VIVEKANAND COLLEGE, KOLHAPUR

(AUTONOMOUS COLLEGE)

Department of Foundry Technology

Board of Studies in Foundry Technology

Syllabus

For

M. Voc. in Foundry Technology

(To be implemented from Academic Year 2020-2021 onwards)

MASTER OF VOCATION (M. Voc.)

STRUCTURE OF SYLLABUS:

To be implemented from the academic year 2020-2021

1. Title of the course: Post-Graduate Diploma in Foundry Technology

A. INTRODUCTION

The proposed curriculum is with the view to make it more contextual, industry affable and suitable to cater the needs of society and nation in present day context. The committee examined the nature of the existing syllabus of various courses in foundry technology and after analysing other curricula of existing universities in respective subjects in terms of content, relevance, quality and pattern of teaching and examination, has synthesized the present proposal. After guidance from industry professionals, consultants and senior faculty, feedbacks from the core faculty and intensive discussions the syllabus is suitably finalized.

The syllabus needs revision in terms of preparing the student for the professional scenario with relevance to practical needs and requirements. A holistic approach includes providing industry training via on job training/internships, handling live projects, visits to foundry units. Regular expert's interaction will help to build a bridge between students and industry.

Technical advancement is the key to a substantial teaching system in today's world and thus a great responsibility lies on the curriculum to prepare students to rise to meet global standards and align seamlessly to changing trends.

B. RATIONALE

Casting process is an art and need to be developed to fulfil the requirement of the global market. The skill of casting will provide us the better quality of automobile, aeronautical agricultural and heavy engineering cast components. In recent days, Foundry sectors are lacking skilled employees in Quality control, Simulation and overall Management. This curricular area aims at enabling the students to develop their skills of these different foundry sections.

In today's world of competition, the rejection control has become the key factor in the foundry industry. Rejection control benefits the industry in both quality and profit. This control is not possible without skilled employees present in the industry, which makes this course important for the industry.

The Foundry Technology curriculum focuses on building a strong foundation and managerial skills for developing a career in foundry by learning the basic key factors and advanced tools in Quality, Simulation, Pattern making, Production, Melting and Fettling. Practical orientation of this course strengthens the skills of students and makes them solving the problems of foundry industry.

C. COURSE OBJECTIVES

To enable the students-

- To promote understanding of advance facts and concepts in foundry process while retaining the excitement of foundry industry.
- To make students capable of studying foundry technology in academic and Industrial courses.
- To expose the students to various emerging new areas of foundry technology and apprise them with their prevalent in their future studies and their applications in various spheres of manufacturing technology.
- To develop problem solving skills in students.
- To expose the students to different processes used in Foundry Industries and their applications.
- To develop ability and to acquire the skill and knowledge of terms, facts, concepts, processes, techniques and principles of foundry industries.
- To develop ability to apply the skill and knowledge of contents of principles of foundry technology.
- To inquire of new skill and knowledge of foundry technology and developments therein.
- To expose and to develop interest in the fields of foundry technology.

D. CORE CONTENT GOALS FOR FOUNDRY TECHNOLOGY

The students will learn:

1. Research Methodology
2. Advances in Engineering Materials
3. Behavior of material under mechanical load
4. Non-ferrous casting production techniques
5. Work study and Work measurement
6. Quality control and Assurance
7. Entrepreneurship Development and Human Resource development
8. Costing and Cost control
9. Non Destructive testing
10. Foundry Automation and Safety
11. Casting Simulation
12. About career options in foundry industry.
13. Improve their skills and techniques through practical and projects.
14. Problem solving techniques.

In this class, students will learn the advance theory behind all the foundry operations. The Practical part of course will make them confident to work on shop floor as well as at

managerial level. They will demonstrate the processes as expected by the teacher. They are expected to maintain facilities in an appropriate working condition.

2. Duration:

The duration of the M. Voc. Course will be of **Two years.**

M. Voc. Part I - Post- Graduate Diploma in Foundry Technology

M. Voc. Part II - M. Voc in Foundry Technology

The final M. Voc degree will be awarded only after completion of two years course. The suggested credits for each of the years are as follows:

Awards		Normal calendar duration	Skill Component Credits (Theory)	Skill Component Credits (Practical)
Year 1	**Post Graduate Diploma in Foundry Technology**	Two Semesters	36	24
Year 2	**M. Voc in Foundry Technology**	Two Semesters	-	60
		TOTAL	**36**	**84**

General Education Component should not exceed 40% of the total curriculum.

Credits can be defined as the workload of a student in

1. Lectures
2. Practicals
3. Seminars
4. Private work in the Library/home
5. Examination
6. Other assessment activities.

The following formula should be used for conversion of time into credit hours.

a) One Credit would mean equivalent of 15 periods of 50 minutes each, for theory, workshops /labs and tutorials;
b) For internship/field work, the credit weightage for equivalent hours shall be 50% of that for lectures/workshops;
c) For self-learning, based on e-content or otherwise, the credit weightage for equivalent hours of study should be 50% or less of that for lectures/workshops.

3. Eligibility:

The eligibility condition for admission to M. Voc. programme shall be

B. Voc in Foundry Technology from any recognized board or university.

BE/B.Tech in Mechanical/Production/Metallurgy from any recognized board or university.

4. Medium of Instruction:

The medium of instruction of the course will be **Marathi/English.**

5. Pattern: Choice Based Credit System with Course Outcomes.

6. Examination:

A. Scheme of examination:

- The semester examination will be conducted at the end of each term (both theory and practical examination)
- Theory paper will be of 50 marks each. The practical examination will be of 150 marks and
  seminar of 50 marks..
- Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus.
- For each semester there will be five theory papers. Practical Examination will be conducted at the end of every semester.

Paper Number	Title of Paper (For Semester I)	Internal Marks	Theory Exam Marks	Total Marks
I	Design of Experiment and Research Methodology	10	40	50
II	Concepts in Material Science	10	40	50
II	Advances in Iron and Steel Making	10	40	50
IV	Mechanical Behaviour of Materials	10	40	50
V	Elective I	10	40	50
TOTAL		**50**	**200**	**250**

Paper Number	Title of Paper (For Semester II)	Internal Marks	Theory Exam Marks	Total Marks
VI	High Pressure Die Casting	10	40	50
VII	Industrial Engineering	10	40	50
VIII	Total Quality Management	10	40	50
IX	Entrepreneurship Development	10	40	50
X	Elective II	10	40	50
TOTAL		**50**	**200**	**250**

The practical examination will be of 200 marks.

Sr. No.	Practical examination	Marks	Internal Assessment	Marks
1	Practical	120	Seminar	50
2	Journal	15		
3	Oral	15		
Total		**150**		**50**

The total weightage of first term is of 450 marks, the details of which are-

Sr. No.	Title	Marks
1	Theory Examination 40 X 5	200
2	Theory Internal	50
3	Practical Examination.	150
4	Seminar	50
	TOTAL	**450**

B. Nature of question paper:

For each paper there will be **THREE** compulsory questions.
General nature of the question paper will be:

Question Number	Type		Marks
Q.1	Multiple choice question	No internal options.	8
Q.2	Short answer	Any four out of six	16
Q.3	Long answer	Any two out of three	16

C. Standard of Passing:
To pass the examination a candidate must obtain at least 40% (i.e 16 marks out of 40) in individual subjects, in internal assessment and University examination each in all theory and practical subjects.

D. External Students: Not applicable as this is a practical oriented course**.**

7. University Terms: As per academic calendar of the Vivekanand (Autonomous) college.

For the first year i.e. Post-Graduate Diploma in Foundry Technology practical examination and theory paper assessment will be done at college level.

8. List of equipment and instruments:

1. Liquid penetrant testing kit
2. Magnetic particle testing kit
3. Ultrasonic testing equipments
4. Radiography testing (Radiographs)
5. Microstructure using replica method
6. UTM
7. Computer lab with simulation software

9. Laboratory Safety Equipments:

Part I: Personal Precautions:
1. Must wear Lab Aprons and safety shoes.
2. Except in emergency, over – hurried activities is forbidden.
3. Eating, Drinking and Smoking in the laboratories is strictly forbidden.

Part II: Use of Safety and Emergency Equipments:

1. First aid Kits

2. Fire extinguishers (dry chemical and carbon dioxide extinguishers)
3. Management of Local exhaust systems.
4. Sign in register if using instruments.

10. Workload:

Each skill based paper will have five **theory** periods per week. There are five **practical** per week. Each practical will be of three periods.

The total workload:

1. **Five Papers** on skill based Education: 5 X 4	=	20 Theory Periods.
2. **Five Practical** work per week: 5 X 3	=	15 Practical periods.
3. **Project Work** per batch per week:	=	05 Periods

	TOTAL	**40 Periods.**

Working hours will be 5 hours (300 minutes) per day i.e. six periods each of 50 minutes.

13. MEMORANDUM OF UNDERSTANDING (MOU):

The purpose of this MOU is to clearly identify the roles and responsibilities of each party (i.e. college and industry partner) as they relate to the implementation of the **M .Voc. Programme in Foundry Technology** at the college.

It is suggested to sign at least **TWO MOU** with the industry partners in the related field.

14. Program Outcomes:

1. Acquire in-depth knowledge of Materials so as to develop an ability to discriminate, evaluate, analyze and synthesize existing and futuristic needs in global perspective towards improvement of materials.
2. Critically analyze complex engineering problems related to Materials and apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. Think laterally and originally, conceptualize and solve engineering problems related to Materials to evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
4. Acquire professional and intellectual integrity, professional code of conduct, ethics of research, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
5. Apply various advanced software skills and Quality tools to model, analyze and solve problems related to foundry and related filed.

6. Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards to promote entrepreneurship.
7. Effectively communicate through technical reports, presentations and scientific publications with the technical and engineering community as well as society at large.
8. Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.

15. Program Educational Outcomes:

1. To train the students for successful careers in metallurgical and manufacturing industry, academics, in the field of research and development that meet the needs of Indian and multinational companies, R&D organizations and also prepare them for higher studies.
2. To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
3. To inculcate in student's leadership qualities, techno-economical considerations, an aptitude for life-long learning, and introduce in them the professional ethics and codes.

16. Program Specific Outcomes:

1. Students from Foundry Technology will collect and analyze data for solving the problems related with casting by using modelling, analysis & quality tools.
2. Student will make use of advance material testing techniques, gating design and casting simulation for improving quality of product.

Syllabus with credits

Level	Semester	Subjects	Credits
Level 8	Semester I	1. Design of Experiment and Research Methodology	3
		2. Concepts in Material Science	3
		3. Advances in Iron and Steel Making	3
		4. Mechanical Behaviour of Materials	3
		5. Elective I	3
		Metal Testing Lab	12
		Seminar I	3
	Semester II	1. High Pressure Die Casting	3
		2. Industrial Engineering	3
		3. Total Quality Management	3
		4. Entrepreneurship Development	3
		5. Elective II	3
		CAD and Simulation Lab	12
		Seminar II	3
Level 9	Semester III	Industrial Training and Report	16
		Seminar III	3
		Dissertation Phase I	11
	Semester IV	Dissertation Phase II	30

Elective I	Elective II
Non-Destructive Testing	Human Resource Management
Advanced Composites and Polymers	Production and Operation Management
Nano Materials and Nano Technology	Costing and Cost control
Foundry Automation and Safety	Quality management system

M. VOC IN FOUNDRY TECHNOLOGY

SEMESTER I

SKILLED BASED PAPERS:

PAPER-I: DESIGN OF EXPERIMENT AND RESEARCH METHODOLOGY

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Basics of Data analysis for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Understand the importance of research design and sampling.	7
CO2	Analyze the data collected measure the same.	7
CO3	Construct a hypothesis and analyse it with different tools.	7
CO4	Understand the importance of report writing.	7

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1							2			1
CO2							2			1
CO3							2			1

CO4							2			1

Course content:

1. Introduction**:** Meaning and objectives of research, Types of research, Research approaches, Research process, Research problem, Selection of research problem, Defining research problem, Literature review, Meta-analysis, Effect sizes, Integrating research findings, Identification of research gaps, Errors in research.

2. Research Design: Meaning, need, and features of good design, Dependent, independent, and extraneous variables, Experimental and control groups, Treatments, Experiment, Research designs in exploratory studies, Research designs in descriptive studies, Experimental research designs (informal and formal), Replication, Randomization, Blocking

3. Sampling: Need for sampling, Population, Sample, Normal distribution, Steps in sampling, External validity and threats, Sampling error, Probability sampling, Random sampling, Systematic sampling, Stratified sampling, Cluster sampling, Student's distribution, Standard error, Determination of sample size

4. Measurement Techniques: Measurement scales, Errors in measurement, Content validity, Criterion-related validity, Construct validity (convergent and discriminant), Reliability, Rating scales, Paired comparison, Differential scales, Summated scales, Cumulative scales, Factor scales

5. Data Collection and Analysis: Primary data collection through observations and interviews, Questionnaire surveys, Secondary data collection, Data processing, Measures of central tendency and dispersion, mean, median, mode, range, variance, standard deviation, inter-quartile range, histogram, box-plot, normal probability plot, Measures of association (simple regression analysis, association of attributes) (Use Minitab software)

6. Hypothesis Testing: Null and alternative hypothesis, Level of significance, Type I and type II error, Two-tailed and one-tailed tests, Procedure of hypothesis testing, Power of hypothesis test, Hypothesis testing of means, Hypothesis testing of mean difference

7. Analysis of Variance: Introduction, One-way ANOVA, Two-way ANOVA, Preparation of ANOVA Table and calculation of F-ratio

8. Report Writing: Interpretation of results, Techniques and precaution in interpretation, Steps in report writing, Layout of research report, Types of research report, Mechanics and precautions in writing research report, Structure of research paper, Referencing and bibliographic styles, Citations, Impact factor, Peer review, Plagiarism

Test books/ Reference Books:

1. Montgomery, Douglas C. (2007) – Design & Analysis of Experiments, 5/e. (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.) ISBN: 978-81-265-1048-1

2. Montgomery, Douglas C. & Runger, George C. (2007) – Applied Statistics & Probability for Engineers, 3/e, . (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.), ISBN: 978-81- 265-1424-3

3. Ranjit Kumar, (2006), Research Methodology- A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN: 81-317-0496-3

4. Trochim, William M.K., (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN: 81-7722-372-0

5. Kothari, C.K., (2004), 2/e, Research Methodology- Methods and Techniques, (New Age International, New Delhi)

6. Krishnaswamy, K. N., Sivakumar, Appa Iyer and Mathirajan, M. (2006), Management Research Methodology: Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)

7. Panneerselvam – Research Methodology, (PHI), ISBN: 81-203-2452-8

PAPER-II: CONCEPTS IN MATERIAL SCIENCE

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Basic information related to materials
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Understand basics of the structure- properties relationship.	1,2
CO2	Understand importance of phase diagrams in micro structure design.	1,2
CO3	Analyze, interpret and solve scientific materials data/ problems.	1,2
CO4	Apply principles of heat treatments of steels.	1,2

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	3	2							3	
CO2	3	2							3	
CO3	3	2							3	

CO4	2	1							3	

Course content:

1. Introduction to engineering materials & their properties. Crystalline versus non crystalline solids, Unit cell, Crystal systems, Bravais lattice, Fundamental reasons behind classification of lattice, Miller indices for directions & planes, Close-packed planes & directions, packing efficiency, Interstitial voids, Role of X-ray diffraction in determining crystal structures.
2. Deformation of metals, Understanding of some material-properties independent of inter atomic bonding forces/energies, Stiffness versus modulus, Theoretical/ideal strength versus actual strength of metals, Crystal defects, Role of dislocations in deformation, Strengthening Mechanisms, Role of Cottrell atmosphere.
3. Objectives & classification, System, Phases & structural constituent of phase diagram. Temperature–Pressure phase diagram of iron & Clausius – Clapeyron equation for boundary between phase regions of temperature-versus-pressure phase diagrams, Gibbs phase rule, Lever rule, Solid solutions, Hume-Rothery rules, Isomorphous, Eutectic, Peritectic & Eutectoid system, Equilibrium diagrams for non-ferrous alloys.
4. Experimental methods of determining phase diagrams, Iron–Carbon equilibrium diagram, Steels & Cast-irons. Gibbs free-energy curves for pure system, Solidification of pure metals, Nucleation, Growth, Growth of the new phase, Solidification of alloys, Nucleation-, growth- & overall transformation- rates, TTT & CCT diagrams.
5. Definition, Purpose & classification of heat treatment processes for various types of steels, Bainite&Martensite formation, Introduction & applications of various case hardening & surface hardening treatments, Precipitation Hardening, Heat treatment defects.

Test books/ Reference Books:

1. V. Raghvan, Materials Science and Engineering, Prentice Hall of India Publishing 5th Edition, 2006.
2. Askland&Phule, Material Science & Engineering of materials 4th Edition.
3. Reed Hill, Physical Metallurgy 4th Edition, 2009.
4. S.H. Avner, Introduction to Physical Metallurgy 2nd Edition, 1974.
5. W.D. Callister, Materials Science and Engineering 8th Edition, 2006.
6. D.A. Porter & K.E. Easterling, Phase Transformations in Metals & Alloys 3rd Edition, 1992.

PAPER-III: ADVANCES IN IRON AND STEEL MAKING

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Basics of Iron and Steel
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours

Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Design alloy chemistry for manufacturing /procurement of desired composition of the steel as per the specification.	2
CO2	Decide raw materials quality and sequence of refining for making clean steel.	2
CO3	Control the cost of the steel by careful selection of the raw materials and other necessary ingredients required for steel manufacturing.	2
CO4	Understand metallurgical benefits of ingot and continuous cast products.	2
CO5	Devise ways for energy conservation and environmental pollution.	2

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1		2							2	1
CO2		2							2	1
CO3		2							2	1
CO4		2							2	1
CO5		2							2	1

Course content:

1. Raw Materials for Steel making, Refractories, Scrap, Fluxes, Sponge Iron production, Electric Furnace Steel Making, Construction, Operation, Transformer Rating, Primary and Secondary Circuit, Power Factor, Thermal efficiency of the furnace.
2. Ladle Metallurgy: Construction and Operation of LRF, Principle of Steel making and Refining Technology, Gases removal, Deoxidation of Steel and Non-Metallic inclusions, Role of Slag Composition on Quality of Steel, Processes-AOD, VOD& VD.
3. Continuous Casting M/Cs: Operation and Construction, bloom, Billet, Slab and Thin strip Caster, primary and Secondary Cooling, Process parameters of the caster. Ingot Casting: Types of Moulds.
4. Defects in Cast Product, Electromagnetic Stirring (EMS) for Quality improvement, Types of EMS, Selection Advantages, and Disadvantages. Dust generation from Furnaces and environmental impacts

Test books/ Reference Books:

1. Steel Making –V. Kudrin, Mir. Publisher

2. Introduction to Modern Steel Making- Dr.R.H.Tupkari, Khanna Publishers
3. Electrometallurgy-I - By Edneral
4. Continuous Casting Vol-III - J.J.Moore
5. Continuous Casting of Steel – By Irving W.R.,
6. Electric Furnace Steel Making (Vol I & III) Higgins.

PAPER-IV: MECHANICAL BEHAVIOUR OF MATERIALS

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Knowledge about mechanical properties of materials
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Analyze mechanical deformation of the materials using analytical treatment.	3
CO2	Use mechanical metallurgical concepts in understanding mechanical deformation.	3
CO3	Identify failure modes and reasons of failures of engineering components.	3
CO4	Incorporate fracture mechanics concepts in the mechanical design.	3
CO5	Use micro structural principles for the design of fracture and creep resistant materials.	3

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1			2						2	
CO2			2						2	
CO3			2						2	
CO4			2						2	
CO5			2						2	

Course content:

1. Mechanical properties of materials, Theory of plasticity: The flow curve, yielding criteria for ductile metals, Plastic deformation of single crystal and polycrystalline materials, Deformation by slips, Deformation by twinning, strain hardening of single crystals.

2. Dislocation theory: Dislocations in FCC, HCP and BCC lattice, forces on dislocations, forces between dislocations, dislocation climb, intersection of dislocations, Jogs, multiplication of dislocations, dislocation pile-ups.
3. Strengthening mechanisms: Strengthening of grain boundaries, yield point phenomenon, strain aging, solid solution strengthening, strengthening from fine particles, fiber strengthening, martensitic strengthening.
4. Fracture mechanics and fracture toughness evaluation: Strain energy release rate, stress intensity factor, fracture toughness and design, KICPlain-strain toughness testing, crack opening displacement, probabilistic aspects of fracture mechanics, and toughness of materials.
5. Fatigue of metals: Stress cycles, S-N curve, statistical nature of fatigue, low cycle fatigue, structural features of fatigue, fatigue crack propagation, effect of stress concentration on fatigue, size effect, surface effects and fatigue, effect of metallurgical variables on fatigue, corrosion fatigue, effect of temperature on fatigue.
6. Creep and Stress rupture: High temperature materials problem, time dependent mechanical behavior, creep curve, stress rupture, structural changes during creep, mechanisms of creep deformation, deformation mechanism maps, fracture at elevated temperature, high temperature alloys and Fractography - important aspects.

Test books/ Reference Books:

1. Mechanical Metallurgy– Geroge E. Dieter, SI Metric Edition, 1988, McGraw Hill Book Co Ltd, U.K.

2. Mechanical Behaviour of Materials, Marc Andre Meyers and KishanKumarChawala, Second Edition, 2009, Cambridge University Press, U.K.
3. The Indian Academy of Sciences Proceedings: Engineering Science – Alloy Design, Vol 3 Part 4, December 1980 andVol 4 / Part 1, April 1981,Published byThe Indian Academy of Sciences, Bangalore- 560080.

4. Dislocations and Mechanical Behaviour of Materials, M.N. Shetty, 2013, PHI Learning Pvt Ltd, New Delhi -110092.

5. C. Wagnev, Thermodynamics of alloys, Addison Wesley, Cambridge, 1952.

6. F. D. Richardson, Physical Chemistry of Melts in Metallurgy, Academic, N. Y., 1974.

SEMESTER II

PAPER-V: HIGH PRESSURE DIE CASTING

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Knowledge about different non-ferrous

	casting processes
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Establish correlation between process parameters to resultant die casting.	5
CO2	Solve numerical problems related to die casting design.	5
CO3	Understand concepts and process capabilities of casting	5
CO4	Know pre-treatment and post heat treatments of die castings	5
CO5	Understand die casting defects and their remedial measures.	5

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1					2				2	2
CO2					2				2	2
CO3					2				2	2
CO4					2				2	2
CO5					2				2	2

Course content:

1. Introduction. Evolution of die-casting processes. Permanent mold casting. Die-casting of low melting metals and alloys, Zinc and lead alloys. Die-casting of aluminum alloys. Hot-chamber and cold-chamber pressure die casting methods. Low pressures die casting developments. General advantages and limitations of high-pressure die-casting methods.
2. High pressure die-casting machines. Plate type and toggle type machines. Range of pressures and capacities of HPDC machines. PQ2 analysis of machine capacity. Basic process and pressure-time cycles. Hydraulic systems. General control systems in HPDC machines.
3. Alloys for HPDC method. Zinc alloys. Aluminum alloys. Alloys with short and long melting temperature ranges. Hot shortness and related solidification problems. Common Aluminum die-casting alloys. Magnesium and Aluminum-magnesium alloys.
4. Melting methods and melt quality problems in aluminum alloys, charge calculation for alloy preparation, raw materials, quality, cost of production and energy consumption Scrap, ingots, master alloys, degassing agents and other additives. Gas content measurement. Densitometry for casting quality. Analytical methods for routine heat quality records. Basic

factors in the process of solidification in metallic molds. Solidification: Controlled solidification, Microstructure Development, etc., Inspection/Quality Check: mechanical/ Microstructural/ physical/ Chemical properties, NDT, etc

5. Dies for High pressure die-casting processes. Common alloys for HPDC dies and their heat-treatment. CAD systems for HPDC die design. Provision of cooling channels, inserts and supports in die-design. Die-coats and die-casting consumables.

6. High Integrity Die Castings. Advanced methods for high integrity and quality aluminum pressure die-castings. Squeeze casting, Semi-solid casting methods, Rheo-casting, vacuum die casting systems.

Test books/ Reference Books:

1. Degarmo, E. Paul; Black, J T.; Kohser, Ronald A. (2003), Materials and Processes in Manufacturing (9th ed.), Wiley, ISBN 0-471-65653-4.

2. Andresen, Bill (2005), Die Casting Engineering, New York: Marcel Dekker, ISBN 978-0-8247-5935-3.

3. Alan Kaye and Arthur Street , Die Casting Metallurgy, Butter worths Monographs in Materials, 1982.

4. Davis, J. (1995), Tool Materials, Materials Park: ASM International, ISBN 978-0-87170-545-7.

5. ASM Metals Handbook, 9th Edition, Vol 15: Casting , 2008 , Metals Park, Ohio, U.S,A.

6. Brevick, Jerald; Mount-Campbell, Clark; Mobley, Carroll , 2004 , Energy Consumption of Die Casting Operations (PDF), Ohio State University.

7. North American Die Casting Association, Arlington Heights, Illinois IL 60004, USA.: Publications and Handbooks, 2015

PAPER-VI: INDUSTRIAL ENGINEERING

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Basics about Productivity and work study
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Demonstrate interdisciplinary knowledge of method study, work measurement techniques and ergonomics for the overall improvement of productivity and effectiveness.	8

CO2	Demonstrate an interdisciplinary knowledge of method study, work measurement techniques and ergonomics for the overall improvement of productivity and effectiveness.	8

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1								2	2	
CO2								2	2	

Course content:

1. Introduction to Productivity and Work Study: Definition and scope, Productivity and quality of life, Evolution of work study, contribution of Taylor and Gilbreth, Work study techniques and basic procedure, Human factor in application of work-study. Method study: a) Definition, objectives and basic procedure. b) Record, Examine, Develop – Process chart symbols, Outline and flow process charts, Flow diagrams, Critically Examine Techniques c) Movement of workers and material – string diagram, flow process charts worker Material and equipment type, multiple activity chart – Man – Machine, Machine- Machine chart, Travel charts for workplace d) Methods and Movements at workplace- Principles of motion economy, Classification of movements, Two handed process chart, SIMO chart, Micro Motion study, Therbligs. e) Evaluate, Define, Install and Maintain methods.

2. Working conditions and Environment: Occupational hazards, health and safety, housekeeping, lighting, noise and vibrations, climatic conditions, ILO norms Ergonomics: Human factor engineering, man- machine interaction, Design of controls, environment factors, Anthropometry, workplace design.

3. Value Engineering: Introduction, Concept, Difference between Value Engineering and Value Analysis, Case study.

4. Work Measurement: Definition, objectives, basic procedure, Techniques of work measurement, Time study – Equipment and forms, selection of a job, steps in time study, breaking the job into elements, timing the elements; Rating in time study – standard rating and standard performance, factors affecting rate of working, standard time determination, use of time standards, allowances; Work sampling – Need, procedure for work sampling, determining time standard by work sampling. Predetermined time standards (PTS) – definition, methods time measurement (MTM) standard data from PTS, introduction, Methodology.

5. Location Layout: Factors affecting site selection, factors affecting layout design, types of layout, systematic layout planning procedure, travel chart, information gathering, flow analysis and activity analysis relationship diagram, space requirement and availability, designing of layout – use of CAD; Material Handling Systems– Principles, functions and equipments, selection of MH systems, unit load concept in MH, Economics of material handling.

6. Job Evaluations and Merit Rating: Job analysis, Ranking system, Grade description system, Point system, Factor comparison system; Method of merit rating systems, Incentives: Types of Incentives, Relationship of motion and time study with the incentives.

Test books/ Reference Books:

1. Work Study: - I L O

2. Work Study: - Curie and Faraday (ELBS)

3. Industrial Engineering Handbook, Maynard (Mc Graw Hill)

4. Time and Motion Study Design, Barnes, R.M. (John Wiley)

5. Work Study & Ergonomics, L.C. Jhamb (Everest)

6. Facility Layout and Location – An Analytical Approach, Francis et. al.(PHI)

7. Facilities Planning – 3/e, Tompkins, White, Bozer, Tanchoco (John Wiley & Sons)

8. Job Evaluation - ILO

9. Payment by Results, - ILO

10. Work Study by O.P. Khanna (Dhanapat Rai and Sons)

PAPER-VII: TOTAL QUALITY MANAGEMENT

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Knowledge about quality
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Understand the concepts in TQM.	5
CO2	Implement quality tools towards Quality improvement	5
CO3	Understand the structure and functions of quality council in order to drive TQM implementation	5

CO4	Setting direction for TQM efforts, creating vision, mission, quality policy and establishing strategic objectives	5

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1					3				3	
CO2					3				3	
CO3					3				3	
CO4					3				3	

Course content:

1. Basic concepts, need for TQM, principles of TQM, Quality philosophies of Deming, Crosby, Juran, Ishikawa and Feigenbaum, TQM models.
2. Quality policy deployment, quality function deployment, voice of customer, quality planning.
3. QC tools, problem solving methodologies, new management tools, quality circles, quality costs, prevention and appraisal costs, failure costs, models to minimize failure costs, benchmarking.
4. KAIZEN, 5S, JIT, POKAYOKE, Taguchi methods: Introduction to parameter and tolerance design, Six Sigma
5. Steps in TQM implementation, national and international quality awards, case studies.

Test books/ Reference Books:

1. Dale H. Besterfiled, "Total Quality Management", Pearson Education Asia
2. Rose, J.E. Total Quality Management, Kogan Page Ltd. 1993.
3. John Bank, The essence of total quality management, Prentice Hall, 1993.
4. Greg Bounds and Lyle Yorks, Beyond Total Quality Management, McGraw Hill, 1994.
5. Masaki Imami, KAIZEN, McGraw Hill, 1986.
6. Phil Crosby, Quality Without Tears, McGraw Hill
7. Six Sigma: Hemant Urdhwareshe.

PAPER-VIII: ENTREPRENEURSHIP DEVELOPMENT

Course Type: Theory / Practical	Theory
Required/Elective	Required
Prerequisite	Knowledge about entrepreneurship
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours

Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Outcomes (COs): Upon completion of this course, students will be able to		Mapping with PO's
CO1	Understand traits in entrepreneurship	4
CO2	Understand the role of small scale industries in Indian economy.	4
CO3	Create a feasibility repost for business	4
CO4	Create Business plan and prepare project report.	4

Correlation matrix of Course outcomes with Programmed outcomes (CO-PO)
1=Low correlation, 2=Medium correlation, 3=High correlation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1				2						1
CO2				2						1
CO3				2						1
CO4				2						1

Course content:

1. Entrepreneurship: Definition of Entrepreneur and Entrepreneurship, entrepreneurial Process, Entrepreneurship and economic development, job creation, Indian scene.
2. Small Scale Units: Concept and definition, role of S.S.I. in Indian economy, Government policies and facilities.
3. Planning Small Scale Business: Business opportunity identification, idea generation, ideas from marketplace, market assessment, demand estimation.
4. Government Support Organizations: Central Government, State government, c) Financial support organizations, d) Government schemes and procedures.
5. Entrepreneurial Motivation: Self-disclosure, personality effectiveness, risk taking, Entrepreneurial competencies, case studies.
6. Business plan preparation: Meaning of business plan, project parameters, Information sources of economical and technical knowhow, selection of location, identification of raw material, suppliers, plants/machinery, process, manpower and other inputs such as power, water etc.
7. Small Business Management: Techniques of marketing, materials, production, Manpower and financial management, crisis management, working capital management, Fixed capital assessment, cash flow analysis, ROI, techniques of decision making.
8. Statutory Requirements: Factories Act 1948, Industrial disputes Act 1947, Indian Contract Act, Indian sales and Goods Act, Indian Partnership Act, Central Excise Sales Tax , Income Tax Act, Value Added Tax (VAT), GST.

9. Preparation of project report: Selection of product, Process and plant and machinery selection, Layout planning, Financial viability, Marketing and distribution of goods, Study of probable reasons of failure
10. Business Aspects: Business ethics, export environment, procedure and Documentation, venture capital financing, intellectual property act, patents, GATT.

Test books/ Reference Books:
1. Developing New Entrepreneurs - Entrepreneurship Development Institute of India, Ahmadabad.
2. Handbook of New Entrepreneurs
3. Management of Small Scale Industry - Vasant Desai (Himalaya Publication)
4. Entrepreneurship Playing to Win- Gordon Betty (Taraporwala & Co.)
5. Motivating Economic Achievement- David C. McClelland, David G. Winter
6. Industrial Maharashtra- Facts, Figures and Opportunities (M.I.D.C. Mumbai).
7. Project Planning & Entrepreneurship Development - T. R. Banga
8. Dynamics of Entrepreneurial Development & Management- Vasant Desai (Himalaya Publication)
10. S.S.I. and Entrepreneurship- Vasant Desai (Himalaya Publication)

ELECTIVE I for Semester I

1. NON-DESTRUCTIVE TESTING

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Basics of Data analysis for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Content:

1. Visual Testing Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes– light sources and special lighting–calibration- computer enhanced system – Employer defined applications, metallic materials including raw materials and welds – Inspection objectives, inspection checkpoints, sampling plan, inspection pattern etc– classification of indications for acceptance criteria - Codes, Standards and Specifications (ASME,ASTM,AWS etc.)

2. Liquid Penetrant Testing Principles – types and properties of liquid penetrants – developers – advantages and limitations of various methods - Preparation of test materials – Application

of penetrants to parts, removal of excess penetrants, post cleaning – Control and measurement of penetrant process variables –selection of penetrant method – solvent removable, water washable, post emulsifiable – Units and lighting for penetrant testing – calibration- Interpretation and evaluation of test results - dye penetrant processapplicable codes and standards.

3. Magnetic Particle Testing Theory of magnetism – ferromagnetic, paramagnetic materials – characteristics of magnetic fields – magnetic hysteresis–magnetization by means of direct and alternating current – surface strength characteristics –Depth of penetration factors– Circular and longitudinal magnetization techniques, current calculation — field produced by a current in a coil, shape and size of coils, field strength, inspection materials, wet and dry particles – portable, mobile and stationary equipment – calibration- capabilities of equipment– magnetic particle inspection of castings and welding – Dry continuous method, wet residual method – Interpretation and evaluation of test indications – Principles and methods of demagnetization – Residual magnetism – applicable codes and standards.

4. Eddy Current Testing Generation of eddy currents – effect of change of impedance on instrumentation – properties of eddy currents – eddy current sensing elements, probes, type of coil arrangement – absolute, differential, lift off, operation, applications, advantages, limitations –Through encircling coils, type of arrangements –absolute, differential fill factor, operation, application, advantages, limitations - Factors affecting sensing elements and coil impedance - test part and test system – Signal to noise ratio – equipment's, reference samples, calibration, inspection of tubes, cylinders, steelbars, welded tubing, plates and pipes, Remote Field Sensing - Interpretation/Evaluation – Applicable codes and standards.

5. Ultrasonic Inspection Methods and Equipment Principle of pulse echo method, through transmission method, resonance method – Advantages, limitations – contact testing, immersion testing, couplants– Data presentation A, B and C scan displays, comparison of contact and immersion method. Pulse Echo instrumentation, controls and circuits, pulse generation, signal detection, display and recording methods, gates, alarms and attenuators, detectability of defects. Calibration of Testing Equipment Basic instrument calibration Testing/Evaluation/interpretation types, origin and typical orientation of discontinuities - response of discontinuities to ultrasound – safety precautions, Test Procedure- Scan plan/technique sheets, Applicable codes and standards, specifications (ASME, ASTM, AWS, BS. etc.)

6. Radiographic Image Quality and Radiographic Techniques Radiographic sensitivity – Radiographic Contrast, film Contrast, Subject Contrast, Definition, Radiographic density – penetrameters or Image Quality Indicators – Intensifying screens – intensification factor, control of scattered radiation, filters, diaphrams, masks – Radiography of weldments – single and double wall Radiography – panoramic radiography-procedure shooting sketch/technique sheets. Radiation Detectors and Safety Special and SI Units of radiation – Principle of radiation detectors – ionization chamber, proportional counter, G. M. counters, scintillation counters, solid state detectors – Biological effect of ionizing radiation – Operational limits of exposures – Radiation hazards evaluation and control – Design of radiography installation and shielding calculations.

Test books/ Reference Books:

ASNT industry handbook

2. ADVANCED COMPOSITES

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Basics of Data analysis for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Contents:

Composite materials in engineering, reinforcements and the reinforcement matrix interface - natural and synthetic fibers, synthetic organic and inorganic fibers, particulate and whisker reinforcements, reinforcement-matrix interface. Polymer matrix composites (PMC) – polymer matrices, processing of polymer matrix composites, characteristics and applications, composites with metallic matrices - metal matrix composites processing (MMC), Interface reactions, properties of MMCs, characteristics and application, Ceramic matrix composites (CMC)- processing and structure of monolithic materials, processing of CMCs, some commercial CMCs. Mechanical properties in composites, large particle composites and the rule of mixtures for elastic constants, Mechanical properties of fiber reinforced composites, Effect of fiber length, Critical fiber length, Strength of continuous and aligned fiber composites, Discontinuous and aligned fiber composites, Toughening Mechanism, Impact Resistance, Fatigue and Environmental Effects. Structural Composites: Cement matrix composites, Steel Reinforced Concrete, Pre-stressed concrete, Thermal Control, Vibration reduction. Polymer matrix composites-vibration damping. Composite materials for Electrical, Electromagnetic and Dielectric applications, Microelectronics and Resistance heating, Electrical insulation, capacitors, piezoelectric, ferroelectric functions, electromagnetic windows, solid electrolytes, microwave switching. Composite materials for optical and magnetic applications, optical waveguide, optical filters and lasers, multilayer for magnetic applications.

Text books/Reference Books:

1. Principles of Materials Science and Engineering, William F. Smith, Third Edition, 2002, McGraw-Hill.
2. Composite Materials: Engineering and Science, Matthews F.L., and Rawlings R. D., 1999, Wood head Publishing Limited, Cambridge England.
3. Composite Materials-Functional Materials for Modern Technology, DDL Chung, Springer-Verlag Publications London.
4. The nature and Properties of Engg. Materials, Jastrzebaski, John Wiley & Sons, New York.
5. Composite Materials Handbook, Mel M. Schwartz (R), 2nd Edition, 1992, McGraw-Hill, New York.
6. Mechanics of Composite Materials, Autar K. Kaw, 1997, CRC Press, New York. 16

7. Fundamentals of Fiber Reinforced Composite Materials, A. R. Bunsell, J. Renard, 2005, IOP Publishing Ltd.
8. Composite Materials Science and Engg., Chawla K.K., Second Edition, 1998, Springer Verlag.

3. NANO MATERIALS AND NANO TECHNOLOGY

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Basics of Data analysis for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Contents:

Definition, length scales, classification of nanomaterials, effect of particle size on thermal, mechanical, electrical, magnetic, and optical properties of the nanomaterials, Inspiration from Nature about nanotechnology (or Nanobiotechnology). Synthesis of nanomaterials: Top down approaches like ball milling, severe plastic deformation, lithography (optical, UV-visible, Deep-UV visible, X-ray, e-beam), soft lithography etc., Bottom-up approaches like inert gas condensation, chemical vapor deposition, colloidal method, sol-gel method, and atomic layer deposition (ALD) and Laser nanomanufacturing. Synthesis and applications of nanowires; Synthesis, purification and applications of carbon nanotube (CNT); Synthesis of expanded graphite (EG)/graphene. Fabrication of nanocomposites; Clay-polymer, metal-polymer, CNT-polymer, EG-polymer and CNT-metal. Characterization of Nanomaterials; X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning probe microscopy (SPM), Raman spectroscopy, UV-visible spectroscopy, Laser particle size analyzer, and specific surface area analyzer (BET). Applications of nanomaterials in nanocomposites, electrical/electronics, solar cells, computer chips, display, nanofluids, ferrofluids, hydrogen storage, fuel cell, antibacterial fabrics, sensors, magnetic tapes, nanocomposite coating for wear and corrosion resistance, cosmetic and construction industries. Pros and cons of the nanomaterials and nanotechnology for the human being.

Text books/ Reference Books:

1. Textbook of Nanoscience and Nanotechnology by B.S. Murty and P. Shankar, Universities Press (India) Private Limited, 2012, 1st Edition.
2. Nanostructures and Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press, 2004, 2nd Edition.
3. Introduction to Nanoscience and Nanotechnology by Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, CRC Press, 2008, ISBN-13: 978-1420047790.

4. Introduction to Nanotechnology by Charles P. Poole, Jr., Frank J. Owens, Wiley, 2003, ISBN: 978-0-471-07935-4.
5. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects by Daniel L. Schodek, Paulo Ferreira, and Michael Ashby, Butterworth-Heinemann, 2009, 1st Edition.
6. Nanomaterials: An Introduction to Synthesis, Properties and Applications by Dieter Vollath, Wiley-VCH, 2ndEdn, 2013, ISBN: 978-3-527-33379-0.
7. Nanoscale Materials in Chemistry edited by Kenneth J. Klabunde and Ryan M. Richards, 2ndedn, John Wiley and Sons, 2009.
8. Nanocrystalline Materials by A I Gusev and AARempel, Cambridge International Science Publishing, 1st Indian edition by Viva Books Pvt. Ltd. 2008.
9. Springer Handbook of Nanotechnology by Bharat Bhushan, Springer, 3rdedn, 2010.
10. Carbon Nanotubes: Synthesis, Characterization and Applications by Kamal K. Kar, Research Publishing Services; 1stedn, 2011, ISBN-13: 978-9810863975.

4. Industrial Automation and Safety

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Foundry Processes
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	30/20/--/--

Course Contents:

Introduction to Automation: Definition and fundamentals of automation, reasons for Automating, basic elements of an automated system: Power, Program and control system

Advanced automation functions: safety, maintenance & repair diagnosis, error detection and recovery

Mechanization and Automation: Mechanization and automation, product cycle, hard Vs flexible automation, Capital- intensive Vs low cost automation, Types of systems-mechanical, electrical, hydraulic, pneumatic and hybrid systems, Automation using CAMS, Geneva mechanisms, gears etc.

Pneumatics and hydraulics: Hydraulic and pneumatic devices-Different types of valves ,

Actuators and auxiliary elements in Pneumatics & hydraulics , their applications

Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC

Robots and their applications: Introduction to robots, Types, Classifications, Selection of robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls:

Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications of robots

Factories act and rules - Workmen compensation act. Indian explosive act - Gas cylinder rules - SMPV Act - Indian petroleum act and rules. Environmental pollution act Manufacture, Storage and Import of Hazardous Chemical rules 1989 Indian Electricity act and rules. Overview of OHSAS 18000 and ISO 14000

Text books/ Reference Books:

1. Industrial Automation and Robotics: An Introduction, A.K. Gupta, S.K. Arora, Jean Riescher Westcott · 2016

2. The Factories Act 1948, Madras Book Agency, Chennai,

3. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.

4. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd., New Delhi.

5. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.

6. Explosive Act, 1884 and Explosive rules, 1883 (India), (2002), Eastern Book company, Lucknow, 10th Edition

7. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.

8. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria& Sons, Delhi

ELECTIVE II for semester II

1. HUMAN RESOURCE MANAGEMENT

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Basics of Data analysis for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course content:

1. Overview of Human Resource Management:- Evolution of Human Resource Management from commodity approach to systems approach. Activity of Human Management – Perspective and challenges.

2. Role of Human resource Management:- Human resources Management of work Changing Environmental and Human resource Management Objectives and Importance of HRM to-day and tomorrow.
3. Human Resource Planning: Human resource planning on macro level, Human resource planning in India Challenges and Possible solutions, Human Resource Demand Forecasting Supply forecasting. Preparing actions plan.
4. Human resource planning at micro level:- Job analyses,- uses of job analyses; Methods and process of job analyses, Job description and job specification, Examples and exercise.
5. Procurement of Human Resource: Recruitment – Meaning and Process Formulating recruitment Policy, Evaluation of Recruitment Sources Modern Techniques of Recruitment Sources – Internet Based , Placement Agencies
6. Selection of Human Resource: Meaning and Process, Selection Hurdles – Application Blank, Employment Test – Utility and Validity, Employment Interviews, Principles and Techniques, Medical Text, referenced Cheek Appointment – Terms and Conditions.
7. Training for Development: Concept of Training and Developing ,Steps in Training and Development, Training Process: Identification of Training Needs, Sources of Information, designing the Program, Methods of Training Uses, Advantages and Disadvantages, Evaluation of Training, Evaluation of Procedures.
8. Performance Appraisal: Definition, Objectives, Essential of Performance appraisals and problems of performance appraisal process of Performance appraisal – Self Assessment and importance, Methods of Performance Appraisal – Traditional and Modern Methods – Straight Ranking Method, Peared Comparison Method, Critical Incident Method, Behavioral Anchored Rating Scale.

Test books/Reference Books :

1. Managing Technical People – Humphrey –Pearson.
2. Management of Organizational Behavior Leading Human Resources – Hersey.
3. Strategic Human Resource Management – Greer.
4. Managing Human Resources – Gomez – Mejm.
5. A framework for Human Resource Management – Dessler.

2. PRODUCTION AND OPERATION MANAGEMENT

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Basics of Data analysis for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Content:

1. Introduction: Relation between production and operations and other functions, products and services, impact of information technology on productions and operations management, Business strategy- competitive priorities, developing operations strategy, productivity and competitiveness.
2. Product and Service Design: Traditional and concurrent product design, design for manufacture, service, assembly, Design of services, types of services, Quality of design, costs of quality
3. Forecasting Models: Classification, simple and weighted moving average method, exponential smoothening methods: additive model, trends and seasonality model, mixed model, Regression (linear and multiple) models, causal model, measures of forecasting accuracy, reliability of forecasts
4. Aggregate Production Planning: Production planning strategies, aggregate production planning model, chase demand and level workforce strategies, and techniques- trial and error, linear programming, transportation model, dynamic programming, Master production schedule, Materials requirement planning - structure and application; Capacity planning-measures and methods to generate capacity, Aggregate planning for services- yield management
5. Operations Scheduling: Approaches to scheduling – infinite and finite loading, forward or backward scheduling, Assignment model for assigning jobs to work centers, dispatching rules for scheduling n jobs on one machine, composite rules, scheduling with Johnson's rule – n jobs-2 stations with same and different sequence, 2 jobs-n stations (graphical method), preparation of Gantt's chart, job shop scheduling, open shop scheduling, dynamic scheduling in flexible manufacturing systems, employee scheduling for service.
6. Independent Demand Inventory Management: Classification, EOQ models, order timing decisions, Safety Stock and reorder level decisions. Order quantity and reorder point, Continuous review systems, periodic review systems, selective inventory control - ABC analysis, Multi-item and Coordinated Replenishment Models- Spare parts and maintenance inventory models,
7. Inventory models with probabilistic demands: Single period discrete probabilistic demand model, multiple period probabilistic models
8. Theory of constraints: Optimized Production Technology, Drum-rope-buffer models, Constant- WIP (CONWIP) models, Planning and Control of JIT Systems

Test books/ Reference Books:

1. R. B. Khanna, (2007), Production & Operations Management, PHI
2. Martin K. Starr, (2007), Production & Operations Management, India Edition, Cengage Learning
3. Dr. K.C. Arora,(2009), Production & Operations Management, University Science Press (Laxmi Publications Pvt. Ltd.)
4. Edward S. Buffa & Rakesh K. Sarin, (2010), Modern Production / Operations Management, 8/e, Wiley India Pvt. Ltd.
5. Joseph S. Martinich, (2010), Production & Operations Management- An Applied Modern Approach, Wiley India Pvt. Ltd.
6. Everett E. Adam Jr, & Ronald J. Ebert, Production & Operations Management,
7. Jay Heizer, Barry Render & Jagdeesh Rajshekhar, (2009), Operations Management, 9/e, Pearson Education

8. Lee J. Krajewski & Larry P Ritzman, Operations Management- Strategy & Analysis, 6/e, Pearson Education.

9. Inventory management and Production Planning and Scheduling by E Silver, D Pyke and R Peterson, Wiley India
10. R Tersine, Principles of Inventory and Materials Management, Pearson Education
11. B. Mahadevan, (2007), Operations Management- Theory & Practice, Pearson Education
12. Panneerselvam R., (2006), Production & Operations Management, PHI
13. Silver, Pyke & Peterson, Inventory Management & Production Planning & Scheduling 3/e, John Wiley & Sons

3. COSTING AND COST CONTROL

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Basics of Data analysis for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Content:

SECTION – I

1. Introduction: (a) Concept of cost, cost unit, cost center, classification of cost, different costs for different purposes. (b) Definition of costing, cost-price-profit equation, desirable conditions for a costing system.
2. Cost Estimating: Definition, purpose and functions of estimation, role of estimator, constituents of estimates, estimating procedures.
3. Estimation of Weight and Material Cost: a) Process of breaking down product drawing in to simpler elements or shapes, estimating the volume, weight and cost b) Review of purchasing procedure, recording of stock and consumption of material by LIFO, FIFO, Weighted average method
4. a) Estimation of foundry cost: Constitutes, direct cost, indirect cost, Procedure of estimation foundry cost b) Estimation of machining cost: Constituents, direct cost, indirect cost, Procedure of estimation of machining cost.
5. Machine hour rate: definition, constituents, direct cost, indirect cost, steps for estimation of machine hour rate for conventional machines, CNC lathe and machining centre
6. Labour Cost – Direct and indirect labour, Workmen classification, Definition of wages, Methods of remuneration

SECTION –II

7. Overheads: Elements of overheads, classification, general considerations for collection, analysis of overheads, different methods for allocation, apportionment, absorption of overheads.

8. Cost Accounting Methods: Job costing, Batch costing, Unit costing, Process costing, Contract costing, Activity based costing
9. Cost Control: Use of cost data for policymaking and routine operation, control techniques such as budgetary control, standard cost, variance analysis, marginal cost and break even analysis
10. Cost Reduction Areas: Procedures and systems in product, methods and layouts, administrative and marketing, rejection analysis, cost of poor quality, value analysis and value engineering, Zero Base Budgeting
Note: Numerical treatment on topics 3, 4, 5, 7, 8 and 9 is essential.

Text books/ Reference Books:
1. Principles & Practice of Cost Accounting – N. K. Prasad (Book Syndicate Pvt. Ltd.)
2. Costing Simplified: Wheldom Series – Brown & Owier (ELBS)
3. Cost Accounting: B. Jawaharlal (TMH)
4. Cost Accounting: R.R. Gupta.
5. Cost Accounting, 13/e - B. K. Bhar, (Academic Publishers, Kolkata)
6. Cost Accounting: Jain, Narang (Kalyani Publishers)
7. A Text Book of Estimating and Costing Mechanical – J.S. Charaya & G. S. Narang (Satya Prakashan)
8. Mechanical Estimation and Costing – TTTI, Chennai (TMH)
9. Theory & Problems of Management & Cost Accounting – M.Y. Khan, P. K. Jain (TMH)

4. QUALITY MANAGEMENT SYSTEM

Course Type: Theory / Practical	Theory
Required/Elective	Elective
Prerequisite	Basics of Data analysis and interpretation for research
Teaching Scheme (Lecture/Practical/Tutorial/Drawing)	04/00/00/00 Hours
Total contact Hours (Lecture/Practical/Tutorial/Drawing)	50/00/00/00 Hours
Evaluation Scheme: Theory Theory Paper /Term Work/Oral/Practical	40/10/--/--

Course Content:

1. Scope, Contest of the organization, Leadership, Planning, support, Operation, Performance evaluation, Improvements.

2. Executive Overview, ISO 9001:2015 Compliance, Documentation and Implementation, Internal Auditing, IATF (The International Automotive Task Force)

Text books/ Reference Books:

1. ISO 9001 QMS

LIST OF EXPERIMENTS

Semester I

Sr. No.	Name of Experiment
1.	Surface defects finding using Liquid penetrant testing
2.	Sub-Surface defects finding using Magnetic particle testing
3.	Internal defects finding using Ultrasonic testing
4.	Internal defect interpretation using Radiography testing (Radiographs)
5.	Microstructure analysis using replica method
6.	Grain size measurement by Line-Intercept method
7.	Study of Deformation behaviour of ductile and Brittle materials
8.	Study of Recrystallization of metal at cold and hot working.

Semester II

Sr. No.	Name of Experiment
1.	Prepare 3D model of objects using suitable modelling software
2.	Simulate the metal flow and evaluate the design using simulation software

M. VOC IN FOUNDRY TECHNOLOGY PART-II

Level	Semester	Subjects	Credits
Level 8	Semester I	1. Design of Experiment and Research Methodology	3
		2. Concepts in Material Science	3
		3. Advances in Iron and Steel Making	3
		4. Mechanical Behaviour of Materials	3
		5. Elective I	3
		Metal Testing Lab	12
		Seminar I	3
	Semester II	1. High Pressure Die Casting	3
		2. Industrial Engineering	3
		3. Total Quality Management	3
		4. Entrepreneurship Development	3
		5. Elective II	3
		CAD and Simulation Lab	12
		Seminar II	3
Level 9	Semester III	Industrial Training and Report	16
		Seminar III	3
		Dissertation Phase I	11
	Semester IV	Dissertation Phase II	30

M.VOC. (FOUNDRY TECHNOLOGY) SEMESTER– III

1. INDUSTRIAL TRAINING AND REPORT

Course Type: Theory / Practical	Practical
Required/Elective	Required
Evaluation Scheme:	200

The purpose of industrial training is to offer wide range of practical exposures to latest practices, equipment and techniques used in the field. This training programme will help the student in acquiring hands on experiences of various practices and events required to perform in different job situations. Through the industrial training the students are given an opportunity to develop psychomotor skills and problem-solving ability.

The industrial Training has basically the following three components:

1. Industrial Training in the Industry

2. Report Writing and Evaluation

2. SEMINAR- III

Course Type: Theory / Practical	Theory
Required/Elective	Required
Evaluation Scheme:	50

Seminar - III shall be based on topic of the Dissertation Work. It may include literature review, required theoretical input, study and comparison of various approaches for the proposed dissertation work. The candidate shall prepare a report of about 25 pages. The report typed on A4 sized sheets and bound in the prescribed format shall be submitted after approval by the Guide and endorsement of the Head of Department. It will be assessed for term work.

DISSERTATION:

Course Type: Theory / Practical	Practical
Required/Elective	Required
Evaluation Scheme:	200

The dissertation work to be carried out individually commences in the Semester III and extends through Semester IV. The topic of dissertation work related should be related to the areas of Foundry/Casting and related applications. Applications of computer as a tool for conceptualization, design, analysis, optimization, manufacturing, manufacturing planning /management, quality engineering, simulation of products / processes / mechanisms / systems, experimental study, etc. are to be encouraged and preferred.

SYNOPSIS APPROVAL The Head of the Department and/or Principal shall appoint a Guide and one External expert to review and approve. The candidates shall submit the synopsis to the College/Department in the prescribed format before the due date.

DISSERTATION PHASE - I It shall include the problem definition, literature survey, approaches for handling the problem, finalizing the methodology for the dissertation work and design calculations / experimental design etc. A report of the work shall be submitted at the end of Semester III after approval by the Guide and endorsement of the Head of Department. It will be assessed for term work, by the evaluation committee (*) appointed by the Head of the Department, for appropriateness, sufficiency of contents and offer suggestions if any.

M.VOC. (FOUNDRY TECHNOLOGY) SEMESTER– IV

DISSERTATION PHASE II

Course Type: Theory / Practical	Practical
Required/Elective	Required
Evaluation Scheme: Internal/External	150/300

The candidate shall submit the detailed report as per the synopsis approved by the Department/College/Approval Committee, of the dissertation work in the prescribed format after approval by the Guide and endorsement by the Head of the Department. It will be assessed for term work by the evaluation committee (*) appointed by the Principal/Head of the Department, for completion of the proposed work.

(*) Note: The evaluation committee shall consist of the Guide, one External expert faculty member and the Head of the Department or his/her representative.

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