GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-V

Course Title: Advance Foundry
(Course Code: 4352106)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	5th Semester

1 RATIONALE

Diploma metallurgy engineers must be aware about the advancement in foundry by modernization and mechanization of production, equipment and working conditions to reduce the cost and to increase the productivity of casting. The further aim of this course is to understand the mechanism of solidification, principles of gating and risering system and their importance to get the sound castings. The course shall help the students to study the foundry practices of ferrous and non-ferrous metals & alloys for alloy development, process design and material selection for specific application.

2 COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- Utilize advance foundry knowledge to manufacture cast products that meet specified service conditions.

3 COURSE OUTCOMES (COs)

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

CO1: Discuss about the advancement in foundry shop.

CO2: Explain the mechanism of solidification in pure metals and alloys.

CO3: Understand the principle of gating and risering design for castings.

CO4: Select appropriate foundry practice for production of ferrous and non-ferrous metals & alloys.

4 TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	2	3	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA**- Continuous Assessment; **ESE** -End Semester Examination.*

5 SUGGESTED PRACTICAL EXERCISES

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Analyze quality aspects and safety measures followed in foundry during industrial visit.	I	4
2	Measure the fluidity of liquid metal.	II	2
3	Design gating and riser system.	III	4
4	Observe the microstructure of cast steels.	IV	4
5	Prepare Simple pattern for steel castings.	IV	4
6	Measure the size of graphite flakes and types in cast iron.	IV	4
7	Melt and cast given Al in foundry shop.	IV	6
	Total Hours		**28**

Notes:

1. More Practical Exercises can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
2. The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed Practical Exercises of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs.	Weightage in %
1	Identification of equipment/tools/setup/materials required for the experiment & preparation of experimental setup	20
2	Operate equipment setup, observation and recording of results	20
3	Interpretation of the result and conclusion	20

4	Active participation and response to the questions asked regarding the experiment	10
5	Safety measures and good housekeeping	10
6	Submission of report in time and attendance in the laboratory	20

6 MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Metallurgical Microscope (up to 1000x magnification)	4, 6
2	Wheel Grinder and Belt Grinder, Emery Papers (120, 220, 320, 400, 600, 800, 1000, 1200, 1500, 2000, 3000 grit), Double Disc Polishing Machine, 2% Nital as etchant	4, 6
3	Standard steel samples in cast condition	4
4	Standard graphite flake size chart jointly prepared by American Foundrymen's Association (AFA) and American Society of Testing Materials (ASTM)	6
5	Gray cast iron samples	6
6	Pattern of any simple shape, Mold with gating system, Electrically heated resistance furnace, Crucible, Skimming bar, Thermocouple or Pyrometer	7
7	Pure Al or Scrap Al, Molding sand, Grain refiners (Sodium or Ti), Flux (Nacl)	7

7 AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned Cos. More could be added to fulfill the development of this course competency.

- Make the foundry economical and quality production on mass scale by modernization and mechanization of production, equipment and working conditions.
- Apply principles of gating and risering design for effective solidification process.
- Follow ethical practices while selecting a proper metal or alloy for any applications considering safety of society and environment.
- Design and modification of ferrous and non-ferrous alloys for specific application.

8 UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes	Topics and Sub-topics
UNIT-I Introduction to Advance Foundry	1a. State importance of foundry industry in modern scenario 1b. Describe advancement in material handling system in foundry 1c. Describe quality aspects, pollution control and safety measures in foundry shop	1.1. Importance of foundry industry in modern scenario 1.2. Advancement in material handling system in foundry 1.3. Quality aspects in foundry 1.4. Pollution control in foundry 1.5. Safety measures in foundry shop
UNIT-II Solidification of Metals	2a. Explain the mechanism of solidification 2b. Explain the solidification of pure metals and alloys 2c. Describe structure properties relationship for alloys and prediction of solidification 2d. State characteristics of liquid metals	2.1. Cooling curves for pure metals and alloys 2.2. Concept of nucleation and growth 2.3. Solidification of pure metals 2.4. Solidification of alloys 2.5. Structure properties relationship and solidification time 2.6. Characteristics of liquid metals and their relevance to casting practice
UNIT-III Principles of Gating and Risering Design for Castings	3a. Explain the principle of gating design for castings 3b. Explain the types of gating system 3c. Explain the principle of riser design for castings 3d. Describe the risering methods for casting 3e. Describe different feeding aids used in risering design	3.1. Gating system design 3.2. Concept of progressive and directional solidification 3.3. Gating ratio, types of gating-pressurized and unpressurised gating system 3.4. Riser efficiency and riser design variables 3.5. Feeding and chills effect

UNIT-IV Melting and Casting Practice for Ferrous and Non-ferrous Metals & Alloys	4a. State the metals cast in foundry industry 4b. Describe foundry practices for production of steel and different cast irons 4c. State engineering properties of Al casting alloys 4d. Explain foundry practices of Al and Cu- base castings 4e. State the advantages and limitations of Al and Cu castings	4.1. Classification of foundry alloys 4.2. Melting and casting practice for production of steel castings 4.3. Melting and casting practice for production of cast iron 4.4. Casting properties of Aluminium & copper alloy 4.5. Melting practice of Aluminum & copper alloy 4.6. Advantages and limitations of Al and Cu castings

9 SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Advance Foundry	04	03	04	03	10
II	Solidification of Metals	06	03	10	03	16
III	Principles of Gating and Risering Design for Castings	09	07	08	07	22
IV	Melting and Casting Practice for Ferrous and Non-ferrous Metals and Alloys	09	07	12	03	22
Total		**28**	**20**	**34**	**16**	**70**

Legends: R= Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

Notes:

1. This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may slightly vary from above table.
2. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

10 SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-

curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group:

1. Industrial visit of any advance foundry plant.
2. Make a report based on the observations of various materials and basic/advanced tools being used in visited foundry.
3. Prepare a layout of integrated advance foundry plant.
4. Discuss on environmental issues and control in the foundry shop.
5. Prepare safety plan to be used in the event of an accident in foundry shop.
6. Prepare a list of various fluxes used in melting practices for the casting production of ferrous and non-ferrous metals & alloys.
7. List out relevant ASTM standards used for various testings of cast ferrous and non-ferrous metals & alloys.

11 SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) 'L' in section No. 4 means different types of teaching methods that is to be employed by teachers to develop the outcomes.
d) About 20% of the topics/sub-topics which are relatively simpler or descriptive in nature is to be given to the students for self-learning, but to be assessed using different assessment methods.
e) With respect to section No.10, teachers need to ensure to create opportunities and provisions for co-curricular activities.
f) Guide students on how to address issues on environment and sustainability.
g) Encourage students to read codes and standards.

12 SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that he/she contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of

individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Selection of various materials used for specific casting for specific application.
2. Seminar/presentation on advancement in foundry.
3. Prepare chart/model for Foundry plant.

4. Make a report on collection of different final casting products and identify the possibilities of casting processes from which it is made.
5. Make a report on environmental impact of foundry.
6. Compare suitability of different cast irons for service conditions.
7. A literature review on specific ferrous or non-ferrous casting for specific application.

13 SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Principle of Foundry Technology	P. L. Jain	Publisher: Tata McGraw Hill Inc. Year: 2017 ISBN -10: 0070151296 ISBN -13: 978-0070151291
2	Foundry Technology	Beeley Peter	Publisher: Heinemann Pvt. Ltd., New Delhi Year: 2001 ISBN-10: 0750645679 ISBN -13: 9780750645676
3	Principles of Metal Casting	Rechard W. Heine, Carl R. Loper & Philip C. Rosenthal	Publisher: Tata McGraw -Hill Publishing Co. Ltd., New Delhi Year: 2011 ISBN- 13: 9780070993488, ISBN- 10: 0070993483
4	Fundamental of metal Casting technology	P. C. Mukherjee	Publisher: Oxford & IBH Publishing Company Private Ltd., New Delhi

			ISBN: 8120403630 ISBN: 9788120403635
5	Fundamentals of Metal Casting	Richard A. Flinn	Publisher: Addison-Wesley Educational Publishers Inc ISBN-10 : 0201020203 ISBN-13 : 978-0201020205
5	Foundry Technology	O. P. Khanna	Publisher: Dhanpat Rai Year: 2011 ISBN-10: 8189928341 ISBN -13: 9788189928346
6	ASM Handbook Volume 15: Casting	ASM International	Publisher: ASM International Year: 2008 ISBN: 978-0-87170-711-6

14 SOFTWARE/LEARNING WEBSITES

- https://onlinecourses.nptel.ac.in/noc23_me48/preview
- http://efoundry.iitb.ac.in/index.html
- https://www.doitpoms.ac.uk/tlplib/microstructural_exam/castiron.php
- https://www.doitpoms.ac.uk/tlplib/casting/microsegregation.php
- https://www.industr.com/en/meeting-optimal-production-rates-with-automated-material-handling-syst-2673863

15 PO-COMPETENCY-CO MAPPING

Semester V	**Advance Foundry (Course Code:4352106)**						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline Specific Knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ Develop-ment of Solutions**	**PO 4 Engineering Tools, Experimentation & Testing**	**PO 5 Engineering Practices for Society, Sustainability & Environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long Learning**
Competency	Utilize advance foundry knowledge to manufacture cast products that meet specified service conditions.						
CO1: Discuss about the advancement in foundry shop.	3	3	2	2	2	2	2
CO2: Explain the	3	3	2	2	-	1	1

mechanism of solidification in pure metals and alloys.							
CO3: Understand the principle of gating and risering design for castings.	3	3	2	1	-	2	1
CO4: Select appropriate foundry practices for production of ferrous and non-ferrous metals and alloys.	3	2	2	2	-	2	1

Legend: '3' for high, '2' for medium, '1' for low or '-' for the relevant correlation of each competency, CO, with PO/ PSO

16 COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Person

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