
UNIT-IV IMPACT TESTS (CL Hrs-06, Marks-07)				
4	TLO 4.1. Explain the significance of the impact test. TLO 4.2 Give an example of a dynamic test. .TLO 4.3 Explain/Compare Charpy and Izod in terms of principle, procedure and parameter TLO 4.4 Explain the factor effect on impact strength.	4.1 Significance of impact test. 4.2 Izod and Charpy impact tests. Their specimen details, and mounting of specimens in each case. Effect of variables on the impact test values such as variation in striking velocity, size and shape of specimen, temperature, grain size and composition. 4.3 Embrittlement phenomena: temper and hydrogen embrittlement. 4.4 Impact strength- Temperature relationship and transition temperature range.	Improved Lecture Tutorial Assignment Demonstration	**CO3**
SECTION II				
UNIT- V HARDNESS TEST (CL Hrs-14, Marks-18)				
5	TLO 5.1: Explain and compare the method of hardness test TLO 5.2: Enlist and Explain various indentations. TLO 5.3: Explain the working and advantages of Brinell, Vicker, Rockwell and Knoop TLO 5.4: Draw and explain the Poldi hardness test. TLO 5.5: State principle of Micro hardness tester. TLO 5.6:Explain the principle of the universal hardness test.	5.1 Concept of hardness. Methods of hardness test, such as indentation, scratch and rebound. 5.2 Types of indentation hardness tests, such as Brinell, Vicker, Rockwell and Knoop, their indenters and measurements of hardness number. 5.3 Rebound hardness test. Shore Scleroscope. Dynamic hardness tester. Poldi Hardness Tester. 5.4 Scratch hardness test: Moh's scale of hardness, File test, Brief introduction to hardness machines and their operations. 5.5 Principle of Microhardness Tester 5.6 Introduction to universal hardness tester, working, advantages & uses.	Improved Lecture Tutorial Assignment Demonstration Simulation	**CO4**

UNIT –VI NON DESTRUCTIVE TESTING (CL Hrs-10, Marks-10)				
6	TLO 6.1: State the needs and requirements of NDT. TLO 6.2: Classify NDT. TLO 6.3: Enlist the advantages of NDT and state its type TLO 6.4: Compare NDT & DT. TLO 6.5: Explain the testing procedure of penetrant test/Magnetic method etc.	6.1 Need for non-destructive tests. Concept of nondestructive tests. 6.2 Comparison between destructive and non-destructive tests. 6.3. Introduction to various non-destructive tests such as Visual examination, Leakage testing, Penetrant test, Magnetic methods, Acoustic methods, Ultrasonic test, Radiography, Thermal tests, Electrical methods- Eddy current method.	Improved Lecture Tutorial Assignment Demonstration	**CO5**
UNIT –VII QUALITY ASPECT CL Hrs-06, Marks-07)				
7	TLO 7.1: Explain quality and state its importance. TLO 7.2: Enlist various quality standards. TLO 7.3: Explain ISO 9000 Series standards.	7.1 Concept of quality. Brief introduction to various quality standards, such as ISI, BIS and ISO. A brief introduction to ISO 9000 series standards. 7.2 Standard method/procedure for mechanical testing. 7.3 Validation method /procedure for mechanical testing.	Improved Lecture Tutorial Assignment Demonstration	**CO6**

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1: (a) Calculate Tensile strength, and compressive strength using UTM. (b) Calculate % elongation & reduction in area. (c) identify types of fracture.	To carry out tensile tests on mild steel and aluminium.	08	CO1
2	LLO 2.1: Study behaviour of stress-strain curve of ductile & brittle materials.	To draw a stress-strain curve. To interpret the curve concerning the applicability of materials.	08	CO1
3	LLO 3.1: Familiar with ASTM standards & procedures to conduct the tensile test.	To acquaint with various tensile test machines.	08	CO1
4	LLO 4.1: Perform fatigue test using fatigue testing machine.	To carry out fatigue tests on mild steel and aluminium specimens	08	CO2
5	LLO 5.1: Perform Creep test using fatigue testing machine.	To study creep test. Interpretation of test results.	08	CO2
6	LLO 6.1 Perform charpy or izod impact test on the given specimen.	To carry out impact tests on brass, aluminium and copper specimens.	08	CO3
7	LLO 7.1: perform hardness test using the standard procedure on different hardness machines.	To carry out hardness tests on samples using Vicker, Brinell, Rockwell and Poldi Hardness Testers.	08	CO4

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
8	LLO 8.1: Perform dye penetraint test on a common component.	To carry out dye penetrant test and magnetic particle test.	04	CO5

VI.SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

Micro project

- Mechanical properties of metal: Collect data on the mechanical properties of different metals & alloys. Make a pdf file.
- **Hardness Test**: Collect data about standards, indentor, working procedure & calibration of hardness test.
- **Impacct Test**: Prepare a Charpy test below zero temperature set-up.
- **Fatigue Test**: Collect data on component/job under constant cyclic load & plot a graph to measure endurance limit.
- **Creep Test**: Prepare a standard procedure & plot a graph to measure the creep of components.
- **Non-Destructive Test**: Collect all information about anyone NDT.
- **Quality assurance** Study the effect of quality policy on quality of work with one suitable example.

Assignment

- Collect examples based on various properties of metals & alloys and prepare a PDF file.
- Collect examples of various hardness testing methods and prepare a PDF file.
- Represent the Graph of the stress-strain curve of ductile metals and interpret the nature of the graph. Make a PDF file.
- Measure the impact strength of different alloys using the Charpy method. Make a PDF file.
- Study fatigue failure and factors to control fatigue failure.
- Study fatigue Creep and factors to control Creep failure.
- Collect at least 10 examples based investigation of the component using NDT.
- Collect at least 10 examples based on Quality policy.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	UTM 40 T, V.C., Gauge length marker	LLO 1.1 to LLO 3.1
2	Fatigue testing machines-Rotating beam	LLO 4.1
3	Creep Testing setup	LLO 5.1
4	Impact Tester – Charpy or Izod	LLO 6.1
5	Vicker, Brinell, Rockwell and Poldi Hardness Testers.	LLO 7.1
6	DPT Setup and MPT Setup,	LLO 8.1

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
SECTION I								
1	I	MECHANICAL PROPERTIES OF METALS	CO1	08	04	04	04	12
2	II	FATIGUE TEST	CO2	08	04	02	02	08
3	III	CREEP TEST	CO2	08	04	02	02	08
3	III	IMPACT TESTS	CO3	06	03	02	02	07
			Grand Total	30	15	10	10	35
SECTION II								
4	IV	HARDNESS TEST	CO4	14	06	06	06	18
6	V	NON DESTRUCTIVE TESTING	CO5	10	04	03	03	10
7	VI	QUALITY ASPECT	CO6	06	02	02	03	07
			Grand Total	**30**	**12**	**11**	**12**	**35**

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Tests 2. Rubrics for COs 3. Assignment 4. Midterm Exam 5. Self-Learning 6. Term Work 7. Seminar/Presentation	1. End Term Exam 2. Micro-project 3. Tutorial Performance

X. SUGGESTED COS- POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes *(PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	2	2	1	2	1	-	1	2	2	1	1
CO2	3	2	3	3	1	2	2	2	3	2	1
CO3	2	2	1	2	1	2	2	2	3	1	1
CO4	2	2	2	2	1	-	2	1	3	2	1
CO5	2	2	2	2	1	1	2	2	2	1	2
CO6	2	1	1	1	1	1	1	1	1	1	1

Legends:- High:03, **Medium:**02, **Low:**01, **NoMapping:** -
*PSOs are to be formulated at the institute level

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	George E. Dieter	Mechanical Metallurgy	McGraw-Hill Book Company
2	Davis, Troxell and Wiskonell	Testing and Inspection of Engineering materials	McGraw-Hill Book Company
3	A.V.K. Suryanarayan	Testing of Metallic Materials	Prentice-Hall of India Pvt Ltd
4	Dr. V.D.Kodgire	Material Science And Metallurgy	Everest Publishing House

XII. LEARNING WEBSITES & PORTALS

Sr.No	Link/Portal	Description
1.	https://www.youtube.com/watch?v=Ugfr_ULp2HM	Mechanical behaviour of metal: stress-strain curve, Elastic, plastic limit, yield strength, proof stress etc
2.	https://www.youtube.com/watch?v=pLt-MaxKW0o	Working on fatigue testing machine
3.	https://www.youtube.com/watch?v=FztoEU87B90	Explanation of creep test.
4.	https://www.youtube.com/watch?v=tpGhqQvftAo	The procedure of the Charpy impact test.
5.	https://www.youtube.com/watch?v=i1x-vJ85sBA	Rockwell hardness test
6.	https://www.youtube.com/watch?v=7Z90OZ7C2jI	Vickers hardness test
7.	https://www.youtube.com/watch?v=RJXJpeH78iU	Brinell Hardness test
8.	https://www.youtube.com/watch?v=QqmSzUxnrXo	Dye penetrant test

Name & Signature: Pkamble **Mr. Pravin B. Kamble** (Course Experts)	
Name & Signature: Nkadam **Smt.Namita S Kadam** (Programme Head)	Name & Signature: **Shri. Sudin B Kulkarni** (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**STEEL MAKING**
COURSE CODE	**MT31205**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS ECLARATION COURSE	**NO**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration Hrs.	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT31205	STEEL MAKING	DSC	4	--	2	--	6	3	3	30	70	100	40	25	10	25@	10	--	-	150

Total IKS Hrs for Term: 2 Hrs

Abbreviations: CL-Classroom Learning, **TL**-Tutorial Learning, **LL**-Laboratory Learning, **SLH**-Self Learning Hours, **NLH**-Notional Learning Hours, **FA** - Formative Assessment**, SA** -Summative assessment, **IKS** – Indian Knowledge System, **SLA**- Self Learning Assessment

Legends: @-Internal Assessment, # - External Assessment, *# - Online Examination, **@$** - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

1. If a candidate is not securing minimum passing marks in **FA-PR** (Formative Assessment - Practical) of any course, then the candidate shall be declared as **'Detained'** in that course.
2. If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as **'fail'** and will have to repeat and resubmit SLA work.
3. **Notional learning hours** for the semester are **(CL + LL + TL + SL) hrs. * 15 Weeks**
4. **1 credit** is equivalent to **30 Notional hours**.
5. * Self-learning hours shall not be reflected in the Timetable.
6. * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

Steel is one of the most important materials. Applications of steel are much more. The use of steel is much more for construction as well as manufacturing industries. Because of this, knowledge of various methods of steelmaking is very much essential for metallurgists. In this course, the emphasis is given to the principles of steelmaking and different processes of steelmaking.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1. Understand the necessity of conversion of pig iron into steel.
CO2. Understand the principles of steel making to obtain quality steel.
CO3. Select proper raw materials for steel production.
CO4. Recommend suitable methods of production for different types of steel.
CO5. Understand the importance of oxygen addition in steel production and the role of secondary steel making.
CO6. Identify various components of various continuous casting machines

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I INTRODUCTION CL (Hrs- 06, Marks- 08)				
1	TLO 1 Write down the history of steel making. TLO 2. Give classification of steels. TLO 3 States the necessity of conversion of pig iron into steel. TLO 4 . Enumerate various raw materials for steel making. TLO 45State status of different iron and steel industries in India.	1.1 History of steel making. 1.2 Classification of steels. 1.3 Necessity of conversion of pig iron into steel. 1.4 Raw materials for steel making: a. Sources of metallic iron, b. Oxidizing agent, c. Fluxes, d. Sources of heat, e. Deoxidisers and alloying additions, f. Furnace Refractories. 1.5 Present status of iron and steel industries in India.	Lecture Assignment	**CO1**
UNIT-II PRINCIPLES OF STEEL MAKING (CL Hrs- 06, Marks- 08)				
2	TLO 2.1 TLO 2 Use concepts given in Ancient Indian Metallurgy for metal extraction. TLO 2.2 Explain the classification of fuels. TLO 2.3 Explain factors for the selection of fuels. TLO 2.4 Explain the properties of fuels. TLO 2.5 Distinguish between solid, liquid and gaseous fuels.	2.1 Principles of steel making: a. Carbon reaction, b. Phosphorous reaction, c. Silicon reaction, d. Manganese reactions, e. Sulphur reaction, f. De-oxidation of steel. 2.2 Types of steel-making processes- Acid and basic steel making. 2.3 Efficiency of steel-making processes	Lecture Assignment	**CO2**
UNIT-III STEEL MAKING PROCESS (CL Hrs- 18, Marks- 20)				
3	TLO 3.1 Describe the Bessemer process and open hearth process. TLO 3.2. Describe the operation of an electric arc and induction furnace. TLO 3.3. Draw a neat sketch of the Bessemer, open hearth, electric arc and induction furnace. TLO 3.4. Describe constructional details of the Bessemer, open hearth and electric arc furnace. TLO 3.5. Compare characteristics of steel produced by the Bessemer process with the open hearth process.	3.1 Bessemer process - Principle, constructional details, process details, merits and demerits, characteristics of steel produced. 3.2 Open-hearth process - Principle, constructional details, process details, merits and demerits, characteristics of steel produced, twin hearth furnace. 3.3 Electric steel-making processes: a. Electric arc furnace: Principle, constructional details, charge materials, process detail, outline, merits and demerits, characteristics of steel produced. b. Induction furnace: Principles, charge materials, merits and demerits of process, characteristics of steel produced.	Lecture Assignment Videos	**CO3**

UNIT-IV OXYGEN STEELMAKING PROCESSES (CL Hrs- 10, Marks- 12)				
4	TLO 4.1. State the principle of steel making in the L.D. converter, Kaldo process, Rotor process and OBM process. TLO 4.2. Describe the constructional details of the L.D. converter. TLO 4.3. Describe the operation of L.D. converter, Kaldo process, Rotor process and OBM process. TLO 4.4. Draw the sketches of L.D. converter, Kaldo process, Rotor process and OBM process. TLO 4.5. State merits, demerits and characteristics of steel produced by L.D. converter, Kaldo process, Rotor process and OBM process. TLO 4.6. Draw plant layout of primary steel-making	4.1 L.D. Converter - Principle, constructional details, process details, outline, merits and demerits, characteristics of steel produced. 4.2 Kaldo process - Principle, process, merits and demerits, characteristics of steel produced. 4.3 Rotor Process - Principle, process, merits and demerits, characteristics of steel produced. 4.4 OBM Process - Principle, process, merits and demerits, characteristics of steel produced. 4.5 Plant layout of primary steel-making.	Lecture Assignment videos	**CO4**
UNIT-V SECONDARY STEEL MAKING (CL Hrs- 12, Marks- 14)				
5	TLO 5.1. State the merits of secondary steel making. TLO 5.2. Describe various decarburizing techniques. TLO 5.3. Describe VAR and ESR. TLO 5.4. Draw a ladle furnace and explain its working. TLO 5.5 Explain the various degassing techniques with a neat sketch. TLO 5.6 Draw plant layout of secondary steel making.	5.1 Introduction and merits of the secondary steel-making process. 5.2 Decarburization techniques - AOD, VOD, CLU. 5.3 VAR and ESR processes. 5.4 Ladle furnace. 5.5 Vacuum Treatment of Steel – Functions, principles, Degassing techniques: a. Ladle degassing b. Stream degassing c. Recirculation degassing –R.H. and D-H degassing processes. 5.6 Plant layout of secondary steel making.	Lecture Assignment	**CO5**
UNIT-VI CONTINUOUS CASTING OF STEEL (CL Hrs- 08, Marks- 08)				
6	TLO 6.1. State principle of continuous casting. TLO 6.2. Describe the essential details of a continuous casting machine. TLO 6.3. Compare different continuous casting machines. 6d. State the merits and demerits of continuous casting.	6.1 State principle of continuous casting. 6.2 Describe the essential details of a continuous casting machine. 6.3 Compare different continuous casting machines. 6.4 State the merits and demerits of continuous casting.	Lecture Assignment videos	**CO6**

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Explain the classification of steel.	Study of classification of steel	2	CO1
2	LLO 2.1 Explain the construction and working of the Bessemer converter.	Study of construction and working of Bessemer converter.	2	CO1
3	LLO 3.1 Explain the construction and working of an open-heart furnace.	Study of construction and working of open-heart furnace.	4	CO2
4	LLO 4.1 Explain the construction and working of an Electric Arc furnace.	Study of construction and working of Electric Arc furnace.	2	CO3
5	LLO 5.1 Explain the construction and working of the Induction furnace	Study of construction and working of Induction furnace	2	CO3
6	LLO 6.1 Explain the construction and working of the LD Converter.	Study of construction and working of LD Converter.	2	CO3
7	LLO 7.1 Explain the working principle of the Kaldo and Rotor process.	Study of working principle of Kaldo and Rotor process.	2	CO4
8	LLO 8.1 Explain Decarburization techniques - AOD, VOD, CLU.	Study of Decarburization techniques - AOD, VOD, CLU.	2	CO4
9	LLO 9.1 Explain various types of continuous casting machines	Study various types of continuous casting machines	4	CO6
10	LLO 10.1 Explain the Plant layout of primary steel making.	Draw Plant layout of primary steel making.	4	CO5
11	LLO 11.1 ExplainPlant layout of secondary steel making	DrawPlant layout of secondary steel making.	4	CO5

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

- Prepare a tabulated summary for various steel making process
- Collect the information on the present scenario of steel industries in India.
- Prepare the poster of the layout of the modern steel plant.
- Gather the data of modern techniques of steel making.
- Prepare the sheets of various steel-making furnaces.
- Prepare the poster of the continuous casting machine.
- Prepare the report on Ancient Steel making.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of Bessemer converter.	LLO 2.1
2	Model of Open - hearth furnace.	LLO 3.1
3	Model of Electric Arc furnace.	LLO 4.1
4	Model of Induction furnace	LLO 5.1
5	Drawing board Chart of primary steel making.	LLO 9.1
6	Drawing board Chart secondary steel making	LLO 10.1
7	Drawing board Chart Continuous casting machines	LLO 11.1

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	INTRODUCTION	CO1	06	2	6	--	08
2	II	PRINCIPLES OF STEEL MAKING	CO2	06	2	4	2	08
3	III	STEEL MAKING PROCESSES	CO3	18	4	8	8	20
4	IV	OXYGEN STEEL MAKING	CO4	10	2	6	4	12
5	V	SECONDARY STEEL MAKING	CO5	12	2	8	4	14
6	VI	CONTINUOUS CASTING OF STEEL	CO6	08	2	4	2	08
Grand Total				**60**	**14**	**36**	**20**	**70**

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Unit Tests: Average of two unit tests (30 marks) 2. Term Work: FA-PR (25 marks) 3. Self-Learning: SLA (25 marks)	1. End Term Exam: SA-TH (70 marks) 2. End Term Exam: SA-PR (25 marks)

X. SUGGESTED COs- POs MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	3	1	1	1	2	1	2	3	--	--	2
CO2	3	1	2	1	1	1	1	3	--	--	2
CO3	3	2	2	1	1	2	2	3	--	--	3
CO4	3	1	2	2	2	2	2	3	--	--	3
CO5	2	2	2	1	1	1	2	3	--	--	2
CO6	3	1	2	1	1	1	2	3	--	--	2
Legends:- High: 03, **Medium:** 02, **Low:** 01, **No Mapping:** --											

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr. No	Author	Title	Publisher
1	Dr. R.H. Tupkary, V.R. Tupkary	An Introduction to Modern Iron Making	Khanna Publication, 4th Edition, 2016. 978-81-7409-021-5
2	Dr. R.H. Tupkary, V.R. Tupkary	An Introduction to Modern Steel Making	Khanna Publication, 7th Edition, 2017. 978-81-7409-026-6
3	Boris Kuznetsov	General Metallurgy	Mir Publishers, Moscow, 2nd Edition, 1979. 5-03-000026-7

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://nptel.ac.in/courses/113/104/113104013/	Steel-making
2	https://nptel.ac.in/courses/113/107/113107096/	Modelling of Tundish Steel-making
3	https://www.steel.org/steel-technology/steel-production	Steel production.

Name & Signature:

Mrs. Sarika Satish Aglave
Lecturer in Metallurgical Engineering
(Course Expert)

Name & Signature:	Name & Signature:
Mrs. Namita S. Kadam (Programme Head)	**Mr. Sudin B Kulkarni** (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**POWDER METALLURGY**
COURSE CODE	**MT41202**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS DECLARATION COURSE	**NO**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration Hrs.	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT41202	POWDER METALLURGY	DSC	3	--	2	1	6	3	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Term: 0 Hrs

Abbreviations: CL-Classroom Learning, **TL**-Tutorial Learning, **LL**-Laboratory Learning, **SLH**-Self Learning Hours, **NLH**-Notional Learning Hours, **FA** - Formative Assessment**, SA** -Summative assessment, **IKS** – Indian Knowledge System, **SLA**- Self Learning Assessment

Legends: @-Internal Assessment, **#** - External Assessment, ***#** - Online Examination, **@$** - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

1. If a candidate is not securing minimum passing marks in **FA-PR** (Formative Assessment - Practical) of any course, then the candidate shall be declared as '**Detained**' in that course.
2. If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as '**fail**' and will have to repeat and resubmit SLA work.
3. **Notional learning hours** for the semester are **(CL + LL + TL + SL) hrs. * 15 Weeks**
4. **1 credit** is equivalent to **30 Notional hours**.
5. * Self-learning hours shall not be reflected in the Timetable.
6. * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

Powder metallurgy is one of the important techniques of manufacturing metallic components used in several fields of engineering like automotive, atomic energy, defence, high-temperature technology etc. This course deals with the production, testing, blending, and compaction of metal powders and sintering. It also included the manufacturing of various powder metallurgical products.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1: Compare the powder metallurgy method with other manufacturing processes.
CO2: Produce the metal powder with some metal powder production processes.
CO3: Measure different properties of powders using various tests.
CO4: Select the appropriate compaction process for a particular application.
CO5: Understand the mechanism of sintering.
CO6: Draw the flowsheet for manufacturing various powder metallurgical products.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I INTRODUCTION TO POWDER METALLURGY (CL Hrs-02, Marks-06)				
1	TLO 1.1 State the principle of powder metallurgy. TLO 1.2 State the applications, advantages and limitations of powder metallurgy. TLO 1.3 Compare the powder metallurgy method with other manufacturing processes. TLO 1.4 Enlist five powder metallurgical companies in India.	1.1 Principle of powder metallurgy, its applications, advantages and limitations. 1.2 Comparison of powder method with other shaping or forming methods of production. 1.3 Scope of powder metallurgy in industry.	Lecture Assignment	**CO1**
UNIT-II METAL POWDER PRODUCTION (CL Hrs-07, Marks-14)				
2	TLO 2.1 Enumerate metal powder production methods. TLO 2.2 Explain the working principle of the mentioned powder production methods. TLO 2.3 Sketch the milling and atomization processes.	2.1 Classification of Metal Powder Production Methods. 2.2 Various methods of metal powder production such as: a. Machining, b. Crushing, c. Milling, d. Atomization, e. Condensation, f. Thermal Decomposition, g. Reduction,	Lecture Assignment	**CO2**
UNIT-III CHARACTERISTICS AND TESTING OF METAL POWDERS (CL Hrs-08, Marks-10)				
3	TLO 3.1 Explain coning and quartering. TLO 3.2 Explain particle size measurement techniques with a neat sketch. TLO 3.3 State the importance of particle shape, size, and size distribution. TLO 3.4 Draw Hall Flow meter. TLO 3.5 Measure apparent and tap densities. TLO 3.6 Measure flow rate. TLO 3.7 Define Compressibility, compatibility, specific surface, and green strength.	3.1 Sampling – Coning and Quartering. 3.2 Particle size measurement – Sieving method, Sedimentation and decantation method, Elutriation method. 3.3 Particle shape and size distribution, its measurement, Hall flow meter. 3.4 Density of metal powders- Apparent density and its measurement, tap density and its measurement. 3.5 Flow rate and its measurement. 3.6 Definitions – Compressibility, compatibility, specific surface, green strength.	Lecture Assignment	**CO3**

UNIT-IV POWDER CONDITIONING AND COMPACTION (CL Hrs-10, Marks-16)				
4	TLO 4.1 Describe the role of powder conditioning and blending. TLO 4.2 State the purpose of powder compaction. TLO 4.3 Classify powder compaction methods. TLO 4.4 Describe the various pressureless shaping techniques. TLO 4.5 Describe the mechanism of the cold pressure shaping technique. TLO 4.6. State roles of lubrication. TLO 4.7 Enlist properties of dies and materials for dies. TLO 4.8 Describe the working of presses. TLO 4.9 Explain the working of different types of cold compaction and pressure shaping techniques with heat. TLO 4.10 Explain the principle of additive manufacturing. TLO 4.11 Describe Metal Injection Molding of Ti Powder.	4.1 Powder conditioning – Preliminary heat treatment, blending process. 4.2 Powder compaction: Classification of powder compaction a. Pressureless shaping techniques: Loose sintering, slip casting, slurry casting. b. Cold pressure shaping techniques: Mechanism, role of lubrication, die materials and its properties, Die compaction technique and its types- Single action compaction and double sction compaction. Cold isostatic pressing. c. Pressure shaping technique with heat: Hot pressing, sinter forging, hot rolling, hot isostatic compaction. 4.3 3D Printing- Additive Manufacturing: Introduction, principle, classification, advantages, limitations and applications. Comparison between additive and conventional manufacturing processes. 4.4 Metal Injection Molding of Ti Powder.	Lecture Assignment	**CO4**
UNIT-V SINTERING (CL Hrs- 06, Marks- 10)				
5	TLO 5.1 State the principle and purpose of sintering. TLO 5.2 Explain the stages of sintering and its mechanism. TLO 5.3 Define liquid phase sintering. TLO 5.4 Describe the stages of liquid phase sintering, TLO 5.5 Describe the construction of a sintering furnace and its atmosphere. TLO 5.6 Classify sintering furnaces. TLO 5.7 Describe sizing, coining and impregnation.	5.1 Sintering – Principle, purpose. 5.2 Stages of sintering. 5.3 Mechanism of sintering. 5.4 Liquid phase sintering – Definition, stages, advantages. 5.5 Sintering Furnace – Construction, classification, atmosphere. 5.6 Post sintering operations- sizing, coining, impregnation.	Lecture Assignment	**CO5**
UNIT-VI APPLICATIONS (CL Hrs- 12, Marks- 14)				
6	TLO 6.1 State the applications and properties of bearing, friction and tool materials. TLO 6.2 State the applications of ferrites	6.1 Bearing Materials – Applications, properties, methods of production, oil-impregnated bearings. 6.2 Friction Materials - Applications, properties, methods of production,	Lecture Assignment	**CO6**

	TLO 6.3 Describe the production of bearing, friction, tool and ferrites materials.	formulation. 6.3 Tool Materials - Applications, properties, and production of cemented carbide. 6.4 Ferrites – Applications, production.		

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Explain powder metallurgy advantages, limitations and applications	To study powder metallurgy advantages, limitations and applications.	2	CO1
2	LLO 2.1 Explain various metal powder manufacturing processes.	Study various metal powder manufacturing processes.	2	CO1
3	LLO 3.1 Measure size distribution of metal powder by sieving method.	Measure the size distribution of metal powder by the sieving method.	4	CO2
4	LLO 4.1 Perform metallography to explain powder particle shape.	To study powder particle shape by metallography.	4	CO3
5	LLO 5.1 Calculate apparent density of metal powder	Calculate the apparent density of metal powder	2	CO3
6	LLO 6.1 Calculate tap density of metal powder	Calculate the tap density of metal powder	2	CO3
7	LLO 7.1 Calculate flow rate of metal powder.	Calculate the flow rate of metal powder.	2	CO4
8	LLO 8.1 Explain various types of die compaction techniques.	Study various types of die compaction techniques.	2	CO4
9	LLO 9.1 Explain sintering of compacted products.	Study sintering of compacted products.	2	CO5
10	LLO 10.1 Draw the flow sheets for the production of bearings, friction materials and Sintered Cemented Carbides.	Draw the flow sheets for the production of bearings, friction materials and Sintered Cemented Carbides.	4	CO6
11	LLO 11.1 Metallography of common powder metallurgical components.	Metallography of common powder metallurgical components.	4	CO6

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

Microproject:

- Prepare the flowsheet for the production of particular applications by powder metallurgy process.
- Search for information about presses for compaction.
- Collect information on new developments in powder metallurgy.
- To prepare a paper model for the Production of metal powder by any one method.
- To prepare a chart for the Compaction of powder with any one method of pressureless technique.
- Prepare the flowsheet for compaction of powder with any one method of cold pressure shaping technique.
- Prepare the flowsheetCompaction of powder with any one method of pressure shaping technique with heat.
- To prepare a chart diagram for the construction, working and atmospheres of a sintering furnace.
- Draw the detailed flow sheet of production of any one powder metallurgy application and explain it.

Assignment

1. List the basic steps in Powder Metallurgy.
2. Write about the mechanism of milling for metal powder production.
3. Enumerate the variables affecting the process of mixing metal powders.
4. Brief about the major metal powder characteristics.
5. Describe, a) apparent density b) compression ratio
6. Describe rapid sintering methods.
7. Detail about applications of powder rolling.
8. Outline the various post-sintering operations adopted in powder metallurgy.
9. Explain the powder extrusion process.
10. Illustrate the different mechanical methods of metal powder production.
11. Explain the various methods used in determining the following powder particle characteristics: i) Particle size and ii) Porosity. iii) Surface area. iv) Particle density.
12. Explain the different pressureless powder shaping methods.
13. Differentiate between the various Mechanical and thermal methods of powder compaction
14. Discuss sintering furnaces, the atmospheres and the various factors to be considered in their selection.
15. Explain the various types of high-temperature compaction processes
16. Suggest manufacturing method to make the following components by powder metallurgy
    a. Porous bearings b. Electrical contact materials c. Friction materials d. Composites
17. Paraphrase the application of powder metallurgy products in automobile and power generation industries.
18. Comparison between products manufactured by additive manufacturing (3D printing) and conventional methods

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Sieves Shaker, Metal Powder, Stop Watch, Weighing Machine	3-7
2	Hall-Flow Meter, Density Cup, Stand, Weighing Machine	5-7
3	Metallurgical microscope	4,11
4	Standard specimen of common powder metallurgical components for microscopic observation	11

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE

(Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	INTRODUCTION	CO1	02	02	02	02	06
2	II	METAL POWDER PRODUCTION	CO2	07	02	08	06	14
3	III	CHARACTERISTICS AND TESTING OF METAL POWDERS	CO3	08	02	04	04	10
4	IV	POWDER CONDITIONING AND COMPACTION	CO4	10	02	06	08	16
5	V	SINTERING	CO5	06	04	06	02	10
6	VI	APPLICATIONS	CO6	12	02	02	06	14
Grand Total				**45**	**14**	**28**	**28**	**70**

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Unit Tests: Average of two unit tests (30 marks) 2. Term Work: FA-PR (25 marks) 3. Self-Learning: SLA (25 marks)	1. End Term Exam: SA-TH (70 marks) 2. End Term Exam: SA-PR (25 marks)

X. SUGGESTED COs- POs MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	3	1	1	1	1	2	2	3	-	1	1
CO2	3	1	2	2	1	2	2	3	1	1	2
CO3	3	3	3	3	1	2	2	3	3	1	2
CO4	3	2	2	1	2	2	2	3	1	1	2
CO5	3	2	2	1	1	1	1	3	-	1	1
CO6	3	2	2	1	1	3	2	3	-	1	2
Legends:- High: 03, **Medium:** 02, **Low:** 01, **No Mapping:** -											

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr. No	Author	Title	Publisher
1	A.K. Sinha	Powder Metallurgy	Dhanpat Rai Publications. ISBN-10 : 9383182148 ISBN-13 : 978-9383182145
2	V.D. Kodgire	Material Science and Metallurgy for Engineers	Everest Publishing House. ISBN-10: 8186314008 ISBN-13: 978-8186314005
3	G. S. Upadhyaya	Powder Metallurgy: Science, Technology and Materials	Cambridge International Science Publishing Ltd ISBN-13: 9781138075016 ISBN-10: 1138075019
4	P.C.Angelo, R.Subramaniam	Powder Metallurgy: Science, Technology and Applications	Prentice Hall India Learning Private Limited ISBN : 9789391818487

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://youtu.be/uRVaLUQUmA8?si=ibTwB1IwKysHoYIp	Powder Metallurgy - 1
2	https://www.youtube.com/watch?v=oDA3aIDmkv8	Powder manufacture and characteristics.
3	https://youtu.be/H8wxmJoJW8M?si=Lsq06ULY_eN5zJu6	Sintering furnace mechanism/

Name & Signature: **Mrs. Sarika S. Aglave** Lecturer in Metallurgical Engineering (Course Expert)	
Name & Signature: **Mrs. Namita S. Kadam** (Programme Head)	Name & Signature: **Mr. Sudin B. Kulkarni** (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**FOUNDRY ENGINEERING**
COURSE CODE	**MT41203**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT41203	FOUNDRY ENGINEERING	DSC	04	--	02	02	08	4	3	30	70	100	40	--	--	25#	10	25	10	150

Total IKS Hrs for Term: 01 Hrs

Abbreviations: CL-Classroom Learning, **TL**-Tutorial Learning, **LL**-Laboratory Learning, **SLH**-Self Learning Hours, **NLH**-Notional Learning Hours, **FA** - Formative Assessment**, SA** -Summative assessment, **IKS** – Indian Knowledge System, **SLA**- Self Learning Assessment

Legends: @-Internal Assessment, **#** - External Assessment,***#** - Online Examination,**@$** - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

1. If a candidate is not securing minimum passing marks in **FA-PR** (Formative Assessment - Practical) of any course, then the candidate shall be declared as '**Detained**' in that course.
2. If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as '**fail**' and will have to repeat and resubmit SLA work.
3. **Notional learning hours** for the semester are **(CL + LL + TL + SL) hrs. * 15 Weeks**
4. **1 credit** is equivalent to **30 Notional hours**.
5. * Self-learning hours shall not be reflected in the Timetable.

6.* Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

The Metallurgical engineer who is supposed to work as metallurgist or methods Engineer in foundry industries come across specialized foundry processes. He should be able to work as a supervisor for various processes. These processes have been developed depending upon the quantity of castings to be produced, surface quality required, dimensional accuracy achieved, metal cast etc.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1 – Enlist various pattern materials and identify different types of patterns.
CO2 – Explain various sand molding processes.
CO3 – Select a casting method for producing a sound and defect free casting.
CO4 – Draw and explain different types of melting furnaces.
CO5 – Select a molding process for a given application.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
		SECTION I		
		UNIT-I INTRODUCTION (CL Hrs-04 Marks-06)		
1	TLO 1.1 Explain the status of Foundry in ancient India. TLO 1.2 State the importance of foundry engineering. TLO 1.3 Compare casting process with other manufacturing processes.	1.1 Foundry in ancient India 1.2 Importance of foundry engineering. 1.3 Comparison of casting process with other manufacturing processes.	Improved Lecture Assignment	**CO1**
		UNIT-II PATTERN MAKING (CL Hrs-10 Marks-12)		
2	TLO 2.1 Enlist types of pattern material. TLO 2.2 Explain different types of patterns. TLO 2.3 Design and construct a pattern. TLO 2.4 Design and construct of various types of core boxes. TLO 2.5 Explain purpose of core venting.	2.1 Pattern materials: Material for patterns and core boxes such as metal, wood, epoxy resin, wax, thermocol etc. 2.2 Types of patterns: One piece, split, loose piece, matchplate, gated, skeleton etc. Comparison of various patterns. Pattern plates for hand and machine molding, master pattern. 2.3 Pattern design and construction: Pattern allowances, pattern joints, parting line selection, core prints, loose pieces, location of pins on pattern, pattern-lifting devices, color codes for pattern. 2.4 Design and construction of various types of core boxes, core venting.	Improved Lecture Assignment Demonstration	**CO1**
		UNIT-III SAND MOLDING PROCESS (CL Hrs-16 Marks-17)		
3	TLO 3.1 Explain the principal ingredients of molding sand. TLO 3.2 Explain the role of additives in molding sand. TLO 3.3 Explain the necessity of mold coatings. TLO 3.4 Explain the need for and explain various sand control tests. TLO3.5 Explain the principle, ingredients, pattern and equipments, casting size, alloy range, application, advantages and limitations of; green sand, dry sand, loam sand, CO2 sand, shell molding, investment casting processes.	3.1 Molding sand: Principal ingredients, sand grains, moisture, binders- inorganic and organic. 3.2 Additives in molding sand: Role of additives, commonly used additives such as; Coal dust, Iron oxide, Dextrin, Molasses etc. 3.3 Mold washers/coatings, sand preparation and treatment. 3.4 Molding sand testing: Need for sand testing, various sand control tests; Moisture content, clay content, grain fineness, permeability, strengths, refractoriness, mold hardness. 3.5 Types of sand molding processes: Principle, ingredients, pattern and equipments, casting size, alloy range, application, advantages and limitations of: green sand, dry sand, loam sand, CO2 sand, shell molding, investment casting processes.	Improved Lecture Assignment Demonstration	**CO2**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
SECTION II				
UNIT-IV MOLDING PROCESS USING METAL MOULDS (CL Hrs-11 Marks-10)				
4	TLO 4.1 Explain the principle, equipments, casting size, alloy range, application, advantages and limitations of Die casting – Gravity, low pressure, high pressure.	4.1 Principle, equipments, casting size, alloy range, application, advantages and limitations of: Die casting –Gravity, low pressure, high pressure. 4.2 Centrifugal casting. 4.3 Continuous casting.	Improved Lecture Assignment Demonstration	**CO3**
UNIT-V MISCELLANEOUS MOLDING PROCESSES (CL Hrs-03 Marks-06)				
5	TLO 5.1 Explain miscellaneous molding processes : plaster molding, ceramic molding, slush casting, pit and floor molding, stack molding.	5.1 Study of miscellaneous molding processes such as:, slush casting, pit and floor molding, stack molding.	Improved Lecture Assignment	**CO3**
UNIT-VI MELTING FURNACES (CL Hrs-09 Marks-10)				
6	TLO 6.1 Explain the principle, construction, melting procedure, types of cupola furnace. TLO 6.2 Explain the principle, construction, melting procedure of Electric furnace- Coreless, Induction furnace, Duplexing. TLO 6.3 Explain the principle, construction, melting procedure of Oil fired furnace	6.1 Cupola furnace: Principle, construction, melting procedure, types of cupola furnace. 6.2 Electric furnace- Coreless, Induction furnace, Duplexing. 6.3 Oil fired furnace	Improved Lecture Assignment	**CO4**
UNIT-VII SELECTION OF MOLDING PROCESS (CL Hrs-07 Marks-09)				
7	TLO 7.1 Select a molding process with respect to quantity and weight of metal e.g. lathe bed, manhole cover, piston ring, gear box housing, motor body, turbine housing. TLO 7.2 Explain important safety considerations in Foundry.	7.1 Selection of molding process with respect to quantity and weight of metal e.g. lathe bed, manhole cover, piston ring, gear box housing, motor body, turbine housing 7.2 Safety in Foundries: Important safety considerations in Foundry.	Improved Lecture Assignment	**CO5**

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1: (a) Familiar with molding tools (b) Study of various molding tools.	Study of various molding tools.	04	CO1
2	LLO 2.1: (a)Familiar with different types of patterns. (b) Study of different types of patterns	Study of different types of patterns.	04	CO1
3	LLO 3.1: Perform various sand control tests	Study of various sand control tests.	08	CO2
4	LLO 4.1: Perform green sand molding	Study of green sand molding	08	CO2
5	LLO 5.1: Study of CO2 sand molding	Study of CO2 sand molding.	04	CO2
6	LLO 6.1 Perform shell molding	Study of shell molding.	08	CO2
7	LLO 7.1: Study of stack molding.	Study of stack molding.	04	CO2
8	LLO 8.1: Perform gravity die casting	Casting aluminum in gravity die casting.	04	CO5
9	LLO 9.1: Study of cupola furnace	Study of cupola furnace.	08	CO3

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/ SKILLS DEVELOPMENT (SELF-LEARNING)

Micro project

- Prepare a chart comparing the various molding processes- Sand molding and Shell molding, on the basis of: Principle, ingredients, pattern and equipments, casting size, alloy range, application, advantages and limitations
- Prepare a chart comparing low pressure and high pressure Die casting .
- Prepare a chart comparing induction furnaces-core and coreless type.
- Prepare a chart showing details of Cupola .
- Prepare report of any one non ferrous foundry
- Prepare report of any one ferrous foundry
- Prepare visit report on a visit to a nonferrous foundry
- Prepare visit report on a visit to a ferrous foundry

Assignment-

- To select molding process for particular application- lathe bed, manhole cover, piston ring, gear box housing, motor body, turbine housing
- Report of Visit to various foundries to see induction and direct arc furnace.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Patterns, molding equipments	LLO 1.1
2	Sand testing equipments	LLO 3.1
3	Sand molding equipment	LLO 4.1
4	Shell molding equipment	LLO 6.1
5	Gravity die casting equipment	LLO 8.1
6	Study of cupola furnace.	LLO 9.1

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
SECTION I								
1	I	INTRODUCTION	CO1	4	4	2	--	6
2	II	PATTERN MAKING	CO1	10	4	4	4	12
3	III	SAND MOLDING PROCESS	CO2	16	3	7	7	17
			Grand Total	**30**	**11**	**13**	**11**	**35**
SECTION II								
4	IV	MOLDING PROCESS USING METAL MOULDS	CO3	11	2	4	4	10
5	V	MISCELLANEOUS MOLDING PROCESSES	CO3	3	2	2	2	06
6	VI	MELTING FURNACES	CO4	9	2	4	4	10
7	VII	SELECTION OF MOLDING PROCESS	CO5	7	2	3	4	9
			Grand Total	**30**	**8**	**13**	**14**	**35**

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Unit Tests: Average of two unit tests (30 marks) 2. Self-Learning: SLA (25 marks)	1. End Term Exam: SA-TH (70 marks) 2. End Term Exam: SA-PR (25 marks)

X. SUGGESTED COS- POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes *(PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	2	1	1	1	2	1	2	3	1	1	2
CO2	3	1	2	3	2	2	2	3	2	1	2
CO3	3	3	3	3	3	3	3	3	3	3	3
CO4	2	1	1	1	2	1	2	3	1	1	1
CO5	3	3	2	3	3	2	2	3	2	2	3

Legends:- High:03, **Medium:**02, **Low:**01, **NoMapping:** -
*PSOs are to be formulated at the institute level

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	T. V. Ramana Rao	Metal Casting Principle and Practice	New Age International (P) Ltd,Publishers. 1996
2	Richard W.Heine, Carl R Loper, Philip C Rosenthal	Principle of Metal Casting	Tata MacGraw Hill Publishing Comp. 1976
3	O.P.Khanna,Lal	Foundry Technology	Dhanpatrai and sons 1996

XII. LEARNING WEBSITES & PORTALS

Sr.No	Link/Portal	Description
1	https://youtu.be/8RUXvdsgsyg	Moulding sand properties
2	https://youtu.be/H78qWl4sf54?si=i9ysTTwEi1_YNgGu	Pattern and allowances
3	https://youtu.be/Sr7xZo0F86I?si=Qm9nTfVUCNP-tMXo	Investment casting process
4	https://youtu.be/C5ZGebiQbyI?si=DFYsoPSM4EMFWcbb	Shell molding process
5	https://youtu.be/P1G2EwbRnw0?si=PuEPSYjMQ1DKjjrZ	Die casting process
6	https://youtu.be/U81LJAdzFsY?si=5yz4KijbQvoLWdts	Centrifugal casting
7	https://in.docworkspace.com/d/sIEbA3J5EraOVuAY?sa=wa1&ps=1&fn=Melting%20Furnaces.pdf	Melting furnaces
8	https://youtu.be/6WIABd84404?si=ISLn5SUwueIAvOsV	Continous casting process
9	https://youtu.be/5zmpwoQlm_8	Stack molding

Name & Signature: Kadam **Smt. Namita S Kadam** (Course Experts)	
Name & Signature: Kadam **Smt. Namita S Kadam** (Programme Head)	Name & Signature: Kulkarni **Shri. Sudin B Kulkarni** (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**HEAT TREATMENT OF METALS AND ALLOYS**
COURSE CODE	**MT41204**
PREREQUISITE COURSE CODE & TITLE	**MT41201, PHYSICAL METALLURGY**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT 41204	HEAT TREATMENT OF METALS AND ALLOYS	DSC	04	--	02	02	08	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Term: 01 Hrs

Abbreviations: CL-Classroom Learning, **TL**-Tutorial Learning, **LL**-Laboratory Learning, **SLH**-Self Learning Hours, **NLH**-Notional Learning Hours, **FA** - Formative Assessment**, SA** -Summative assessment, **IKS** – Indian Knowledge System, **SLA**- Self Learning Assessment

Legends: @-Internal Assessment, **#** - External Assessment,***#** - Online Examination,**@$** - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

1. If a candidate is not securing minimum passing marks in **FA-PR** (Formative Assessment - Practical) of any course, then the candidate shall be declared as **'Detained'** in that course.
2. If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as **'fail'** and will have to repeat and resubmit SLA work.
3. **Notional learning hours** for the semester are **(CL + LL + TL + SL) hrs. * 15 Weeks**
4. **1 credit** is equivalent to **30 Notional hours**.
5. * Self-learning hours shall not be reflected in the Timetable.
6. * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

The subject includes study of transformation systems, TTT diagram, hardenability of steel. The mechanical properties of metals and alloys are important from design point of view. After selection of material and alloys the mechanical properties such as tensile strength, ductility, fatigue, hardness can still be further improved by various types of heat-treatment given to ferrous and non -ferrous alloys. Hence, the course has its own value in metallurgical field.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1- Explain the need of heat treatments on alloys.

CO2- Relate different cooling rates with the transformation products and properties of steels.

CO3- Select appropriate heat treatment for steels and cast irons to achieve required properties for particular application.

CO4- Select appropriate heat treatment for Al-Cu, Ti and Mg-Li alloys.

CO5- Use safety measures in heat treatment shop.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
SECTION I				
UNIT-I INTRODUCTION TO HEAT TREATMENTS (CL Hrs-06 Marks-05)				
1	TLO 1.1 State the importance of heat treatments for metals and alloys. TLO 1.2 State and explain the factors governing heating rate in heat treatment. TLO 1.3 State the classification of heat treatment furnaces. TLO 1.4 Explain the need for and control of furnace atmospheres. TLO 1.5 Explain the process of Shot blasting and Shot pinning. TLO 1.6 State the causes and remedies for common defects in heat treatments. TLO 1.7	1.1 Need for heat treatments. 1.2 Factors governing heating rate. 1.3 Heat treatment furnaces, use of vacuum in furnaces. 1.4 Furnace atmospheres: oxidation, decarburization. 1.5 Finishing operations on heat treated component: Shot blasting and Shot peening. 1.6 Defects in heat treatment: causes and remedies. 1.7 History of heat treatments in India.	Lecture Assignment	**CO1**
UNIT-II PHASE TRANSFORMATIONS IN STEELS (CL Hrs-08, Marks-10)				
2	TLO 2.1 Explain the steps in austenitic, pearlitic, martensitic and bainitic transformations in steel. TLO 2.2 Explain the effect of grain size on the properties of various transformation products. TLO 2.3 Explain the effect of Ms/Mf temperatures, alloying elements, CCR and retained austenite on martensitic transformation. TLO 2.4 Compare the characteristics of pearlitic, martensitic and bainitic transformations.	2.1 Transformation of pearlite into austenite on slow heating: Effect of grain size, determination of austenitic grain size. 2.2 Transformation of austenite into pearlite on slow cooling: Nucleation and growth of cementite and ferrite, effect of time and grain size. 2.3 Transformation of austenite into martensite: Ms/Mf temperatures, characteristics of martensitic transformation, effect of carbon and alloying elements, retained austenite, CCR, effect of austenitic grain size, volumetric changes during martensitic transformation. 2.4 Transformation of austenite into bainite: Characteristics, comparison with martensitic and pearlitic transformations.	Lecture Assignment	**CO2**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-III ANNEALING AND NORMALIZING OF STEELS (CL Hrs-08 Marks-10)				
3	TLO 3.1 Explain the objectives, principle & process of Annealing. TLO 3.2 Describe different types of Annealing treatments. TLO 3.3 Explain the objectives, principle & process of Normalizing. TLO 3.4 Differentiate between Annealing and Normalizing.	3.1 Objectives, principle and process of Annealing. 3.2 Classification and applications of different types of Annealing- Full, partial, subcritical, isothermal, recrystallization, diffusion, process and spheroidizing annealing. 3.3 Objectives, principle and process of Normalizing. 3.4 Difference between Annealing & Normalizing.	Lecture Assignment Demonstration	**CO3**
UNIT-IV HARDENING AND TEMPERING OF STEELS (CL Hrs-08, Marks-10)				
4	TLO 4.1 Explain the objectives, principle and process of different methods of Hardening. TLO 4.2 State the properties of various quenching mediums. TLO 4.3 Explain the factors of selection of quenching medium. TLO 4.4 Describe the stages in quenching. TLO 4.5 Explain the Working, advantages and applications of Sealed quench furnace. TLO 4.6 Explain the objectives, principle and stages in Tempering. TLO 4.7 Explain precipitation of carbides, temper embrittlement and secondary hardening in steels.	4.1 Objectives and principle of Hardening. 4.2 Methods of Hardening. 4.3 Quenching mediums: properties of various mediums, selection of quenching medium, stages in quenching. 4.4 Sealed Quench furnaces: Working, advantages and applications. 4.5 Objectives, principle and stages in Tempering. 4.6 Precipitation of carbides, Temper embrittlement. 4.7 Principle of secondary hardnening of steels.	Lecture Assignment Demonstration	**CO3**
SECTION II				
UNIT-V HEAT TREATMENTS BASED ON T.T.T. DIAGRAM (CL Hrs-06, Marks-08)				
5	TLO 5.1 Explain the principle and applications of various heat treatments based on T.T.T. diagram of steels.	Principle and applications of following heat treatments based on T.T.T. diagram of steels, 5.1 Martempering. 5.2 Austempering. 5.3 Ausforming. 5.4 Patenting. 5.5 Isothermal annealing.	Lecture Assignment	**CO3**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-VI CASE HARDENING OF STEELS (CL Hrs-06, Marks-08)				
6	TLO 6.1 Explain the principle and process of different methods of carburizing, nitriding, carbonitriding. TLO 6.2 State the need and advantages of using vacuum in carburizing and nitriding.	6.1 Carburizing: pack, gas and liquid carburizing, heat treatments after carburizing. 6.2 Nitriding, Plasma nitriding, Sursulf process. 6.3 Cyaniding, Carbonitriding. 6.4 Diffusion metallizing. 6.5 Vacuum processes- Carburizing, Nitriding.	Lecture Assignment	**CO3**
UNIT–VII SURFACE HARDENING OF STEELS (CL Hrs-06, Marks-06)				
7	TLO 7.1 Explain the principle and applications of surface hardening treatments like induction, flame, laser & electrolytic bath hardening.	Principle and applications of following heat treatments of steels, 7.1 Induction hardening. 7.2 Flame hardening. 7.3 Laser hardening. 7.4 Electrolytic bath hardening.	Lecture Assignment	**CO3**
UNIT–VIII HEAT TREATMENTS OF CAST IRONS (CL Hrs-04, Marks-06)				
8	TLO 8.1 Explain the principle and applications of heat treatments of different types of Cast Irons.	Principle and applications of heat treatments of- 8.1 Grey C. I. 8.2 White C. I. 8.3 Malleable C.I. 8.4 S. G. Irons.	Lecture Assignment	**CO3**
UNIT–IX HEAT TREATMENT OF NON-FERROUS METALS AND ALLOYS (CL Hrs-04, Marks-05)				
9	TLO 9.1 Explain the effect of annealing on cold working metals. TLO 9.2 Enlist different heat treatments of Al, Cu and Mg alloys. TLO 9.3 Explain the process of precipitation hardening of Al-Cu alloys. TLO 9.4 Explain the principles of heat treatments of Ti and Mg-Li alloys.	9.1 Effect of annealing on cold working metals. 9.2 Purposes and principle of heat treatments of Al, Cu and Mg alloys. 9.3 Modification of Al-Si alloys using St/Na. 9.4 Precipitation hardening of Al-Cu alloy system. 9.5 Principle of heat treatments for Ti and Mg-Li alloys.	Lecture Assignment	**CO4**
UNIT–X SAFETY MEASURES IN HEAT TREATMENT SHOP (CL Hrs-04, Marks-02)				
10	TLO 10.1 State the role of various safety equipment in heat treatment shop. TLO 10.2 Explain the safety measures and precautions to be taken in heat treatment shop.	10.1 Use of safety equipment in heat treatment shop. 10.2 Safety measures and precautions in heat treatment shop.	Lecture Demonstration	**CO5**

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Study of construction, working and applications of various heat treatment furnaces.	Study of heat treatment furnaces.	04	CO1
2	LLO 2.1 Perform Annealing heat treatment on the given steel specimen.	Perform Annealing heat treatment on steel specimen.	04	CO2/CO3
3	LLO 3.1 Perform Normalizing heat treatment on the given steel specimen.	Perform Normalizing heat treatment on steel specimen.	04	CO2/CO3
4	LLO 4.1 Perform Hardening heat treatment on the given steel specimen.	Perform Hardening heat treatments on steel specimen.	04	CO2/CO3
5	LLO 5.1 Perform Annealing heat treatment on the given steel specimen.	Perform Tempering heat treatments on steel specimen.	04	CO2/CO3
6	LLO 6.1 Study of heat treatments based on TTT diagram of steels.	Study of heat treatments based on TTT diagram of steels.	02	CO2/CO3
7	LLO 7.1 Study of Carburizing and Nitriding treatments of steel.	Study of Carburizing and Nitriding treatments of steel.	02	CO2/CO3
8	LLO 8.1 Study of surface hardening treatments of steel.	Study of surface hardening treatments of steel.	02	CO2/CO3
9	LLO 9.1 Study of heat treatments of Cast Irons.	Study of heat treatments of Cast Irons.	02	CO2/CO3
10	LLO 10.1 Study of precipitation hardening of Al-Cu alloys.	Study of precipitation hardening of Al-Cu alloys.	02	CO4

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

Micro project

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- Prepare industrial survey report of various heat treatment shops and the heat treatments performed in these shops for various materials.
- Collect technical specifications of various heat treatment furnaces.
- Prepare visit report on heat treatment shop.
- Prepare display board of various heat treatment processes.
- Prepare tabulated summary for temperature, time, furnace atmospheres etc for various heat treatment processes.
- Prepare report on construction of various heat treatment furnaces.
- Prepare report on working of various heat treatment furnaces.
- Prepare report on specifications, sketches of various heat treatment furnaces.
- Prepare detailed cycle of heat treatments for various alloys.
- Prepare report on the effect of a particular heat treatment on the microstructure and properties of given steel.
- Prepare metallograpical specimen of different alloys, before and after heat treatments.

Assignments

- Prepare journals based on practical performed in laboratory. Journal consists of write ups, diagrams, observations, required tools, equipment and date of performance with teacher signature.
- Power Point Presentation and report on different heat treatments.
- Power Point Presentation and report on furnaces required for different heat treatments.
- Power Point Presentation and report on furnace atmospheres required for different heat treatments.
- Prepare charts showing before and after heat treatment microstructures for different heat treatments of alloys.
- Prepare flow sheets for different heat treatment processes.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Muffle furnace	LLO 1.1 to LLO 5.1
2	Steel specimen for heat treatment	LLO 2.1 to LLO 5.1
3	Standard steel & C.I. samples (heat treated)- Annealed, normalized, hardened, tempered, carburised, nitride, surface hardened etc.	LLO 2.1 to LLO 9.1
4	Standard precipitation hardened samples of Al-Cu alloy	LLO 10.1
5	Metallurgical microscopes	LLO 2.1 to LLO 5.1

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
SECTION I								
1	I	INTRODUCTION TO HEAT TREATMENTS	CO1	06	02	02	01	05
2	II	PHASE TRANSFORMATIONS IN STEELS	CO2	08	06	02	02	10
3	III	ANNEALING AND NORMALIZING OF STEELS	CO3	08	06	02	02	10
4	IV	HARDENING AND TEMPERING OF STEELS	CO3	08	06	02	02	10
			Grand Total	30	20	08	07	35
SECTION II								
5	V	HEAT TREATMENTS BASED ON T.T.T. DIAGRAM	CO3	06	04	02	02	08
6	VI	CASE HARDENING OF STEELS	CO3	06	04	02	02	08
7	VII	SURFACE HARDENING OF STEELS	CO3	06	02	02	02	06
8	VIII	HEAT TREATMENTS OF CAST IRONS	CO3	04	02	02	02	06
9	IX	HEAT TREATMENT OF NON-FERROUS METALS AND ALLOYS	CO4	04	02	02	01	05
10	X	SAFETY MEASURES IN HEAT TREATMENT SHOP	CO5	04	--	02	--	02
			Grand Total	30	14	12	09	35

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Unit Tests: Average of two unit tests (30 marks) 2. Term Work: FA-PR (25 marks) 3. Self-Learning: SLA (25 marks)	1. End Term Exam: SA-TH (70 marks) 2. End Term Exam: SA-PR (25 marks)

X. SUGGESTED COS- POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes *(PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	1	2	1	-	-	-	1	2	1	1	1
CO2	2	3	3	-	-	1	2	3	1	2	2
CO3	3	3	3	2	2	2	3	3	3	3	2
CO4	3	3	3	2	2	2	3	3	3	3	2
CO5	-	1	1	1	2	2	3	2	3	1	2

Legends:- High:03, **Medium:**02, **Low:**01, **No Mapping:** -
*PSOs are to be formulated at the institute level

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	T.V.Rajan, C.P.Sharma, Ashok Sharma	Heat Treatment Principles & Techniques	PHI Learning Pvt. Ltd., New Delhi ISBN: 9788120340954
2	Sydney H. Avner	Introduction to Physical Metallurgy	Tata McGraw Hill Publishing Company Ltd, New Delhi. ISBN13: 9780070024991, ISBN10: 0070024995
3	Raymond A. Higgins	Engineering Metallurgy	English University Press, London ISBN13: 9780340568309, ISBN10: 0340568305
4	Clark & Varney	Physical Metallurgy for Engineers	Van Nostrand Reinhold Company ISBN10: 0442015704, ISBN13: 9780442015701

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://www.youtube.com/watch?v=X9l9y8bcECg&list=PLyAZSyX8Qy5D8JF2sX2ed1xdHt3AES8RY	Introduction to heat treatment
2	https://www.youtube.com/watch?v=OFu0fCkIuxU	Quenching and Martensite
3	http://msvs-dei.vlabs.ac.in/Quenching.php	Metal Forming Virtual Simulation Lab-Simulation of Quenching
4	https://www.youtube.com/watch?v=pC4EdrC7zWo	Diffusion in Solids
5	https://www.youtube.com/watch?v=uk9m_KUHfmY	Applications of heat treatment

Name & Signature: **Shri. Abhijit V. Mehtre** (Course Experts)	
Name & Signature: **Smt. Namita S Kadam** (Programme Head)	Name & Signature: **Shri. Sudin B Kulkarni** (CDC In-charge)