

GUJARAT TECHNOLOGICAL UNIVERSITY

METALLURGY ENGINEERING (21) FUELS, FURNACES, REFRACTORIES AND PYROMETRY SUBJECT CODE: 2152104 B.E. 5th SEMESTER

Type of course: Engineering Science

Prerequisite: Knowledge of Elements of Metallurgy and basic science skills

Rationale: The Fuels, Furnaces, Refractories and Pyrometry course is to prepare students for careers in metallurgy engineering where knowledge of Fuels, Furnaces, Refractories and Pyrometry can be applied to the advancement of technology. All important metallurgical operations like extraction of metals, melting, heat treatment etc. are carried out in various metallurgical furnaces. Fuels are basic requirements of furnaces and play a major role in quality and cost of any metallurgical product. Optimum utilization and quality control of fuel is must in metallurgical operations. Refractories are very important material for construction of furnaces which help in the efficient utilization of heat in furnace. Knowledge of Temperature Measurement and Control is must for functioning of furnaces. Thus Fuels, Furnaces, Refractories and Pyrometry course will enable students to solve metallurgical problems upon graduation while at the same time, provide a firm foundation for the pursuit of graduate studies in metallurgy engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
PA	ALA	ESE		OEP						
4	0	2	6	70	30	00	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Temperature Measurement and Control: Basic concept of temperature measurement and control. Thermocouples: Principal, calibration, types and advantages. Optical and Radiation pyrometers: principle, construction, working and advantages.	10	17
2	Fuels - General : Definition, Comparative study of solid, liquid and gaseous fuels. Constitution, classification and grading of coal. Testing of fuels like: Grindability, Caking properties, calorific value, Proximate and ultimate analysis, Flash and Fire point, viscosity etc. Non-conventional Energy Resources like Nuclear fuel, Solar, Wind, Geo-thermal, Bio-mass, Hydrogen etc.	10	16
3	Fuels - Manufacturing: Carbonization of coal: Coke making and by-products. Producer gas, Water gas, Natural gas, LPG, Blast furnace gas, Coke oven gas, LD gas. Storage of fuels. Combustion of fuels and problems based on air supplied, excess air and products of combustion.	12	20
4	Furnaces: Definition and Classification of Furnaces, Batch furnaces, Continuous furnaces. Construction and working of furnaces like Cupola, Induction furnace, Arc furnace, Resistance furnace, Pit furnace, Rotary furnace, Muffle furnace etc.	18	30

	Evolution of heat and flame temperature. Available heat. Natural, forced, induced and balanced draft. Chimney height, Heat losses in furnaces and minimization. Waste heat recovery.		
5	Refractories: Definition, Classification, Properties and testing of refractories. General Production method of refractories, Selection of refractories for metallurgical applications, Special types of refractories.	10	17
Total		60	100

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	30	30	10	10	05

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Elements of Fuels, Furnaces and Refractories, O. P. Gupta, Khanna publication.
2. Fuels, Furnaces and Refractories, J. D. Gilchrist
3. Fuels, Furnaces, Refractories and Pyrometry, -A.V.K. Suryanarayana, B. S. Publication
4. Industrial Furnaces - Vol. I & II, W. Trinks and M. H. Mawhiney, Wiley
5. Refractories, F.H.Norton, McGraw-Hill
6. Refractories, M. L. Mishra

Course Outcome:

After learning the course the students should be able to:

1. Explain various temperature measurement and control devices.
2. Compare different types of fuels and describe their testing methods.
3. Explain the coke making process and its by-products recovery.
4. Explain the use of different Non-conventional energy Resources for metallurgical applications.
5. Explain different aspects of Combustion process of fuels and Solve problems based on this.
6. Classify and explain Construction and working of different furnaces.
7. Analyze causes of Heat losses in furnaces and suggest methods of minimization it and Waste heat recovery.
8. Explain various Properties, manufacturing and testing of refractories.
9. Select the relevant refractory material for the metallurgical operations.
10. Demonstrate the ability to use the core concepts of engineering application in Fuels, Furnaces, Refractories and Pyrometry.
11. Demonstrate the ability to select the proper type of furnace with relevant refractory material, use appropriate Fuel and temperature measurement device to obtain qualitative solutions of given metallurgical operation.

List of Experiments:

1. To study working of thermocouple and calibrate a given thermocouple.
2. To measure the temperature of a red hot object using Optical /Radiation Pyrometer.
3. To study and identify different types of fuels.
4. To carry out proximate and ultimate analysis of a given coal sample.
5. To determine calorific value of a solid and liquid fuel.
6. To determine Flash and fire point of a fuel oil.
7. To determine the viscosity (in 'Redwood seconds') of a liquid hydrocarbon and effect of temperature on the viscosity.

8. To study the different types of furnaces.
9. To study the properties and applications of different refractories.
10. To determine permeability number of a refractory sample.
11. To study pyrometric cone equivalent (PCE) test of a refractory sample.

Design based Problems (DP)/Open Ended Problem:

1. Chart of different temperature measurement and control devices.
2. Problems based on Combustion of fuels.
3. Chart of different Furnaces.
4. Chart of flow-sheet of refractory production.
5. Collection and Study of various types of fuel, refractories and temperature measurement devices.
6. Group discussion and Presentations on recent fuel scenario and advancement in furnace technology.
7. Any other problem decided by faculty based on syllabus.

Major Equipment:

1. Thermocouples
2. Milivoltmeter
3. Thermometer
4. Optical / Radiation Pyrometer
5. Muffle furnaces
6. Dessicators
7. Kjeldahl's flask
8. Digital electronic balance
9. Bomb-Calorimeter
10. Pensky-Martens Apparatus
11. Redwood Apparatus No. 1 and 2
12. Permeability meter

List of Open Source Software/learning website:

1. <http://nptel.iitm.ac.in/>
2. www.ocw.mit.edu

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.