### Scheme of Teaching and Examination

**B.E. (V Semester) Metallurgical Engineering**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Board of Study</th>
<th>Subject Code</th>
<th>Subject</th>
<th>Periods per Week</th>
<th>Scheme of Examination</th>
<th>Total Marks</th>
<th>Credit</th>
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<td>L</td>
<td>T</td>
<td>P</td>
<td>ESE</td>
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<tr>
<td>1</td>
<td>Metallurgical Engineering</td>
<td>338551 (38)</td>
<td>Transport Phenomenon in Metallurgical Process</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>80</td>
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<tr>
<td>2</td>
<td>Metallurgical Engineering</td>
<td>338552 (38)</td>
<td>Industrial Pollution and Control</td>
<td>3</td>
<td>1</td>
<td>-</td>
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<tr>
<td>3</td>
<td>Metallurgical Engineering</td>
<td>338553 (38)</td>
<td>Iron Making</td>
<td>3</td>
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<td>4</td>
<td>Metallurgical Engineering</td>
<td>338554 (38)</td>
<td>Mechanical Working Processes</td>
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<td>5</td>
<td>Metallurgical Engineering</td>
<td>338555 (38)</td>
<td>Non Ferrous Extraction Metallurgy</td>
<td>3</td>
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<td>6</td>
<td>Metallurgical Engineering</td>
<td>338556 (38)</td>
<td>Phase Diagram &amp; Phase Transformation</td>
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<td>7</td>
<td>Metallurgical Engineering</td>
<td>338561 (38)</td>
<td>Transport Phenomenon Lab</td>
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<td>338562 (38)</td>
<td>Mechanical Working Processes Lab</td>
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<td>Phase Transformation Lab</td>
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<td>Iron Making Lab</td>
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<tr>
<td>11</td>
<td>Humanities</td>
<td>300565 (46)</td>
<td>Personality Development</td>
<td>-</td>
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<td>12</td>
<td>Metallurgical Engineering</td>
<td>338566 (38)</td>
<td>*Practical Training Evaluation and Library</td>
<td>-</td>
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### Total

|   | 20 | 5 | 15 | 640 | 120 | 240 | 1000 | 35 |

**L:** Lecture  
**T:** Tutorial  
**P:** Practical  
**ESE:** End Semester Examination  
**CT:** Class Test  
**TA:** Teacher’s Assessment

*Industrial Training of eight weeks is mandatory for B.E. student. It is to be completed in two parts. The first part will be in summer after IV sem. after which students have to submit a training report which will be evaluated by the college teachers during B.E. V semester.*
**Chhattisgarh Swami Vivekanand Technical University, Bhilai**

**Name of the Programme:** Bachelor of Engineering  
**Duration of the Programme:** Four years

**Branch:** Metallurgical Engineering  
**Semester:** V  
**Subject:** Transport Phenomenon in Metallurgical Process  
**Code:** 338551(38)

**Total Theory Periods:** 48  
**Total Tutorial Periods:** NIL

**No. of class Tests to be conducted:** 2 (Minimum)  
**No. of assignments to be submitted:** 2 (Minimum)

**ESE Duration:** Three Hours  
**Maximum Marks in ESE:** 80  
**Minimum Marks in ESE:** 28

**OBJECTIVE:**
To learn the concepts behind energy and mass flow in metallurgical furnaces and chimneys. Solve numerical based on these phenomena to evaluate the missing parameter.

**EXPECTED OUTCOME:**
Students will be comfortable in the crucial concepts and their application in finding out the required values in a given set of constraints. They will realize the reasons behind the limitations in the actual and theoretical values in the mass and energy flow system.


**UNIT IV** Mass transfer and kinetics: Steady(state) one dimensional mass diffusion of component through stationary media. Convective mass transfer in fluids, concept of concentration boundary layer, Mass transfer coefficient. Heterogeneous reactions of metallurgical importance and the rate controlling steps. Nucleation and growth and bubble formation phenomenon, Interfacial reaction, Carbon gasification by CO₂, slag-metal reaction at the interface, Topo-chemical model of gas-solid reaction.


**NAME OF TEXTBOOKS:**
1. Ghosh and Ray–Principles  

**TEACHING METHODOLOGY:**
Delivering the concepts on board and rigorously training students for solving the numerical based on the concepts delivered.  
Case study for the reactors and furnaces for the theoretical and practical mismatch of the mass and energy flow.
Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Programme: Bachelor of Engineering
Duration of the programme: Four years

Branch: Metallurgical Engineering
Subject: Industrial Pollution & Control
Semester: V
Code: 338552(38)

Total Theory Periods: 36
Total Tutorial Periods: 12
No. of class Tests to be conducted: 2 (Minimum)
No. of assignments to be submitted: 2 (Minimum)
ESE Duration: Three Hours
Maximum Marks in ESE: 80
Minimum Marks in ESE: 28

OBJECTIVE:
- To increase the awareness of the students towards the detrimental effects of the air pollutants emitted and solid wastes generated by various industries.
- To bring out the curiosity and the hidden potential of students towards suggesting methods to reduce such effect leading towards sustainable development.

EXPECTED OUTCOME:
Students will have an increased level of awareness towards environmental friendly industrial practice.

UNIT I

UNIT II
Air Pollution – Gaseous and particulates; primary and secondary air pollutants, hazardous effect of fly ash. Air pollution in industrial units; ferrous and non-ferrous metallurgical industries. Control of specific gaseous pollutants – SO₂, NO₂, CO₂ etc. Air pollution sampling and measurement. Air pollution control methods and equipment.

UNIT III
Water Pollution – caused by various industries, water pollution in selected process industries: integrated steel plants, electroplating & metal finishing industries,. NF industries waste water treatment technology in general; physical, chemical & biological processes.

UNIT IV
Pollution control for specific pollutants; removal of Cr, Cd, Hg, As, Sb, Pb.

UNIT V
Pollution control in selected process industries; Environmental aspects of sponge iron plants, pollutant emissions from alternative iron and steel making processes. Solid waste from coal, steel, non-ferrous industries; different disposal techniques, waste utilization techniques. Pollution control policies and laws.

REFERENCE BOOKS:
1. Air pollution – V. P. Kudesia
2. Pollution control in process industries – S.P. Mahajan
3. Environmental engineering – Pandey and Carney
4. Energy ecology, environment and society – Deswal and Deswal
5. Environment pollution= V. K. Prabhakar
6. Pollution and Health – P.K. Ray
7. Environmental Pollution control Engineering – Rao

TEACHING METHODOLOGY:
- Explaining the basics of various types of pollution and pollutants
- Using various facts and figures to show the increase in the level of pollutants post industrialization
- Using PPTs at appropriate time to show and compare data and animated video etc.
Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Programme: Bachelor of Engineering :: Duration of the programme: Four years

Branch: Metallurgical Engineering
Subject: Iron Making
Semester: V
Code: 338553(38)
Total Theory Periods: 36
Total Tutorial Periods: 12
No. of class Tests to be conducted: 2 (Minimum)
No. of assignments to be submitted: 2 (Minimum)
ESE Duration: Three Hours
Maximum Marks in ESE: 80
Minimum Marks in ESE: 28

COURSE OBJECTIVES

- To learn the processes of iron making through blast furnaces and other routes.
- To enhance the technical knowledge of the students over metallurgical Thermodynamics and Kinetics
- Apply basic scientific principles for technical problem solving in Iron Making areas to increase Technical Skills

EXPECTED OUTCOME

Blast Furnace is called as the mother in an integrated steel plant. So a good knowledge of iron making is a must for all metallurgists. Students will know the theory and practice of iron making through BF and also the alternative routes of iron making and production of Ferro alloys. They will have an wide range of acceptability after graduation

UNIT I

UNIT II

UNIT III

UNIT IV
Modern trends in Blast furnace practice - production and use of super-fluxes inter, pellets, and cold bonded pellets. Auxiliary fuel injection, High temperature, humidified and oxygen enriched blast, high top pressure. External Desulphurization of hot Metal.

UNIT V
Alternate routes of iron making: charcoal blast furnace, direct reduction processes. Applicability and present status of Technology in India. Production of Ferro-alloys. Ferro-alloy industries in India.

TEXT BOOKS:
1. The manufacture of Iron – G.R. Bashforth
2. Iron making and steel making; theory and practice- Ahindra Ghosh and Amit Chatterjee
3. Principles of Blast Furnace iron making–Dr. A. K Biswas
4. Production of ferro-alloys-Rissand Lipnitzky

REFERENCE BOOKS:
1. Makiingshaping and Treatingofsteel – US. Stel
2. Physical chemistry of iron and manufacture steel – Bodsworth C.h and S.Bell
3. The reduction of iron – Boodandy L.V. and S.j. Engell
4. The theory and practice – Blast Furnace ltd.– J.H. Siressearer
5. Blast Furnace Theory– I Practice Strauff

TEACHING METHODOLOGY

- Explaining the basic principles of treatment of iron ores, reactions inside the blast
- Furnace, thermodynamics and aerodynamics. The design features of BFs, advancement in BF technology. Alternative routes of Iron Making by: Lecture, PPT- Presentation, Class Discussions
- Students’ self study
- Tutorial Classes
- Interactions with the respective Faculty
- Industry Visit
COURSE OBJECTIVE

To learn the process of mechanical deformation of metals as well as the different techniques of metal forming.

EXPECTED OUTCOME

Metal forming is the final step in the processing of the metal. The process requires precision and a good combination of theory and practical knowledge. The student will be able to handle any job situation.

UNIT I
Fundamental concept of metal forming, plastic behavior, flow stress, yield criteria, shear stress, Von-mises theory classification of metal forming operations on the basis of cold, hot & warm working, effect of variables, speed of deformation, friction, lubricants, metallurgical structures, strain rate, temperature of metal working, heating of steels effect of incorrect heating, rate of heating.

UNIT II
Rolling-principle of metal rolling process, theory of longitudinal rolling, simple concept about angle of bite, spread, deformation coefficient, forward and backward slip, relationship between roll diameter and friction angle, specific roll pressure, power requirements.

UNIT III
Classification of rolling mills on the basis of roller arrangement, mill lay out and products, rolling mill equipment. Classification of rolled products, blooms billets, slabs, plates, strips, sheets, wire rod etc. important considerations in roll pass design, Rolling defects.

UNIT IV
Forging–Importance and characteristics of forging, fiber structure, open die and closed die forging typical forged products, Diematerials, forging equipments, Hammers and presses, calculation of forging load, selection of press/hammer capacity, special forging processes rotary swaging, roll pressure, horizontal forging, forging defects and their removal.

UNIT V

TEXT BOOKS:
1. MechanicalMetallurgy–Dieter
2. Rolling mill practice–Polukhia
3. Principles of metal working–Dr.SurendraKumar

REFERENCE BOOKS :
1. Theory of plastic working of metals–Masterovsky(mir)
2. Rolling practice–Burtsev
3. Principles of rolling–Chaturvedi
4. RollingMill–ASM
5. IndustrialMetalWorking–Rowe
6. Forging Practice–Kamenschikov

TEACHING METHODOLOGY
Explaining the basic principles of deformation and different techniques of metal forming. In addition to theory classes, students will visit the different industries and mills to have the first hand knowledge of the metal processing.
COURSE OBJECTIVE

Non-ferrous metals are the next to steel in its use and specialized application. Non-ferrous extraction is a vast and diverse field. A thorough understanding is required of the processes and technology. The knowledge of the basic processes of ore beneficiation and non-ferrous metal extraction processes is mandatory.

EXPECTED OUTCOME

The graduates will be able to work in any NF industry as well as can develop newer and better processes.

UNIT I
Discovery of metals and their importance, important landmarks, non-ferrous metals in Indian history, uses of non-ferrous metals. Non-ferrous metal production and consumption: global and Indian scenario. Sources of nonferrous metals. Sources in land and sea, exploration methods, methods of beneficiation. General methods of ore beneficiation; comminution, classification and concentration, electrostatic, magnetic separations.

UNIT II
Principles of metals extraction; Thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, principles of electro-chemistry. Pyro-metallurgy – calcinations, roasting and smelting, Hydrometallurgy – leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy – electrolysis and electro-refining.

UNIT III
Extraction of metals from oxide sources; Basic approaches and special features of specific extraction processes, Extraction of Magnesium by PIDGEON Process, Aluminum by Bayer process, Hall-Heroult Process, ALCOA Process, TOTH Process, ALCAN Process. Tin; smelting in a reverberatory furnace, pyro-refining of tin.

UNIT IV
Extraction of metals from sulphide ores; Pyro-metallurgy and hydro-metallurgy of sulphides, production of metals such as copper, lead, zinc, nickel etc. Extraction of zinc from horizontal and vertical retort processes, imperials melting process, production of other metals by ISP. Zinc from leads lag. Zinc production in India. Extraction of Lead: lead blast furnace; base bullion production. Modern developments in leads melting.

UNIT V

TEXTBOOKS:
- Extraction of Non-ferrous Metals – HS Ray, R Shridhar and KP Abraham
- Principles of Extractive Metallurgy-T. Rosenquist

TEACHING METHODOLOGY
Explaining the basic principles of treatment of ores, the basic principles of pyro, hydro and electro metallurgy and extraction processes for important Non-Ferrous metals.
Chhattisgarh Swami Vivekanand Technical University, Bhilai

Branch: Metallurgical Engineering  
Subject: Phase Diagram & Phase Transformation  
Semester: V  
Code: 338556(38)

Total Theory Periods: 48  
Total Tutorial Periods: 12  
No. of class Tests to be conducted: 2 (Minimum)  
No. of assignments to be submitted: 2 (Minimum)

ESE Duration: Three Hours  
Maximum Marks in ESE: 80  
Minimum Marks in ESE: 28

COURSE OBJECTIVE
To impart the knowledge of Phases, phase transformation, characteristics of different phases and their implication. These are the basics for metal treatment and processing.

EXPECTED OUTCOME
This will help in design and selection of alloys

UNIT I  
Introduction: Gibb’s phase rule, phases, component & degree of freedom, various types of phase diagram (Unary, Binary phase diagram), determination of phase fraction by using Lever rule, uses of phase diagrams, determination of phase diagrams.

UNIT II  
Thermodynamics related to phase diagrams-Gibb’s free energy for single and Binary solutions. Variation of free energy with temperature, Ideal and Regular solutions, chemical potential of a solution. Ordered and intermediate phases.

UNIT III  
Diffusion, Atomic mechanism of diffusion, interstitial & substitutional (self and vacancy) diffusion Fick’s law of diffusions, determination of diffusion coefficient, effect of temperature on diffusion coefficient, Kirkendal effect, Darken’s equation, application of diffusion in some metallurgical processes like carburizing & nitriding of steels.

UNIT IV  
Solidification- introduction to solidification, energetic of solidification, nucleation and growth mechanism, homogeneous and heterogeneous nucleation, growth of solids, different types of interfaces.

UNIT V  
Interphase interfaces in solids, coherent, semi-coherent & in-coherent interfaces, role of interfacial energy on fully coherent, partially coherent and in-coherent precipitates, interface and diffusion controlled growth.

TEXTBOOKS
- Phase transformation in metal and alloys- David A. Porter, E. Easterling & M. Y. Sherif.
- Physical metallurgy principles- Reed Hill.

METHODOLOGY
- Explaining the basic principles of alloying and phase transformation
- Lecture, PPT- Presentation, Class Discussions
- Students’ self study
- Tutorial Classes
**OBJECTIVE:** To determine material and energy flow during various metallurgical processes.

**METHODOLOGY:** By performing the list of experiments and analyzing the results to get a practical sense of the process.

**EXPECTED OUTCOME:** students will know the various factors driving the flow of energy and material in different metallurgical processes.

**LIST OF EXPERIMENTS:**

1. Determination of Heat Transfer in Natural Convection
2. Determination of heat transfer in forced convection.
3. Determination of thermal conductivity of metal Rod.
4. Determination of Parallel flow/counter flow by heat exchanger
5. Determination of thermal radiation by Stefan Boltzmann
6. Determination of thermal conductivity of Insulating powder
7. Determination of heat transfer through composite walls.
8. Determination of Emissivity by Emissivity measurement apparatus.
9. Fluid Bed heat transfer unit
10. Determination of Temp. of different materials at a given time.

**LIST OF EQUIPMENTS/MACHINERY REQUIRED:**

1. Natural convection unit
2. Thermal conductivity unit
3. Heat Exchanger
5. Emissivity measurement apparatus
6. Brass Tub fitted in a rectangular duct in a vertical fashion
7. Thermocouple
8. Ammeter
9. Voltmeter
10. Voltage stabilizer.

**RECOMMENDED BOOKS:**

Smith- Chemical Engineering Kinetics, McGraw Hill
Bird, Steward and Light foot- Transport Phenomenon John Wiley
OBJECTIVE: To learn the process of mechanical deformation of metals as well as the different techniques of metal forming.

METHODOLOGY: Explaining the basic principles of deformation and different techniques of metal forming. In addition to theory classes, students will visit the different industries and mills to have the first had knowledge of the metal processing.

EXPECTED OUTCOME: Metal forming is the final step in the processing of the metal. The process requires precision and a good combination of theory and practical knowledge. The student will be able to handle any job situation.

LIST OF EXPERIMENTS:

1. Rolling of metal strip
2. Calculation of – Angle of bite, C
   - Change in length
   - Change in width
   - Change in thickness
   - Spread
3. Study of roll passes
5. Study of microstructure of rolled product & rolling defects.
6. Study of various roll arrangements for rolling
7. Comparative study of Direct and Indirect Extrusion.
8. Study of open and closed Die forging.
9. Cold work - annealing cycle of copper-based alloys.
10. Drawing the Rolling mill layout.
11. Study of various forging equipments.
12. Calculation of forging load.
13. Sheet Metal

LIST OF EQUIPMENTS/MACHINERECQUIRED

1. Rolling mill
2. Models
3. Charts
4. Tables
5. Drawing
6. Video Clipping (CD)

RECOMMENDED BOOKS:

1. Metals Handbook
2. Making Shaping and Treating of Metals
3. Production Engineering By Jain
OBJECTIVE
1. introduce students to the basic understanding of the interpretations of iron-carbon diagrams and isothermal transformation diagrams
2. provide students with the skills needed to determine the temperatures to which steel must be heated to cause it to harden
3. Use TTT and CCT diagrams to predict conditions for the heat treatment of steels.
4. Explain how phase transformations control the microstructures of metals and ceramics.

METHODOLOGY
Explaining the basic principles of phase diagrams and heat treatment techniques of materials. In addition to theory classes, students will visit the different industries and mills to have the first had knowledge of the heat treatment and metal forming processes.

EXPECTED OUTCOME
Upon successful completion of this course, the student will be able to:
1. Describe important structural forms of steel and iron
2. interpret an iron-carbon diagram
3. evaluate several industrial isothermal transformation diagrams
4. recognize that different steels have very different isothermal transformation diagrams
5. cite the value of an isothermal transformation diagram and how it can be used;
6. differentiate between the different heat treatment procedures and the structural changes that accompany them
7. identify different structures of alloy;
8. understand the different structural changes that accompany structure modifications

LIST OF EXPERIMENTS
1. Experimental determination of a binary phase diagram
2. Solidification macro/microstructure of some single phase and eutectic alloys
3. Heat Treatment of Steels
4. Solidification Macrostructure of Cast Metals
5. Metallographic sample preparation to study phase changes
6. Microstructure of eutectic systems
7. Study of the Solidification History in Welded Microstructure of Steels
8. Study of pearlite transformation in eutectoid steel
9. Study of the TTT and CCT diagrams
10. Study of the rolling and recrystallisation annealing

LIST OF EQUIPMENTS/MACHINEREQUIRED
1. Microscopes (Optical and Electron Microscopes)
2. Muffle furnace and Induction furnace
3. Tubular furnace
4. Hot and Cold rolling machines
5. Polishing machines
6. Hot mounting press
7. Ultrasonic cleaner

RECOMMENDED BOOKS
1. Materials Science and Engineering, V. Raghvan
2. Phase Transformation in Metals and Alloys, D. A. Porter & K. E. Easterling
3. Physical Metallurgy, Lakhtin
**OBJECTIVE:** To learn the processes iron making through hands on training.

**METHODOLOGY:** To observe the design features of BFs and other processes by visit to industry, and doing literature survey.

**EXPECTED OUTCOME:** Students will know the theory and practice of iron making through BF and also the alternative routes of iron making

**LIST OF EXPERIMENTS:**

1. Study the layout of an integrated steel plant and indicate the role of BF
2. Study the auxiliary equipment in the BF Complex
3. Draw a cross-section of a BF and locate the different reaction zones within.
4. Study the effect of sinter/pellets on the productivity and coke rate in a BF
5. Study the effect of hot blast, humidification, auxiliary fuel injection on the productivity and coke rate in a BF
6. Study the desulfurization process of Hot Metal
7. Study of the alternative routes of iron making
8. Study of DRI process of iron making
9. Mass and heat balance in BF
10. Comparison between DRI and BF process of iron making with respect to economics and fuel efficiency.

**TEXTBOOKS:**

1. The manufactureofIron– G.R.Bashforth
2. Iron Making and Steel Making; theory and practice- AhindraGhosh and AmitChatterjee
3. PrinciplesofBlastFurnaceiron making–Dr.AKBiswas

**REFERENCEBOOKS:**

1. MakingshapingandTreatingofSteel–US.Steel
2. Physicalchemistry ofironandmanufacture steel–BodsworthC.h and S.Bell
3. The reductionofiron–Boadandy L.V.andS.j.Engell
4. The theoryandpractice–BlastFurnaceltd.–J.H.Siressearger
5. BlastFurnaceTheory–IPractice Strauff
**Course Objectives**

Upon completion of this course, the student shall be able

- To understand the concept of personality and image;
- To develop leadership, listening and interacting skills;
- To develop attitudinal changes;
- To develop decision-making qualities; and
- To communication skill.

### UNIT I  
**Personality concepts:** What is Personality – its physical and psychic aspects. How to develop a positive self-image. How to aim at Excellence. How to apply the cosmic laws that govern life and personality. How to improve Memory – How to develop successful learning skills. How to develop and effectively use one’s creative power. How to apply the individual MOTIVATORS that make you a self-power personality.

### UNIT II  
**Interpersonal Skills:** Leadership: Leaders who make a difference, Leadership: your idea, What do we know about leadership? If you are serious about Excellence. Concepts of leadership, Two important keys to effective leadership, Principles of leadership, Factors of leadership, Attributes. Listening: Listening skills, How to listen, Saying a lot- just by listening, The words and the music, How to talk to a disturbed person, Listening and sometimes challenging. How to win friends and influence people, How to get along with others. How to develop art of convincing others. How can one make the difference. How to deal with others particularly elders. Conflicts and cooperation.

### UNIT III  
**Attitudinal Changes:** Meaning of attitude, benefits of positive attitudes, How to develop the habit of positive thinking.

**Negative attitude and winning:** What is FEAR and how to win it. How to win loneliness. How to win over FAILURE. How to win over PAIN. How to win over one’s ANGER and others anger. What is stress and how to cope up with it? The art of self-motivation. How to acquire mental well-being. How to acquire physical well-being.

### UNIT IV  
**Decision Making:** How to make your own LUCK. How to plan goals/objectives and action plan to achieve them. How to make RIGHT DECISION and overcome problems. How to make a Decision. Decision making: A question of style. Which style, when? People decisions: The key decisions. What do we know about group decision making? General aids towards improving group decision making.

### UNIT V  
**Communication Skills:** Public Speaking: Importance of Public speaking for professionals. The art of Speaking - Forget the fear of presentation, Symptoms of stage fear, Main reason for speech failure, Stop failures by acquiring Information; Preparation & designing of speech, Skills to impress in public speaking & Conversation, Use of presentation aids & media.

**Study & Examination:** How to tackle examination, How to develop successful study skills.

**Group discussions:** Purpose of GD, What factors contribute to group worthiness, Roles to be played in GD.

### Course Outcomes:

- The students will be able to develop inner and outer personality exposure;
- The students will be able to develop effective leadership qualities and interacting skills;
- The students will be able to develop positive attitude, motivating skills and develop winning philosophies;
- The students will be able to develop decision-making tools; and
- The students will be able to develop group presentation, public speaking and impressive conversation.

### Text Books:

1. Basic Managerial Skills for all by E. H. McGrawth, prentice Hall India Pvt. Ltd., 2006

### Reference Books:

3. Personality: Classic Theories & Modern Research; Friedman ; Pearson Education, 2006