IPS ACADEMY-INSTITUTE OF ENGINEERING & SCIENCE, INDORE

(An Autonomous Institute Affiliated to RGPV, Bhopal)

Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

II Semester Master of Technology (M.Tech.)

[Industrial Safety Engineering]

S. No.	Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
			Theory			Practical						
			End Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem	Term work / Lab Work & Sessional		L	T	P	
1	PSCC-IS201	Hazardous Material Handling	70	20	10	-	-	100	3	1	-	4
2	PSCC-IS202	Computer Aided Risk Analysis	70	20	10	-	-	100	3	1	-	4
3	PSEC-IS201	Program Specific Elective Course-II	70	20	10	-	-	100	3	-	-	3
4	OEC-IS201	Open Elective Course-I	70	20	10	-	-	100	3	-	-	3
5	MLC-2	Research Methodology & IPR	70	20	10	-	-	100	3	1	-	2
6	LC- IS201	Emergency First Aid	-	-	-	60	40	100	-	-	4	2
7	LC-IS202	Computer Aided Risk Analysis	-	-	-	60	40	100	-	-	4	2
8	AUD-2	Project Management	-	-	-	-	-	-	2	-	-	0
		Total	350	100	50	120	80	700	17	3	8	20

Program Specific Elective Course (PSEC)-II	Open Elective Course (OEC)
PSEC IS201 (A) Work Study & Productivity Management	OEC IS201 (A) Operation Research
PSEC IS201 (B) Safety in Mechanical Industries	OEC IS201 (B) Energy Conservation & Audit
PSEC IS201 (C) Safety in Electrical Systems	OEC IS201 (C) Business Analytics

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PSCC- IS201	Hazardous Material Handling	3L:1T:0P (04 hrs)	04Credits

Course Objective: To learn and understand the general classification of hazardous materials with their specific requirement in handling, transportation and storage.

Module 1 **(06 Hrs)**
INTRODUCTION TO HAZARDOUS MATERIAL: Regulations of Hazards material- Definition & types of Hazardous Material Explosives, Flammable gas, Flammable & Combustible liquids, Flammable Solids, Oxidizers, Radioactive & Corrosive Material.

Module 2 **(06 Hrs)**
GENERAL CLASSIFICATION OF EXPLOSIVE & THEIR MARKING: Common shipping containers, Incident response plan for explosives, Gas emergencies, Physical & Chemical Properties of Gases, Shipping containers for gases, fixed site storage vessels, pipelines, label Requirement, Tank & Cylinder Safety Devices.

Module 3 **(06 Hrs)**
COMBUSTIBLE MATERIALS: Definition of flammable & combustible liquids, Labels & placard Requirements, Storage Containers, Carbo tank trucks, Storage tanks, pipelines. Flammable solids & their dot classification- Radioactive pyrophoric metals, Extinguishing agents for combustible metal fire.

Module 4 **(06 Hrs)**
OXIDIZER AND POISONS: Common Inorganic Oxidizing material, Hazard associated with oxidizers, Organic peroxides and related hazards. Poisons- Poisons classification, target organ of some selected chemicals, pesticides labeling.

Module 5 **(06 Hrs)**
CORROSIVES: Physical & Chemical properties corrosives, Hazard associated with acids & bases, Playcard & label requirement, shipping containers, other miscellaneous hazardous material.

Course Outcomes:
At the end of this course student will be able to:
1. Define the hazardous materials and their types.
2. Explain the classification of explosives with their placard requirement.
3. Differentiate between combustible and flammable liquid.
4. Apply HAZMAT plan for oxidizers and poisonous Materials.
5. Explain Corrosive Materials and their placard requirement.

List of Text/Reference Books:

1. Hazardous Material Hand book – By Joe Varela.
2. Quantitative Risk Assessment in Chemical Process Industries" American Institute of Chemical Industries, Centre for Chemical Process safety.
3. Fawcett, H.h. and Wood, "Safety and Accident Prevention in Chemical Operations" Wiley inters, Second Edition.
4. Encyclopedia of Occupational Health and Safety, by Jeanne Mager Vol. II, International Labour Organisation, Geneva, 1985.

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PSCC- IS202	Computer Aided Risk Analysis	3L:1T:0P (04 hrs)	04Credits

Course Objective:
To learn and teach the application of various software specialized in industrial safety for risk quantification and consequences analysis.

Course Content:

Module 1 **(06 Hrs)**

HAZARD, RISK ISSUES AND HAZARD ASSESSMENT: Introduction, hazard, hazard monitoring-risk issue - Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), hazard operability studies (HAZOP)

Module 2 **(06 Hrs)**

INSTRUMENTATION: Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter (ARC), Principles of operations, Controlling parameters, Applications, advantages.

Module 3 **(06 Hrs)**

EXPLOSIVE TESTING STUDY: Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

Module 4 **(06 Hrs)**

RISK ANALYSIS QUANTIFICATION AND SOFTWARES: Fault Tree Analysis & Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and toxicity index(FETI), various indices – Hazard analysis(HAZAN)- Failure Mode and Effect Analysis(FMEA)- Basic concepts of Software on Risk analysis, CISCON, FETI, ALOHA

Module 5 **(06 Hrs)**

CONSEQUENCES ANALYSIS: Logics of consequences analysis- Estimation- Hazard identification based on the properties of chemicals- Chemical inventory analysis- identification of hazardous processes- Estimation of source term, Gas or vapour release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire- Gas/vapour dispersion- Explosion, UVCE and Flash fire, Explosion effects and confined explosion- Toxic effects- Plotting the damage distances on plot plant/layout.

Course Outcomes:

At the end of this course student will be able to:

1. Explain basic concept of risk and its management.
2. Apply Boolean algebra and cut sets in different risk assessment methods.
3. Demonstrate HAZOP study for a process industry or its distinguish part.
4. Analyze accident and incident data for risk assessment procedure in an organization.
5. Explain fire growth models and scenario for probable fire scenes.

List of Text/Reference Books:

1. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II& III)
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
3. Hazop and Hazon, by Trevor A Klett, Institute of Chemical Engineering.
4. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.
5. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety,AICHE 1992.

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PSEC- IS201(A)	Work Study & Productivity Management	3L:0T:0P (03 hrs)	03Credits

Course Objective: To teach and learn the various attributes of work study and productivity and their role in work place accident prevention.

Course Content:

Module 1 **(06 Hrs)**

PRODUCTIVITY MANAGEMENT: Concept of Productivity, Factors affecting Productivity, Total productivity model. Short term and Long term Productivity Planning Models. Productivity improvement Techniques: Technology based, Material based, Employee based, Product and Time based P.I. Techniques, Work Study: Definition, objectives and areas of application of work study in industries, Historical review,; Human aspects of work-study, Role of work-study in productivity improvement

Module 2 **(06 Hrs)**

INTERRELATION BETWEEN METHOD STUDY AND WORK MEASUREMENT, METHOD STUDY: Definition and objectives; Engineering approach to methods analysis and improvement, Data collection and recording techniques; critical examination and development, creative thinking, tools of creativity, Installation and maintenance of the new improved methods. Motion Economy and Analysis: Principles of motion economy, motion analysis; Micro motion and memo motion study; Therbligs and Simo charts

Module 3 **(06 Hrs)**

WORK MEASUREMENT: Definition and objectives; work measurement techniques, Stop watch time study, Principles and procedures, Systems of performance rating; calculation of basic time, allowances and standard time, predetermined motion time and other standard systems, introduction to MOST, Work Sampling : principles and techniques, application of work sampling studies.

Module 4 **(06 Hrs)**

INTRODUCTION TO ERGONOMICS: Ergonomics as a multi-disciplinary field, components, Importance of ergonomics in equipment and work design, Concept of man-machine system; Types and characteristics of Man-machine systems, Rest Pause design based on physiological consideration, Anthropometry and Work place design.

Module 5 **(06 Hrs)**

WAGE INCENTIVES AND JOB EVALUATION: Various types of wage Incentive schemes and their impact on productivity, Comparison of different incentive plans, design of incentive plans, Group system of Wage payment, Supervisory incentive plans. Job Evaluation: Purpose, Various types of jobs evaluation system and their application of classification. Wage Cure, Designing salary structure and Grade, Merit Rating, Performance Appraisal.

Course Outcomes:

At the end of this course student will be able to:

1. Explain basic concept of productivity and its management.
2. Understand relation between method study and work measurement.
3. Define work measurement techniques with work sampling and its principles.
4. Demonstrate ergonomics at work place and its role in accident prevention.
5. Understand various types of wage incentive and job evaluation schemes at work places.

List of Text/Reference Books:

1. Sumanth D.J., Productivity Management, TMH.
2. I.L.O., Introduction of Work Study, ILO
3. Maynard H.B., Industrial Engineering Hand Book.
4. McCormick, E.J. and Sanders, M.S., Human Factors in Engineering and Design, TataMcGraw
5. Jhamb L.C., Workstudy and Ergonomics.

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PSEC- IS201(B)	Safety in Mechanical Industries	3L:0T:0P (03 hrs)	03Credits

Course Objective: To learn and understand mechanical hazards and their control measures for accident prevention at work places.

Course Content:

Module 1 **(08 Hrs)**

SAFETY IN METAL AND WOOD WORKING MACHINES: General safety rules, principles, maintenance, Inspections of turning machines, boring, machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

Module 2 **(08 Hrs)**

PRINCIPLES OF MACHINE GUARDING: Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS, guarding of hazards - point of operation protective devices, machine guarding, types, fixed, guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearingpresses- forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

Module 3 **(08 Hrs)**

SAFETY IN WELDING AND GAS CUTTING: Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common, hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

Module 4 **(08 Hrs)**

SAFETY IN COLD FORMING AND HOT WORKING OF METALS: Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes; Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

Module 5 **(08 Hrs)**

SAFETY IN FINISHING, INSPECTION AND TESTING: Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in, inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring, devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation.

Course Outcomes:

At the end of this course student will be able to:

1. Explain hazards and their control measures in metal and wood working machines.
2. Demonstrate principles of machine guarding for different machinery.
3. Explain safety in gas cutting and welding operation in different situation.
4. Know safety in cold forming and hot working of metals.
5. Explain safety in finishing, inspection and testing operations at work places.

List of Text/Reference Books:

1. Safety Engineering principles and practices- Frank R Spellman PBC Books Delhi
2. System safety Engineering and management- Harold E Roland PBC Books Delhi
3. Practical Machinery safety- David MacDonald PBC Books Delhi
4. Safety Management; John V. Grimaldi & Rollin H. Simonds, All India Travelers Book seller, New D
5. Safety in Industry N.V. Krishnan Jaico Publisher House, 1996.
6. Indian Boiler acts and Regulations, Government of India.
7. Safety in the use of wood working machines, HMSO, UK 1992.
8. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech.Publishing Ltd

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PSEC- IS201(C)	Safety in Electrical Systems	3L:0T:0P (03 hrs)	03Credits

Course Objective:

1. To learn about electrical hazards and electrical safety.
2. To learn about fire hazards and safety measures in generation systems.
3. To learn about fire hazards and safety measures in Transmission systems.
4. To learn about fire hazards and safety measures in distribution systems and transformers.
5. To learn about electrical safety equipments and its use in preventing fire hazards.

Module 1 **(08 Hrs)**

INTRODUCTION TO ELECTRICAL FIRE: Electrical hazards and electrical safety, Protection Against Direct Contact, Insulation of Live Parts, Additional Protection by Residual Current Devices, Protection Against Indirect Contact, Protection by Automatic Disconnection of Supply, Protection Without Automatic Disconnection of Supply, Non-electrical causes, nature of electrical injuries, Types of injury, Electric shock, Body resistance, The limits of safety, Effect of frequency, Fractures and torn Muscles, Burns and side effects, Protection against electrical Injuries, electrical current effect in the human body.

Module 2 **(08 Hrs)**

FIRE HAZARDS IN GENERATION SYSTEMS: Generation: - Different types of Generating Stations, Thermal, Hydro electric, their equipments, Nuclear power station, Nuclear fission, Radioactivity, Reactor designs, Safety philosophy, Periodical electrical safety reviews, Safety concept and design, electrical underlying standards, Partial safety concept, Fire resistance, Possible Faults and fire outage, Protection and safety measures.

Module 3 **(08 Hrs)**

FIRE HAZARDS IN TRANSMISSION SYSTEMS: Transmission: - Transmission lines, types of transmission lines, their equipments, Main components of over head lines, Conductor materials, Line supports, insulators, Types of insulators, Ground wires, Possible Faults and fire outage, Protection and safety measures.

Module 4 **(08 Hrs)**

FIRE HAZARDS IN DISTRIBUTION SYSTEM AND TRANSFORMERS: Distribution system and their equipments, Substation and their equipments, Possible Faults and fire hazards, their protection and safety measures. Transformer: Their types, Working Principal, Applications, Possible faults and fire hazards, Protection and Safety measures.

Module 5 **(08 Hrs)**

ELECTRICAL SAFETY EQUIPMENTS: Fuses and its types and construction, Requirement of relays, Primary & backup protection, Types of relay protection, Over current, Over Voltage relays, Circuit Breaker, Arc Voltage, Arc Interruption, Classification of Circuit Breakers, Oil, SF6, Vacuum Circuit Breakers, Earthing- Their method and applications, Insulators – Their types and applications, fire detection system, smoke detector, Photo electric smoke detector, Air sampling type smoke detectors.

Course Outcomes:

At the end of this course student will be able to:

1. Describe electrical hazards and electrical safety.
2. Describe fire hazards and safety measures in generation systems.
3. Describe fire hazards and safety measures in Transmission systems.
4. Describe fire hazards and safety measures in distribution systems and transformers.
5. Describe and explain electrical safety equipments and its use in preventing fire hazards.

List of Text/Reference Books:

1. W Fordham Cooper, Electrical Safety Engineering**.**
2. B. Ravindran and M Chander, Power System protection and Switchgear, New Age International.
3. J. Cadick, Electrical Safety Handbook, McGraw-Hill.
4. B. Ram, Power System Protection & Switchgear, McGraw Hill

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MLC- 2	Research Methodology & IPR	3L:1T:0P (04 hrs)	02Credits

Course Objective:

Understand some basic concepts of research and its methodologies, identify appropriate research topics and select and define appropriate research problem and parameters

Module 1 **(08 hrs)**

RESEARCH FORMULATION AND DESIGN: L-9 Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, identifying gap areas from literature and research database.

Module 2 **(08 hrs)**

DATA COLLECTION AND ANALYSIS: Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

Module 3 **(10 hrs)**

SOFT COMPUTING: L-9 Computer and its role in research, Use of statistical software SPSS, GRETL etc. in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.

Module 4 **(10 hrs)**

RESEARCH ETHICS, IPR AND SCHOLARLY PUBLISHING: Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

Module 5 **(10 hrs)**

INTERPRETATION AND REPORT WRITING: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Course Outcomes:

After completion of this course, the students are able to:

1. Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. Have basic knowledge on qualitative research techniques
3. Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis.
4. Understand the ethics used in research approach.
5. Apply the knowledge of research methodology for report writing.

List of Text Book:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Publications.

List of Reference Book:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

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LC- IS201	Emergency First Aid	0L:0T:4P (04 hrs)	02Credits

Course Objective:

1. To learn about the human body & its various system.
2. To learn about the handling of human casualty, its diagnosis & treatment.
3. To learn about the burn, shock and their types with paramedic care.

Practical /lab work / case studies related emergency first aid, student is required to submit a journal/report for the same.

List of Experiment:

1. To measure the bleeding time and clotting time of healthy adult person using vrigid splints.
2. To calculate the victim dressing time using various type of bandage by first aid responder.
3. To calculate the body mass index of an adult person by using surgical height measuring scale with digital weighting machine.
4. To calculate the blood pressure of an adults person using mercury sphygmomanometer and stethoscope apparatus.
5. To calculate the scale of burn.
6. To perform and practice the different methods of handling and transportation of Victim.
7. To perform and practice the first aid treatment of Fractures in different part of human body.
8. To measure the working efficiency of human lungs with lung testing apparatus.

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LC- IS202	Computer Aided Risk Analysis	0L:0T:4P (04 hrs)	02Credits

Course Objective:
To learn about the basic concept of risk and its management using available software in the field of consequences analysis, impact assessment, safety audit methodology for the purpose of legal documentation in safety management in an organization.

Practical /lab work / case studies related computer aided risk analysis, student is required to submit a journal/report for the same.

List of Experiment:

1. Calculation of individual risk and fatal accident rate as theoretical risk factor
2. Preparing the risk matrix for an organization.
3. Application of Hazard study methods to a raw gas holder.
4. Application of Hazop study on an oil vaporizer.
5. Application of Hazop study on ethylene oxide sterilizer.
6. Application of Fault tree analysis to a chemical reactor.
7. Determination of Safety Integrity level by using risk parameter chart for a given sample.
8. Determination of safety integrity level by using SIL class software with risk parameter chart.
9. Evaluation of preliminary safety instrumented system (SIS) design using SHEEL-CASA software tool.

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AUD- 2	Project Management	2L:0T:0P (02 hrs)	0 Credit

Course Objective

To acquaint students with project management method and to develop skills on project planning, analysis implementation and control.

Course Contents

Module 1

PROJECT PLANNING AND PHASES: Need and importance, phases of capital budgeting, project analysis facts, resource allocation framework (investment strategies, portfolio planning tools, and interface between strategic planning and capital budgeting), generation and screening of Project Ideas.

Module 2

PROJECT ANALYSIS: Market and Demand analysis, (Including demand forecasting) Technical Analysis and Financial Analysis (Cost of Project, working capital requirement & its financing).

Module 3

PROJECT MANAGEMENT AND CONTROL: Project Organizations, Planning and Control of project & human aspects of project management, Project control tools (Gantt Charts, Line off Balance).

Module 4

NETWORK TECHNIQUES FOR PROJECT MANAGEMENT: Basic concepts of networks, line estimation and determination of critical path (for both PERT and CPM models), network cost systems and activity crashing.

Module 5

PROJECT REVIEW: Need for reviews, initial review, performance evaluation, abandonment analysis, evaluating the capital budgeting systems.

Course Outcomes:

After completion of this course, the students are able to:

1. Understand project planning, capital budgeting, and idea screening.
2. Analyze market, technical, and financial aspects of projects.
3. Apply project management and control techniques.
4. Use PERT and CPM for project scheduling and optimization.
5. Evaluate project performance and review outcomes.

Text Reading

1. Prasanna Chandra. “Project Planning, Analysis, Selection, Implementation and Review”, New Delhi, Tata McGraw Hill Publications, 2000.

2. P. Gopalkrishnan and E. Rama Moorthy. “Text book of Project Management”. New Delhi,McGraw Hill Publications, 2000.

3. Harold Kerzner, “Project Management: A Systems Approach to Planning, Scheduling and Controlling”**,** New Delhi, CBS Publications, 1994.

4. Rajive Anand**,** “Project Profiles with Model Franchise Agency and Joint Venture Agreement”, New Delhi, Bharat Publications