

SAR 5601	MAINTENANCE AND REHABILITATION OF STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course objectives:

1. To understand the need and importance of structural maintenance, extending the serviceability and durability of structures.
2. To explore the techniques for repairing of structures, selection of suitable materials and enhancement of strength of structural elements.

Course Outcomes:

1. Understanding of the requirements for governance of good serviceability and longevity of structures.
2. Exposure to various types of engineering maintenance and evaluation of damaged structures.
3. Identify suitable materials for repair and selection of appropriate techniques to mitigate the faulty structures.
4. Knowledge about various types of special concrete to meet specific requirements of structures.
5. Identifying enhancement techniques for structural strengths of different members and knowledge about the modern demolition techniques.

UNIT 1 INFLUENCE ON SERVICEABILITY AND DURABILITY**10 Hrs.**

Effects due to climate, temperature, chemicals, wear and erosion - Design and construction errors, corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

UNIT 2 MAINTENANCE AND REPAIR STRATEGIES**14 Hrs.**

Definitions: Maintenance, repair and rehabilitation - Facets of Maintenance importance - Maintenance Preventive measures on various aspects - Inspection - Assessment procedure for evaluating a damaged structure - Causes of deterioration - testing techniques.

UNIT 3 MATERIALS AND TECHNIQUES FOR REPAIR**14 Hrs.**

Special concretes and mortar, concrete chemicals - Special elements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, fibre reinforced concrete. Rust eliminators and polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete - Gunite and shotcrete epoxy injection, mortar repair for cracks, shoring and underpinning.

UNIT 4 EXAMPLES OF REPAIR TO STRUCTURES**10 Hrs.**

Repairs to overcome low member strength - Deflection, cracking, chemical disruption, weathering wear, fire, leakage, marine exposure - Engineered demolition techniques for dilapidated structures - Case studies

Max. 48 Hours**TEXT / REFERENCE BOOKS**

1. Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991
2. Allen R.T. and Edwards S.C., Repair of Concrete Structures, Blahie and Sons, UK, 1993
3. Shetty M.S., Concrete Technology- Theory and Practice, Chand and Company, New Delhi, 2000
4. Verghese P.C., Maintenance, Repair & Rehabilitation & Minor Works of Buildings, Prentice Hall, 2014
5. Samuel Y. Harris, Building Pathology- Deterioration, Diagnostics and Intervention, John Wiley & sons, 2001.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs.****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks**

SAR 5604	STRUCTURAL SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course objectives:

1. To address the design factors pertaining to high rise structures and types of analysis.
2. To understand the special concrete to meet the requirements of high rise and special structures.
3. To explore new techniques in construction such as Pre- engineered buildings and design of special structures.

Course Outcomes:

1. Exposure to different types of loads and analysis methods while designing high rise structures.
2. Explore various types of special concrete to meet the specific purpose for high rise structures.
3. Establish knowledge about the behaviour of high rise structural systems during analysis and design.
4. Understand the design of high rise structures to resist disaster loading.
5. Knowledge about different types of special structures and prefabricated structures.
6. Designing of structures against leak, joint sealants and other issues.

UNIT 1 INTRODUCTION TO HIGH-RISE BUILDINGS AND STRUCTURAL SYSTEMS**14 Hrs.**

Height analysis, plan shapes, grids and core design - Foundations and soil conditions - Construction sequencing, building skin and envelope - Design philosophy, structural loading, sequential loading, materials, high performance concrete – Fibre reinforced concrete, High strength concrete, Light weight concrete - Loading and movement Gravity Loading, Dead and Live load - Methods of Live load reduction – impact, gravity loading, construction loads, wind loading – Static and dynamic approach – Earth quake loading – Equivalent lateral force, model analysis, combinations of loading – Working stress design, limit state design, plastic design - Codes & Standards - Tensile structures in high-rise

UNIT 2 BEHAVIOR OF VARIOUS STRUCTURAL SYSTEMS**12 Hrs.**

Factors affecting growth, height and structural form – High rise behaviour, rigid frames, braced forms, infilled frames, shear walls, coupled shear walls, wall frames, tubular, cores, outrigger- braced and hybrid mega systems.

UNIT 3 DISASTER RESISTANT STRUCTURES**10 Hrs.**

Overall buckling analysis of frames, wall frames - Approximate methods, second order effects of gravity of loading, simultaneous first order and P delta analysis, translational, torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation - Case study of a high-rise structure with 3D model analysis.

UNIT 4 PREFABRICATED STRUCTURES**12 Hrs.**

Specific requirements for planning and layout of prefabricates plant, IS code specification - Design Principles, modular coordination, standardization, disuniting of prefabricates production, transportation and erection, stages of loading and code provisions, safety factors - Reinforced concrete - Prefabricated structures, wall panel types and two way fabricated slabs, partial and curtain walls, trusses, shells, crane - gantry systems - Floor slabs and roofs, types of floor slabs, cored and panel types and two way systems, stair case slab, insulation requirements, joints, their behaviour and reinforcement requirements – Walls, types of wall panels blocks and large panels, curtain - Partition and load bearing walls, wall joints - Behaviour and design, leak prevention, joint sealant, sandwich wall panels.

Max. 48 Hours**TEXT / REFERENCE BOOKS**

1. Gupta Y.P, Proceedings National Seminar on High Rise Structures – Design and Construction Practices for mid- level cities, New Age International Limited, Publishers, 1995
2. Wolfgang Schueller, High Rise Building Structures, John Willey and Sons, 1977
3. Bryan Stafford Smith and Alex Coull, Tall building structures, Analysis and Design, John Willey and Sons, 1991
4. Lin T.Y. and Sidney D. Stotesbury, Structural Concepts and systems for Architects and Engineers, John Wiley & Sons, 1981
5. Bungalow Taranath, Steel, Concrete, and Composite Design of Tall Buildings, McGraw Hill, 1997

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs.****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks**

SAR 5608	REAL ESTATE MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course objectives:

1. To offer hands on experience that is vital to excel in the real estate market by understanding the principles and practices of real estate.
2. To explore real-world scenarios, best practices and effective management techniques for competing successfully in today's dynamic global markets.

Course Outcomes:

1. Summarizing the scope of the existing real estate industry in the current business environment and to classify the various statutory and legal regulations applicable to real estate market.
2. Outlining the roles, responsibilities, rights and liabilities of different real estate stakeholders.
3. Exposure to the various documentation procedures for different real estate transactions, appraisals, agreements and valuation of properties.
4. Quantitative methodology used in different transactions using the current rates of properties, registration charges and appropriate fees applicable in different states.
5. Delineate project development process, compare the different sources of real estate funds and classify the risks associated therein.
6. Formulate a real estate project by assessing its feasibility and evolving strategies for effective management.

UNIT 1 REAL ESTATE MARKET**10 Hrs.**

Real Estate Scope, classification of real estate activities and peculiarities - Factors affecting real estate market - Role of government in real estate market, statutory provisions, laws, rules, and regulations application, land use controls in property development, registration and licensing requirements - Knowledge base for assessment and forecasting the Real Estate market - Environmental issues related to real estate transactions.

UNIT 2 PARTICIPANTS AND STAKE HOLDERS**12 Hrs.**

Role, scope, working characteristics and principal functions of real estate participants and stakeholders - Real estate consultants and their activities - Roles and responsibilities of property managers, code of ethics for real estate participants - Good practices and managerial responsibilities.

UNIT 3 REAL ESTATE DEVELOPMENT**14 Hrs.**

Functions of Real Estate development like project formulation, feasibility studies, developing, costing and financing, managing including planning, scheduling and monitoring of real estate projects, risk management, facilities management, marketing/advertising, post construction management etc - Real estate investment, sources and related issues.

UNIT 4 DOCUMENTATION**12 Hrs.**

Interest rates in real estate - Documentation in real estate processes - Transfer of titles and title records - Real estate appraisal and valuation - Types of agreements between the consultants and principal - Closing the real estate transactions.

Max. 48 Hours**TEXT / REFERENCE BOOKS**

1. Geltner, Miller, Clayton and Eichholtz, Commercial real estate analysis and investments, On-course Learning, 2013
2. John Ratcliffe and Michael Stubbs, Urban planning and real estate (Natural and Built Environment Series), Routledge, 2009
3. Mike E. Miles, Gayle L. Berens, and Mark A. Weiss, Real Estate Development: Principles and Process, Urban Land Institute, 2000
4. Stephen P. Peca, Real Estate Development and Investment: A Comprehensive Approach, Wiley, 2009

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs.****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks**

SAR 5612	BUSINESS STRATEGIES & CORPORATE PLANNING	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course objectives:

1. Touse analytical tools and techniques for studying construction case studies in the context of the business environment.
2. To identifykey elements of a good strategic plan,determinelong term goals, policies and objectives and to translate and communicate the same.
3. To understand the value of purpose in ensuring a high performance organization that achieves results through creative Strategic Planning.

Course Outcomes:

1. Define Business in a social and economic system and assess the external and internal environments.
2. Articulate the importance of corporate social responsibility and to measure its impact on business and society.
3. Learn to make strategic decisions and translate a strategic plan into policies, objectives, tactics and procedures.
4. Classify policies at different levels and organize the various steps in effective policy making.
5. Develop a mission and vision statement for a construction business and implement an appropriate strategy.

UNIT 1 BUSINESS AS A SOCIAL SYSTEM/ECONOMIC SYSTEM**12 Hrs.**

Objective of Business - Business Environment – Socio economic sector, technology Sector, government Sector - The industry environment – customer sector/ supplier sector/ competitor sector - The International environment – Opportunities for International activities - Threats from International activities.

UNIT 2 BUSINESS POLICY IN VARIOUS ECONOMIC SYSTEMS**12 Hrs.**

Business ethics - Social responsibility of Business / Indian businessmen, social audit - Capitalist economy; economic system of socialism and mixed economic system.

UNIT 3 BUSINESS POLICY AND CORPORATE STRATEGY**12 Hrs.**

How to make policy corporate strategy – Policies, strategies and tactics,policies and procedures - Functions and importance, strategy alternatives, considering strategy variations, strategic choice and implementation.

Policy Formulation: objectives, direction,consideration of change - Business Policy concepts, characteristics and importance - Different types of policies: classification, strategies, programmes, procedures and rules - M.B.O./ M.B.E. major and minor policies - Supporting composite and contingency policies: parameter of policy - Development of Business Policy - Swot Analysis - Elements of Business Policy - Implementation of Policy.

UNIT 4 MAJOR BUSINESS POLICIES**12 Hrs.**

Man Power planning - Product Policies, marketing policies, production and purchase policies - Financial policies, capital procurement and distribution - Administration and control of policy - Communication system - Policy implementation - Rules and procedures - GPI policy -Appended implied and imposed policy - Oral and written policies control and review.

Max. 48 Hours**TEXT / REFERENCE BOOKS**

1. Lawrance R Jauch and William F Glueck,Business policy and strategic management, McGraw Hill, 1988
2. SatishMamoria, C.B Rao, P. Subba, Business planning and Policy, Himalaya Publishing house, 2001
3. Budhiraja SB and Athreya MB, Cases in Strategic Management, Tata McGraw Hill, 1996
4. Michael A. Hitt, R. Duane Ireland, Robert E. Hoskisson, Strategic Management - competitiveness and Globalization, Thomson/South-Western, 2003.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs.****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks**

SAR 5622	GREEN BUILDING RATING SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course Objectives:

1. To get a complete overview of various kinds of green building rating systems and how they are used in the industry.
2. To understand the purpose and application of green building rating system.

Course Outcomes:

1. Understanding of the various green rating systems and practices across the globe and Indian Context
2. Critically inquire the merits and demerits of Green rating Systems, Material Certification & stewardship, and their necessity
3. Application of Green Rating Systems in projects and analytical knowledge of various green points required for projects towards achieving Green Rating
4. Appraising the role of a green building consultant and the process of Green accreditation examination.
5. Analyzing and evaluating the basics of energy modeling and auditing.

UNIT 1 INTRODUCTION TO GREEN RATING SYSTEMS**10 Hrs.**

History of green Rating systems- LEED, GRIHA, BREEAM, IGBC- Need and use of green rating systems - Structure of the rating systems- Market response to various rating systems- Selection of the appropriate rating system.

UNIT 2 GREEN RATING SYSTEMS IN INDIA**16 Hrs.**

In-depth study of the requirements of IGBC, LEED and GRIHA rating systems - Cross comparisons between the various requirements, their intents and ability of a project to meet the requirements - Other rating systems such as Eco House, Green Mark, Green Pearl, Living Building Challenge.

UNIT 3 APPLICATION OF RATING SYSTEM REQUIREMENTS**10 Hrs.**

Applying the Green rating systems in a project - Role of Green building consultant- Determining the various green points- Green Accreditation examinations.

UNIT 4 THE FUTURE OF RATING SYSTEMS**10 Hrs.**

Upcoming rating systems- Auditing after rating, Material certifications and stewardships - Energy modeling and energy auditing in green building ratings - Consultancy scope and services for green rating systems.

Max. 48 Hours**TEXT / REFERENCE BOOKS**

1. Linda Reeder, Guide to Green Building Rating Systems: Understanding LEED, Green Globes, 2010
2. Jerry Yudelson, The Green Building Revolution, Island Press, 2007

WEBSITES

1. www.usgbc.org
2. www.igbc.org
3. www.grihaIndia.org
4. living-future.org/lbc

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**Exam Duration: 3 Hrs.****PART A : 2 questions from each unit, each carrying 4 marks.****: 08 x 05 = 40 Marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****: 04 x 15 = 60 Marks**

SARA5101	CONSTRUCTION PROJECT MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- The objective of the course is to introduce and disseminate the knowledge about project management and their application during the pre- construction and construction phase of a large construction project life cycle.
- To provide the basic understanding about the various project management methodologies used in various phases like initiation, feasibility, design phase, bid and award phases, construction and closeout phases of a project.

UNIT 1	PROJECT MANAGEMENT FRAMEWORK	12 Hrs
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Introduction - Project management, Project management versus Traditional management, Different forms of Project Management – Project Phases – Project Life Cycle – Project Management Process through Initiation, Planning, Execution, control and closure within the triple constraints of scope, time and cost with all inputs, tools & techniques and outputs. Construction project organisations, organisation structure and process; scope and services of PMCO, Roles and Responsibilities of Project Manager, client, promoter, consultant, contractor and the organisational procedures.

UNIT 2	COMMUNICATION & MANAGEMENT INFORMATION SYSTEM (MIS)	9 Hrs
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Project Management plan - The Project Management Configuration Plan - Communication requirements analysis, Communication Technology –Communication models and methods: General Guidelines for Effective Communication - Conducting High-Quality Meetings - Communication Skills and the Project Manager - Key Project Documentation – Information distribution. Management Information Systems; Scope, significance, design criteria of MIS; Formats of MIS for construction stages; Information technology in MIS.

UNIT 3	PROJECT COST AND PORTFOLIO PLANNING	9 Hrs
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Building Economics; Cost components of a construction project; Direct & Indirect costs; Distribution of hard cost in the project, Factors that influencing the construction cost, cost estimation tools, Interpretation of cost information; use of cost indexes etc., Defining and Implementing Project Portfolio Management – Objectives, practices and organizational roles – evolution of PPM - Bridging the Gap between Operations management and Project Management for multiple projects -Project Portfolio Optimization- PPM tools -Standardization, measurement and process improvement, Project Selection and Risk.

UNIT 4	QUALITY MANAGEMENT	9 Hrs
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Quality concepts; Evolution of modern concept of Quality management process approach; TQM. Introduction, Concept and philosophy of TQM -Statistical Quality control-Quality control operations – concepts – norms, techniques and procedures – quality and time – concept of quality in building design, construction and concepts of project management Gurus. Quality assurance & control, information needs at different levels of project organization – organizational functions – types of information. Quality management system, Quality System standards elements, Contractual implications of quality systems– quality management systems – concepts and meaning.

UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
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Case study and presentation of large construction projects. Understand and develop site organisation structure, develop site logistics plan for the project planning activities. Develop and present the WBS of the project for various trade packages and prepare a schedule basis CPM technique using scheduling software like MS Project and Primavera Project Planner and find the critical path of the project.

Max. 45 Hours**COURSE OUTCOMES:**

CO1	Understand the basics of traditional management systems, management skills and project planning including initiation and execution.
CO2	Critically evaluate various management methods in planning, execution considering scope verification and control
CO3	Outline various work breakdown structure and other activities with reference to project scope, time and cost.
CO4	Analyse and assimilate communication and coordination skills to handle complex projects during different phases.
CO5	Comprehend various objectives, practices and roles of an organization executing multiple projects.
CO6	Understand and bridge the gap in resource allocation for complex projects.

TEXTS / REFERENCE BOOKS

1. Chitkara, K.K, Construction Project Management, Planning, Scheduling and Controlling, 3rd Edition, Tata McGraw Hill Publishing Co., New Delhi, 2014
2. Calin M. Popescu, ChotchaiCharoenngam, Project planning, Scheduling and Control in Construction: An Encyclopaedia of Terms and Applications, John Wiley, New York, 1995
3. JuriSutt , Manual of Construction Project Management, John Wiley and Sons, 2011

4. Willis E.M., Scheduling Construction projects, John Wiley and Sons, 1986
5. George J. Ritz, Sidney M. Levy, Total Construction Project Management, Second Edition, McGraw-Hill Professional, 2013
6. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute, Incorporated, 2013
7. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling and Controlling, 10th Edition, Wiley India Pvt. Ltd., 2013
8. Jonathan F. Hutchings, Project Scheduling Handbook (Civil and Environmental Engineering), CRC Press, 2003
9. Asma Khan and Sean Burn, Project Portfolio Management in Construction Industry, Booktango, 2013
10. Peter Fewings and Christian Henjewe, Construction Project Management, An Integrated Approach, 3rd edition, Swales & Willis Ltd, Exeter, Devon, UK, 2019.
11. Saleh Mubarak, Construction Project Scheduling and Control, Wiley & Sons, 2015.

End semester examination question paper pattern

Max. Marks: 100

PART A : 2 questions from unit 1 to unit 4, each carrying 4 marks

PART B : 2 questions from unit 1 to unit 4 with an internal choice, each carrying 15 marks

Exam Duration: 3 Hrs

: 08 x 05 = 40 Marks

: 04 x 15 = 60 Marks

SARA5102	CONSTRUCTION TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To introduce and give a comprehensive coverage on all aspects of construction technologies related to building projects.
- To develop awareness and understanding to do the selection of appropriate technology for various building and building related infrastructure projects through planning, design and management approach.

UNIT 1	FOUNDATION & BASEMENT TECHNOLOGY	9 Hrs
Geo-technical investigations, geo-informatics and interpretation of soil investigations; Soil / ground improvement techniques, deep excavations in various conditions; Foundation systems, effect in aggressive soil conditions, special foundation techniques; Planning and design considerations of foundation and superstructure systems for Multi-storeyed, tall and super tall buildings; Construction of basements and waterproofing techniques.		
UNIT 2	CONCRETE TECHNOLOGY	12 Hrs
Concrete Technology, Durability and mix design, production and placement of concrete, including mechanization, Ready Mixed Concrete; Special concrete (High performance concrete, self-compacting concrete, impervious concrete, architectural finishes and aesthetic concrete); Alternative aggregates; Quality Control laboratory facilities and processes, experimental investigations; In-situ tests on concrete (including Non – Destructive Testing), Field laboratory tests.		
UNIT 3	CONSTRUCTION CHEMICAL & STRUCTURAL STEEL	9 Hrs
Coatings, Construction chemicals, Admixtures, Waterproofing chemicals, Painting systems; Waterproofing and moisture / dampness prevention; Formwork systems (including slip-form), temporary works and enabling works; Re-bar technologies and structural steel materials and jointing; Fabrication and erection of steel structures; Design and detailing of joints; Quality assurance in jointing, including welding and fabrication; Pre-engineered buildings; Repair technologies and materials for strengthening and retrofitting for existing / distressed buildings, heritage buildings.		
UNIT 4	PRE-FABRICATED CONCRETE AND INFRASTRUCTURE CONSTRUCTION	9 Hrs
Pre-cast, pre-stressed concrete and composite constructions; Pre-fabricated and off-site technologies (including pre-engineered construction); Technologies for roads and pavements; Development of road infrastructure (including allied works such as drainage, culverts etc.); Construction technologies for affordable housing; Appraisal and performance assessment of construction technologies; Innovations and emerging in technologies for smart infrastructure and buildings; Performance standards of building systems; Concrete versus steel technology suitability.		
UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs

Analysing and presenting various typology of buildings with their structural components and analysing the suitability of possible and economic alternative solutions and combinations. Justifying the selection of technology over the conventional combinational approach and also exploring alternative technology for the implementation.

Max. 45 Hours**COURSE OUTCOMES:**

CO1	Familiarizing on the various types of soil and substructure technology used in the building projects
CO2	In-depth understanding on concrete technology and the various types of usage in the building projects
CO3	Analysing the steel components in the structure and use of steel in various forms in building projects
CO4	Knowledge on the various types of construction chemicals available and their application areas and usage in the building projects
CO5	Understanding and application of various types of techniques for the building construction using the wide range of techniques learnt.
CO6	Comprehensive understanding of technology and the knowledge to use various technology combination for the successful execution of construction project from planning, design and execution stages

TEXTS / REFERENCE BOOKS

1. Brown.R. (1995). Practical foundation engineering hand book. McGraw-Hill, New York.
2. Christian.J. (1981), Management machines and methods in civil engineering. John Wiley and Sons, New Jersey.
3. Das.B. (2007), Principles of foundation engineering, Cengage Learning, Stamford USA.
4. Doran, D. (2006), Site engineering manual. Whittles Publishing, Scotland.
5. Mantri Institute A to Z of practical building construction and its management. Mantri Project and Consultancy Pvt.Ltd.
6. Mehta .P and Monteiro P. (2006).Concrete –Microstructure, properties and materials. McGraw-Hill, New York.
7. Rangwala S., Rangwala K. and Rangwala K. (2000), Construction of structure and management of works, Charotar Publishing House, Anand.
8. Shetty, M (2005), Concrete Technology, S Chand, New Delhi.
9. Singh, J. (2009), Heavy construction planning, equipment's and methods. Vol.I.II.CRC Press, New Delhi.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**PART A : 2 questions from each unit, each carrying 4 marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks**

SARA5103	BUILDING SERVICES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To outline the basic concepts of planning, design, execution and maintainability of mechanical, electrical, plumbing and fire safety services so as to effectively co-ordinate preconstruction and construction phase of projects.
- To familiarize the students with integration and coordination of various internal building services and external infrastructure services such as electrical, storm water drainage, sewerage, communication system and other civil infrastructure facilities.

UNIT 1	WATER SUPPLY AND SANITARY ENGINEERING	9 Hrs
Water Quantity and Pressures - Water-Pipe Sizing Wastewater piping-Wastewater-System Elements - Layout of Waste Piping - Interceptors - Piping for Indirect Wastes - Waste-Pipe Sizing - Venting - Plumbing-System Inspection and Tests. Gas piping - Gas Supply – Gas pipe Sizes - Estimating Gas Consumption – Gas pipe Materials. building automation systems – components of BAS related to Water supply and sanitary system; water pump monitoring and control.		

UNIT 2	HVAC SYSTEM	12 Hrs
Factors in HVAC Design – Ventilation - Duct Design - Heat Losses - Heat Gains - methods of heating buildings – methods of cooling and air conditioning - Air-Conditioning Plant – Refrigeration - Cycles - Air-Distribution Temperature for Cooling - Condensers – Compressor Units. Cooling Equipment – Central Plant - Zoning - Packaged Air-Conditioning Units –Ducts - Variable Air Volume (VAV) Systems – Variable Frequency Drive (VFD) – dampers - Air-Water Systems - Industrial -Air Conditioning - Chemical Cooling - Energy efficiency techniques- Air conditioning in office, hospitals, malls, and laboratory etc. - Air conditioning for green buildings. Building; automation systems – components of BAS related to HVAC, Control of HVAC systems-Direct Digital Control – chiller pumps, BTU monitoring & control. Vibrations from A/C equipment- vibration isolation - all, floor & ceiling, AC ducts - noise sources in ducts & preventive measures, fan room treatment, hangers, noise control in water piping system.		

UNIT 3	ELECTRICAL & FIRE FIGHTING SERVICES	9 Hrs
Electrical - DC / AC system, electrical load and emergency power – electrical conductors and raceways – Substations – power distribution system – standby and alternate power supply system. Light and sight – quality of light – lighting methods – daylight – system design of lighting. Measuring Light and Illumination –selection of recommended Illuminance - Zonal Cavity Method of Calculating Illumination - Lamp characteristics and Selection Guide –Integration of services – Electrical power metering / monitoring. Fire detection and Fire alarm system – fire protections and fire-fighting system and monitoring – sprinkler system - Standpipes- Water Supplies – pump room design and system arrangements - safety and security systems – FAS, PAS – access control system- fire fighter telephone system – CCTV surveillance system – IBMS system. Components of BAS related to Electrical system and fire safety, security – Communication and Automation system		

UNIT 4	VERTICAL TRANSPORTATION & EXTERNAL INFRASTRUCTURE SERVICES	9 Hrs
Escalators - Elevator Installations - Electric Elevators - Hydraulic Elevators –MRL type elevators - Planning for Passenger Elevators – Elevator systems in high-rise buildings - Planning and design of elevator lobby areas- Dumbwaiters - Conveyers and Pneumatic Tubes - Mail Chutes, recent development in elevator technology. External infrastructure services for residential and institutional complexes –planning, design, construction aspects of water supply, sewerage, solid wastes, roads and storm water drainage and RW harvesting. Telecommunications, Structured Cabling Systems - Blown Optical Fibre Technology (BOFT) - Central Station Supervisory Systems-Integration of services		

UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
Case study and presentation of large construction projects.Understanding and presenting the schematic of services and their integration in the complex and large project environment.Study and Presentation of BAS integration of various internal and external services. Study and presentation of noise control measures taken for various services equipment used in construction projects. Exploring the building services provisions and operations during pandemic conditions.		

Max. 45 Hours**COURSE OUTCOMES:**

CO1	Understand various concepts of ventilation systems, which includes, design, planning, execution, installation of the same in various building typologies.
CO2	Critically evaluate and study importance of lighting and appraisal of new technologies in design of lighting systems in complex buildings
CO3	Analyze and interpret various national and international codes for services and understand the concept of application of the same.
CO4	Integrate building services and demonstrate various energy saving practices.

CO5	Examine the various techniques for noise control and related construction methods.
CO6	Evaluate quantitative metrics for various building services.

TEXTS / REFERENCE BOOKS

1. Frederick S. Merritt, Jonathan T. Ricketts, Building design and construction Handbook, McGraw-Hill Inc., 5th edition, 1994
2. Fred hall and Roger Greeno, Building Services Handbook, Routledge, 7th edition, 2013
3. M.David Egan, Architectural Acoustics, J. Ross Pub., 2007
4. Gurcharan Singh, JagdishSingh, Water Supply & Sanitary Engineering, Standard Publishers Distributors, 2007
5. Shri V.K. Jain, Fire Safety in Buildings, New age publishers, 2010
6. Shan Wang, Handbook of Air Conditioning and Refrigeration, 2nd Edition, McGraw Hill, 2000
7. Krieder, J. F., Handbook of Heating Ventilation and Air Conditioning, Taylor & Francis, 2005
8. Barrie Rigby, Design of Electrical Services for Buildings, 4th Edition, Routledge, 2013
9. W. E. Steward, T. A. Stubbs, Modern Wiring Practice Design and Installation; 14 edition, Newnes, 2009
10. BIS, National Building Code 2005, New Delhi, 2005.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**Exam Duration: 3 Hrs****PART A : 2 questions from each unit, each carrying 4 marks****: 08 x 05 = 40 Marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****: 04 x 15 = 60 Marks**

SBAA5141	FINANCIAL MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- The objective of the course is to familiarize the fundamentals of financial management concepts and their applications in the various phases of the project cycle of construction projects.
- To provide a basic knowledge to carry out the financial feasibility of projects, selection of building systems and equipment's and evaluation of project investment decisions.

UNIT 1	PRINCIPLES OF FINANCIAL MANAGEMENT	9 Hrs
Nature of finance management - objectives and principles - various financing decisions - Business firms and their financing - types of business units - capital sources and structures - marginal cost of capital - optimum capital structures.		
UNIT 2	PROJECT EVALUATION	12 Hrs
Evaluation of alternatives – present value method – rate of return method -time value of money –Net present value method, Profitability index and IRR method, Cost Volume benefit analysis - life cycle costing – structural cost – finishing cost – operating cost.		
UNIT 3	BUDGETING AND ESTIMATION	9 Hrs
Budget as management control techniques - requirement of a good budget - budget planning - budget process - cash budget - cash flow analysis - financial ratio analysis - interpretation and return on investment- Contract costing estimation of profit -Percentage completion method – completed contract method. Basis of accounting – accounting for tax reporting & financial reporting purposes.method of recording - cash method, accrual method. Taxation on construction contract.		
UNIT 4	PROJECT FINANCE	9 Hrs
Working capital management needs and computation. Long term fund- Stages of project finance management. - Financing international projects - project cash flow - progress payments and expenditures risk in international contracts - accounting and economic exposure -joint ventures and BOT projects.		
UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
Case study and Presentation on -Interpretation on performance of a company through ratios. Presentations on - How capital structure of various companies are arranged and suggesting the best capital structure, how to choose the best project from alternatives & how to decide profit on a contract, identifying various sources available for both domestic and international projects and the risk associated with it. Presentation on joint venture and BOT.		

Max. 45 Hours**COURSE OUTCOMES:**

CO1	Able to apply the acquired knowledge in mobilizing best possible sources of fund and its effective utilization
CO2	Combat with current changing economic conditions and be able to predict and estimate the future financial requirement.
CO3	Identification of best project proposal to invest.
CO4	Involve in international projects.

TEXTS / REFERENCE BOOKS

1. Andrew Ross, & Williams, P. (2012). Financial Management in Construction Contracting. Wiley & Blackwell,.
2. Hillebrandt P.M. (2000). Economic Theory and Construction Industry. London: Macmillan Publishing House.
3. Kuchhal, S.C. (1999). Financial Management; an Analytical and Conceptual Approach,. Chaitanya Publishing House.
4. Levinson, M. (2001). Guide to financial markets. London.: Economist Profile Books.
5. Madura, J. (2008). Financial markets and institutions. Ohio: Thomson Publications.
6. Peterson, S. J. (2010). Construction Accounting and Financial Management. Pearson Education.
7. Tenah, K. A., & Guevara, J. M. (1985). Fundamentals of Construction Management and organization,. Brady Company.
8. Tompkins., B. G. (1985). Project cost control for managers, . Gulf Pub. Co., .
9. Block, Stanley, B. and Geoffrey, A. (2001), Foundations of financial management. London : McGraw- Hill.
10. Chandra. P. (2008). Financial management -Theory of practice. New Delhi : Tata McGraw - Hill.
11. Damodaran, A. (2008). Corporate finance theory and practice. New Delhi.: Wiley India.
12. Khan. M. and Jain. P. (2008). Financial management. New Delhi. Tata McGraw-Hill,
13. Myers, B., Allen, S. and Mohanty, P. (2010). Principles of corporate finance. New Delhi. Tata McGraw -Hill,
14. Pandey, 1. (2009). Financial management. New Delhi. Vikas Publishing House,
15. Van. Home, J. and Wachowicz, J. (2005). Fundamentals of Financial management. New Delhi. Pearson,
16. Vishwanath, S. (2007). Corporate Finance them and practice. Response Books, New Delhi

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**Exam Duration: 3 Hrs****PART A : 2 questions from each unit, each carrying 4 marks****: 08 x 05 = 40 Marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****: 04 x 15 = 60 Marks**

SARA6101	PROJECT MANAGEMENT WORKSHOP I	L	T	P	Credits	Total Marks
		0	1	2	3	100
Continuous Assessment		University Viva			Min Pass Marks	
50		50			50	

COURSE OBJECTIVES:

- > To augment the knowledge of software technologies in the areas of project management and familiarize the students on the use of software in a given context.
- > To apply the learnings of software technologies in the live case study projects in the applicable areas where possible and compare with the actual scenarios to enable me to get hands-on experience.

WORKSHOP BRIEF

The project management workshop I aims to provide the students with the opportunity to learn the software pertaining to the project management applications like scheduling, tracking, resource optimizing & levelling, MIS management information system, RFI request for information and drawings / submittal approvals, quality checklist of construction, enterprise resource planning, BIM and BMS etc. The software technologies shall be used to create the detailed aspects of scheduling and controlling like creation of WBS and tasks, WBS schedule, milestone schedule, floats, planning resources rates with time, project cost, resource cost, work and material quantity, resource usage, resource graph, update of project progress, earned value analysis, work with multiple projects, critical path etc. And also to explore other areas where the aid of software is key in project management processes.

Students shall gather information from their live case studies related to buildings and use the software to do the project management related functions basis the data gathered. The information shall be discussed / presented among the group to see the relevance to the actual scenario and do the betterment in the process with the help of technologies available. Any open sources of software shall be explored by students to get hands on experience in the process.

DELIVERABLES

The students shall do the learnings in the software and should be aware of using the software for developing the project management functions. A small portion of project management activities or function will be defined to the students to develop the activities with the help of software basis their case study project. The software outputs of students will be validated with respect to the actual case study scenarios. The report containing the above should be submitted at the end of the semester for the evaluation.

TEXT / REFERENCE BOOKS

1. Dayal,S (2008), Earned value management using microsoft office project – A guide for managing any size project effectively, Cengage, New Delhi.
2. Harris,P.(2011), Planning and Scheduling using Microsoft project 2010. BPB Publications, New Delhi.
3. Stover, T (2004), Microsoft office project 2007, Inside out prentice Hall of India, New Delhi.
4. Harris, P. (2008) Project planning and control using Primavera P6.50 for all engineering and construction. BPB, New Delhi.
5. Harris, P (2012) Oracle Primavera P6 version 8.1 and 8.2 professional and optional client. BPB, New Delhi.
6. Software related books & journals
7. Internet resources

SARA9121	BUILDING MANAGEMENT STUDIO I	L	T	P	Credits	Total Marks
		0	0	12	6	300
Continuous Assessment		University Viva			Min Pass Marks	
200		100			150	

COURSE OBJECTIVES:

- To augment the knowledge imparted through lectures by discussion of practical cases to determine practice, critically analyze application of knowledge in the professional context, experience simulated application procedure in a limited context.
- Live case studies are to be undertaken and various aspects of the course to be taken up in the studios. Emphasis is given to interaction with project technical staff and other stakeholders. Application of software and other IT tools on actual real life cases are undertaken to enable hands on experience.

STUDIO BRIEF

The Building Management studio I aims to provide an opportunity for students to get introduced to project management and familiarize with the building project services through studies of project drawings & documents and extracting the inferences for group projects on the various aspects like Project brief - Area Usage - FAR / Area statement - Bye laws - Soil Investigation - Architectural appraisal, Configuration of spaces, plans, sections, elevations, levels, landscaping etc., -Structural appraisal: Foundation system, Structural system, Details on structural members including sizes and material specifications - MEP appraisal: Conceptual drawings, SLDs, and actual drawings showing location of services. Interaction of MEP with other aspects of project in terms of sequencing, layout etc. The study of internal and external co-ordination aspects required in various areas of construction and services to be understood practically through site visits.

Students shall gather information through their investigation from the live case studies related to the building techniques, building services and analyze the details with respect to industry standards and owner requirements to have better understanding on the key factors determining the process of project management at various stages of the project life cycle. The inferences of the study also to be compared with the building codes and standards and recommend the suitability.

DELIVERABLES

The students shall define and record the case study documentation in project management context with reference buildings and related services, infrastructure with the project phases, project stakeholders and project organization and their roles, responsibilities, scope and services of team. The final report to comprise in-depth analysis of existing building services in the form of drawings, sketches, photographs, relevant details, referral codes, schematic charts, reports, cognitive analysis diagram, empirical documentation, detailed narratives and appraise the suitability and efficiency of design and application. The proposal for modification and enhancement of system based on their case analysis.

TEXT / REFERENCE BOOKS

1. National Building Code of India 2016 (NBC Volume 1 & 2)
2. National Fire Prevention Association standards
3. Bureau of Indian Standards (BIS)
4. British Standards (BS)
5. Energy conservation building code (ECBC)
6. Bureau of Energy Efficiency (BEE)
7. American Society of Heating, Refrigeration and Air conditioning Engineers (ASHRAE)
8. SP 72: National Lighting Code 2010.

SARA5201	PROJECT PLANNING AND CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand Project planning control of project realization processes.
- Develop awareness on network analysis, scheduling and costing in project planning process and introduce comprehensive planning in complex projects.

UNIT 1	NETWORK ANALYSIS	9 Hrs
Work break down structure-assessing duration - Project scheduling, Job layout, Bar charts, Milestone charts, Network schedule, time limited and resource-limited schedule, schedule hierarchy. Activity Definition and Sequencing, The critical path method - Calculations for critical path scheduling – PERT vs CPM; Duration estimating – PERT, CPM, Network elements, Time Estimates, Activity float and schedules.		
UNIT 2	SCHEDULING	12 Hrs
Schedule development, Resource oriented scheduling – Scheduling with resource constraints – Use of Advanced Scheduling Techniques-Scheduling with uncertain durations., Control – Factors affecting work scheduling, forecasting inputs and outputs, schedule hierarchy- Relevance of construction schedules, management through networks- Purpose of work scheduling, Bar chart method of work scheduling, Scheduling the network plan, Line of Balance technique of scheduling repetitive projects.		
UNIT 3	COSTING AND CONTROL	9 Hrs
Cost planning: Cost Estimating Process, Inputs, Tools & Techniques classification of costs, financial forecasting, budgeting- BOQ-unit rate costing standards of resources, work-package standard cost, standard 'S' curve forecasting tool Cost control, Cost accounting system, cost control preliminaries, Control approach, revenue or sales control, direct cost control, indirect cost control, project budgetary control systems, control responsibility, risk cost management Project time control, Time progress monitoring methodology, what if analysis, reviewing time progress, time-cost relationship, Time -Schedule control, Time reduction techniques, work progress reviewing procedure.		
UNIT 4	COMPREHENSIVE PLANNING FOR COMPLEX PROJECTS	9 Hrs
Project definition-Objectives-Strategy-Technology and design-External factors, finance and duration – Political and social issues-Planning and control, environmental, and economic factors – Attitudes-Implementation – Organization-Contract Strategy –Strategic issues for enterprises working on multiple projects with thrust on high-rise constructions - Project closeout - Learning from past experience -Releasing people and equipment -Recognizing and rewarding people - Some guidelines for future projects -Questions for getting started.		
UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
Prepare work breakdown structure for the project and basis the understanding on the project execution sequence. List the sequential activities and workout the time required for accomplishing each task and activities. Develop a resource allocation data and optimise the timeline using the resource balancing techniques. Apply crashing techniques to reduce the timeline on the project while doing the tracking as a part of project control.		

Max. 45 Hours**COURSE OUTCOMES:**

CO1	Familiarizing on the work breakdown structure in a construction project and imparting knowledge on project scheduling.
CO2	In-depth understanding on project scheduling with required inputs, tools and techniques applied and outputs achieved.
CO3	Practical application of CPM, PERT analysis in time scheduling through network diagram of construction activities.
CO4	Knowledge on the relationship between cost and time, the pros and cons of cost overrun and cost under run and the techniques adopted for cost control.
CO5	Application of crashing in a construction project to understand the various costs involved and cost overrun through calculations and analysis.
CO6	Understanding the comprehensive planning involved in complex projects through various parameters and creating a detailed schedule for a construction project.

TEXTS / REFERENCE BOOKS

1. Chitkara, K.K. Construction Project Management, Planning, Scheduling and Controlling, 3rd Edition, Tata McGraw Hill Publishing Co., New Delhi, 2014
2. Calin M. Popescu, Chotchai Charoenngam, Project planning, Scheduling and Control in Construction: An Encyclopaedia of Terms and Applications, John Wiley, New York, 1995
3. Juri Sutt, Manual of Construction Project Management for owners and clients, John Wiley and Sons, 2011
4. Willis, E.M., Scheduling Construction projects, John Wiley and Sons, 1986

5. George J. Ritz, Sidney M. Levy, Total Construction Project Management, Second Edition, McGraw-Hill Professional, 2013
6. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute, Incorporated, 2013
7. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling and Controlling, 10th Edition, Wiley India Pvt. Ltd., 2013
8. Jonathan F. Hutchings, Project Scheduling Handbook (Civil and Environmental Engineering), CRC Press, 2003
9. Peter Fewings and Christian Henjewe, Construction Project Management, An Integrated Approach, 3rd edition, Swales & Willis Ltd, Exeter, Devon, UK, 2019.
10. Saleh Mubarak, Construction Project Scheduling and Control, Willey & Sons, 2015.

End semester examination question paper pattern**(To be distributed uniformly among all the units)****Max. Marks: 100****Exam Duration: 3 Hrs****PART A : 2 questions from each unit, each carrying 4 marks****: 08 x 05 = 40 Marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****: 04 x 15 = 60 Marks**

SARA5202	RESOURCE MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- > To understand the necessity of resource like men, materials and equipment management construction industry.
- > To familiarize the students with varied equipment commissioned for various activities at site during different phases of a project.
- > To impart and train rigorously the students for human resources management and to familiarize the knowledge of labour regulations and laws to manage the construction activities.

UNIT 1	EQUIPMENT PLANNING AND ECONOMICS	9 Hrs
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Nature of work in construction projects, site constraints, rate of daily output, equipment suitability, equipment output capability, equipment productivity, future use of equipment; equipment owning costs, equipment operating costs, equipment engineering - standard equipment, minor equipment, operating reliability repair and maintenance considerations, safety features - safety management - equipment acquisition - purchasing plant / equipment, hiring equipment, leasing and hire-purchase equipment, replacing equipment, depreciation analysis.

UNIT 2	CONSTRUCTION EQUIPMENT MANAGEMENT	12 Hrs
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Earth moving equipment - excavation and lifting equipment- earth cutting and moving equipment- transportation equipment - Compacting and finishing equipment. Production Equipment - concrete batching plants, concrete mixers, and transportation equipment - concrete placing equipment - Pre-casting special equipment - pre-stressing equipment, GRC equipment, steam curing equipment, shifting equipment, erection equipment - concrete vibrating, repairing and curing equipment, concrete laboratory testing equipment.

Material hoisting plant- cranes - support and utility services equipment's- pumping equipment's, sewage treatment, compressed air equipment, carpentry equipment - special purpose heavy construction plant- aggregate production plant & rock blasting equipment, piles and pile driving equipment.

UNIT 3	CONSTRUCTION MATERIALS MANAGEMENT	9 Hrs
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Importance of material management - classification and codification of materials, Inventory control - managing the inventory and flow of raw materials, work-in-process, finished goods, and supplies for competitiveness and profitability, ABC analysis in inventory control, Inventory management safety stock, stock outs. stores management- quality control, use of materials management systems - purchase order - indents - marketing, registration of sellers - selection, placement of order - follow up - physical training - contract materials - physical inspection and verification - fixation of the re-order level.

UNIT 4	HUMAN RESOURCES AND MANAGEMENT	9 Hrs
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Introduction – organization– management – employees – human resource management - personnel management – manpower planning, recruitment and selection, in-service training – training inputs, principles, types and assessments. Wages and salary administration – wage rate, wage payment methods, incentive plan, fringe benefits, productivity earnings, profit sharing, bonus payment, wage legislation and wage administration. Productivity in construction, measuring productivity, factors affecting productivity, responsibility for productivity. Employee's relation in an organization, motivating employees, hierarchy of motivation; Labour legislation, labour laws in construction, laws regulating wages, social security law, Industrial relations and trade unions.

UNIT 5	CONSTRUCTIVE ASSESSMENTS	6 Hrs
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Prepare and present equipment and material planning schedule, checklist and productivity analysis for various earth moving equipment, production equipment, Material hoisting for a high rise building. Also prepare and justify the requirement of human resources with the help of histogram and organisation chart for the major construction site.

Max. 45 Hours

COURSE OUTCOMES:

CO1	Understanding the need and importance of equipment management under different task considerations in projects
CO2	Analysis of the options in selection of equipment and commissioning of the correct type of equipment at project site.
CO3	In-depth understanding on the different methods of production & material hoisting equipment, working under different site conditions.
CO4	Exposure towards material management techniques with the inventory control procedures at construction site
CO5	Surveying the factors influencing the labour productivity and applying the same in the construction site.
CO6	Comprehending the role of human resources including the various regulations to be followed in construction projects

TEXTS / REFERENCE BOOKS

1. Peurifoy, R.L., Ledbetter, Schexnayder, C.W.B., Construction Planning, Equipment and Methods, 5th Edition, McGraw Hill, Singapore, 1995
2. Sharma S.C. Construction Equipment and Management, Khanna Publishers New Delhi, 1988
3. Mahesh Varma, Construction Equipment and its Planning and Application, Metropolitan Book Company, New Delhi, 1983
4. Frank Harris and Ronald McCaffer, Management of Construction equipment, Macmillan Publication, 1991
5. Chitkara K.K. Construction Project Management: Planning, Scheduling and Controlling, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.
6. Mamoria C.B and S. V. Gankar, Personnel Management, Himalaya Publishing House. ,2003
7. Stephen E. Condrey, Handbook of Human Resources Administration, Jossey - Bass, 2010
8. Gopalakrishnan, Handbook of Materials management, PHI Learning Pvt. Ltd., 1993.
9. Carlton Coulter and Jill Justice Coutler, The complete standard handbook of construction personnel management, Prentice-Hall, Inc., New Jersey, 1989.
10. Mamoria C.B and S.V.Gankar, Personnel Management, Himalaya Publishing House. 2003.
11. Stephen E. Condrey, Handbook of Human Resources Administration, Jossey – Bass, 2010
12. Dwivedi R.S., Human Relations and Organisational Behaviour, Macmillan 2001.
13. Austen A.D., Managing Construction Projects: A guide to Processes and Procedures, International Labour Organisation, 1984.
14. Geoffrey D.Taylor, Materials in Construction, Longman, 2002.
15. Gopala Krishnan, Handbook of Materials management, PHI Learning Pvt. Ltd., 1993.

**End semester examination question paper pattern
(To be distributed uniformly among all the units)**

Max. Marks: 100

Exam Duration: 3 Hrs

PART A : 2 questions from each unit, each carrying 4 marks

: 08 x 05 = 40 Marks

PART B : 2 questions from each unit with an internal choice, each carrying 15 marks

: 04 x 15 = 60 Marks

SARA5203	REAL ESTATE AND MARKETING MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To provide a comprehensive understanding about real estate practice, financial markets, legal aspects and marketing management.
- To formulate and appraise capital investments for developers for different types of projects and to be able to prepare DPRs.
- To acquire competence in managing real estate and infrastructure assets and interpretation of valuation methods.

UNIT 1	PRINCIPLES AND PRACTICES OF REAL ESTATE MANAGEMENT	9 Hrs
Real and personal property, Characteristics of real estate; Affordable housing; Laws affecting property development, Real estate contracts; Leases; Fair housing and ethical practices; Property management, Environmental issues and real estate transactions; Financial services, markets and institutions- - structure and role; Banking institutions and non-bank financial companies, development & housing finance institutions, Micro finance, Financial regulatory bodies.		
UNIT 2	BUSINESS DEVELOPMENT AND MARKETING MANAGEMENT	12 Hrs
Business development process; Real estate/property markets, forecasting and business cycles, Analytical tools for selection of new business; Market Analysis and Demand Forecasting, Technical analysis including Value Engineering, Economic Analysis, (EIA), Project risk analysis& cash flow analysis, estimation from contractors view and clients View, PPP projects and life cycle perspective from developers aim; DPR from various stakeholders perspective. Project Appraisal; SCBA. Project marketing concepts, Twin-track approach towards project marketing, Project marketing mix.		
UNIT 3	REAL ESTATE DEVELOPMENT PRACTICE	9 Hrs
Development control regulations; Zoning; Rent control Act; Building byelaws; Permissions; Changing land use; Real estate types; Location selection; relevant ownership flats/apartments act; Planning for single, mixed use, planned use, specialized Special Economic Zones (SEZ) projects; Choosing vendors, contract terms; Facilities mix management; Integrating environmental issues in development.		
UNIT 4	VALUATION AND ASSET MANAGEMENT OF PROPERTIES	9 Hrs
Value, valuation and importance of Value, Appraisal/valuation cycle, Valuation principles and factors, Major Approaches to Valuation-Market approach, Cost approach and Income approach, Valuation techniques/methods Valuation for Contemporary Issues viz., Energy and Environment, Contemporary issues in valuation. Asset management strategy and objectives; Overview of asset management standards: British Standard Institution (BSI), Publicly Available Specification (PAS) 55.ISO 55000; Asset management policy, Deterioration modelling; Maintenance - objectives models and maintenance requirements determination; Life cycle costing; Economic life of asset; Replacement analysis; Decision tools for asset management; Prioritization and optimization; System reliability.		
UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
Individual assignments on valuation, EIA, cash flow, project formulation, DPR and case study analysis.		

Max. 45 Hours**COURSE OUTCOMES**

CO1	Summarize the scope of the existing real estate industry in the current business environment and to classify the various statutory and legal regulations applicable to real estate market.
CO2	Outline the roles, responsibilities, rights and liabilities of different real estate stakeholders.
CO3	Get exposure to the various documentation procedures for different real estate transactions, appraisals and valuation of properties.
CO4	Apply quantitative methodology used in different transactions.
CO5	Delineate project development process, compare the different sources of real estate funds and classify the risks.
CO6	Formulate a real estate project by assessing its feasibility and evolving strategies for effective management.

TEXTS/ REFERENCE BOOKS

1. Madura, J. (2008). *Financial markets and institutions*. Ohio: Thomson Publications.
2. Levinson, M. (2001). *Guide to financial markets*. London: Economist Profile Books.
3. Ishkin, F., Eakins, S. (2009). *Financial markets and institutions*. New Delhi.: Pearson Education,
4. Verma, J. (1997). *Venture capital financing in India*. New Delhi.: Response Books.
5. Kotler, P. and Armstrong, G. (2008). *Principles of marketing*. New Delhi.: Prentice-Hall of India.
6. Kotler, P. and Keller, K. (2009). *Marketing Management*. New Delhi: Prentice- Hall of India.
7. Porter, M. (1992). *Competitive strategy*. New York: Free Press.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**PART A : 2 questions from each unit, each carrying 4 marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks**

SARA5204	CONTRACT MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To expose the students to the selection process of different contract types, legal compliance, various international and national contract forms for different types of project.
- To outline the contractual procedures including tendering process, pre-qualification of contractors, evaluation of contract bids, preparation of contract documents, and awarding of contracts.
- To expose the students to the contractual issues and related contract administration and dispute resolution procedures.

UNIT 1	LEGAL FRAMEWORK AND CONTRACTS	9 Hrs
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Laws Governing Sale, Purchase and Use of Urban and Rural Land – Land Revenue Codes – Tax Laws – Insurance and Bonding – Income Tax, Goods and Service Tax, Excise and Custom Duties and their Influence on Construction Costs – Legal Requirements for Planning – Property Law – Agency Law – Local Government Laws for Approval – Statutory Regulations. Indian Contracts Act – Types of Contracts – formation of contracts - Elements of Contracts – potential contractual problems – contracts for engineering and architectural services – contracts for construction.

UNIT 2	CONTRACT DOCUMENTS AND TENDERS	12 Hrs
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Various types of construction contracts, general and special conditions of contract, comparative study of contract conditions - construction contract as a legal proposal, agreement, consideration, contract Planning, tender documents, tendering process - pre-tendering, bid organization, invitation, receipts and evaluation negotiations, award of work, prequalification methods (rating/ evaluation and enlisting of construction agencies), bid review and evaluation, methods of subcontracting; Contract close-out; Defect liability and performance guarantee; Undertaking works at Contractor's risk and cost; Construction Contract Documents – drawings as construction contract document – specifications as construction document – construction contract conditions – construction specification_ list of approved materials and makes.

UNIT 3	LABOUR REGULATIONS, INSURANCES AND CONTRACT ADMINISTRATION	9 Hrs
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Construction specific labour laws and regulations, The Building and Construction Workers (regulation of employment and conditions of service) Act, 1996, Workmen's Compensation Act, Payment of Wages Act, The Employees Provident Fund and Miscellaneous provisions Act 1996;

Insurance in construction works; CAR (contractor all risk policy) Premium determination and risk reduction; duties of employer, contractor, interpretation of contract, Breach of contract – changes during the contract – changes dealing with differing site conditions – Force majeure – delay analysis – claims - cost escalation – time delays and extensions, compensation, notices and termination.

UNIT 4	DISPUTES AND ARBITRATION	9 Hrs
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Types of disputes in construction contracts – methods of dispute resolution processes – alternative dispute resolution and dispute review mechanisms – Dispute Resolution Board proceedings - arbitration and conciliation act 1996 – Arbitration proceedings - managerial approach to dispute minimization – conduct of arbitration proceedings – arbitration award and termination proceedings – powers of arbitrator – setting aside of awards and enforcement of awards – appeal, revision and court proceedings.

UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
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Study the conventional and emerging contract types like CPWD, MES, FIDIC, AIA, NEC, JCT and other international contract types and do the comparative analysis - Prepare a bidding model and strategies for medium / large-scale project cases. Critical appraisal of the conditions of contract for the project; Comparison of contract conditions; determination of special conditions of contract for the project and Professional Ethics.

Max. 45 Hours

COURSE OUTCOMES:

CO1	Understand legal requirements and compliance of construction contracts for the sale and use of urban and rural lands.
CO2	Classify different types of contract and tenders, and preparation of contract documents.
CO3	Categorize the role of labor regulations, insurances in the contract documents for contract administration.
CO4	Analyze the causes and effect of cost and time overruns and relating them to the relevant clauses of contract to prevent litigations.
CO5	Identify the process of negotiation, claims management, conflicts and dispute management.
CO6	Identify issues causing legal disputes between parties and resolution of disputes through arbitration.

TEXTS / REFERENCE BOOKS

1. Gajaria G.T and Kishore Gajaria, Laws Relating to Building and Engineering Contracts in India, LexisNexis Butterworths India, 2000

2. Jimmie Hinze, Construction Contracts, 3rd Edition, McGraw-Hill, 2010
3. Joseph Bockrath and Fredric Plotnick Contracts and the Legal Environment for Engineers and Architects, 6th Edition, McGraw-Hill, 2010
4. Kwaku A. Tenah and Jose M Guevara., Fundamentals of construction Management and organization, Reston Publishing Company, 1985
5. Construction Specifications Institute, Construction Contract Administration Practice Guide, John Wiley & Sons, 2011
6. Greg Goldfay, Construction Contract Administration, UNSW Press, 2004.
7. CPWD-General conditions of contract 2019_construction works / specifications.

End semester examination question paper pattern**(To be distributed uniformly among all the units)****Max. Marks: 100****Exam Duration: 3 Hrs****PART A : 2 questions from each unit, each carrying 4 marks****: 08 x 05 = 40 Marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****: 04 x 15 = 60 Marks**

SARA6201	PROJECT MANAGEMENT WORKSHOP II	L	T	P	Credits	Total Marks
		0	1	2	3	100
Continuous Assessment		University Viva			Min Pass Marks	
50		50			50	

COURSE OBJECTIVES:

- To apply the learning of software technologies in the live case study projects in the applicable areas where possible and compare with the actual scenarios to enable to get hands on experience.
- To do the coordination of services with help of software to understand the areas where the attention of project managers required to do the basic planning in a complex projects.
- To train students for the managerial soft skill developments required for managing project management functions.

WORKSHOP BRIEF

The project management workshop II aims to provide the students with the opportunity to use the software applications for developing project management and services coordination activities. Students shall gather information from their live case studies and use the software to develop comprehensive project management information related to projects like detailed schedule, critical path, resource optimization procedure, cash flow details, and the services coordination activities etc. The outcome of the workshop shall be discussed / presented among the group to see the relevance to the actual scenario and debated to do the betterment in the process. Any open sources of software shall be explored by students to get hands on experience in the process.

Also seminars and workshops shall also be conducted to develop career management skills and students shall present their understanding in the group on interview skills, group discussion skills, career developments, overcoming adversity in career; personal effectiveness skills like time management, stress management, problem solving, positive attitude and confidence, learning and self-development, self-behavior; Team management skills like team building, leadership skills, motivation, conflict management skills, decision making, change management, art of delegation and feedback.

DELIVERABLES

The students shall develop the required project management learnings in the software for the case study project and present the same in the workshop. Also they have to work on the co-ordination aspects of services with the help of suitable software and the level of co-ordination required at various stages of construction shall be discussed and debated in the workshop. Students should also present their understanding on the soft and managerial skills required for project management in the complex projects. The report containing the above should be submitted at the end of the semester for the evaluation.

TEXT / REFERENCE BOOKS

1. Adair, J, (2013) creating success; Develop your leadership skills, 2nd Edition, Viva Books
2. Florence, S (2009), How to resolve conflicts at work, 1st Edition, PHI Learning
3. Mc.Grath, E.H. (2006), Basic managerial skills for all, Prentice Hall India. Delhi
4. Owen, J (2012), The leadership skills handbook, 2nd Edition, Kogan Page.
5. Wallace, Masters (2006), Personality development, Cengage Learning, New Delhi.
6. Whitear, Ribbens (2007), Handling difficult people and difficult situations, CIPD, London
7. Software related books & journals
8. Internet resources

SARA9221	BUILDING MANAGEMENT STUDIO II	L	T	P	Credits	Total Marks
		0	0	11	6	300
Continuous Assessment		University Viva		Min Pass Marks		
200		100		150		

COURSE OBJECTIVES:

- To augment the knowledge acquired through lectures and through live case studies, critically analyze the application of knowledge in the Project Management context with reference to building construction and related infrastructures with topics on project phases, characteristics of the project life cycle, project stakeholders and project organization their roles, responsibilities, scope and services of team members.
- To ensure the logical understanding of the project management procedures and the use of software to prepare, monitor and track the project activities with schedule.
- To understand and devise the quality parameters for the execution of construction activities, services, external infrastructure and co-ordination basis the live case studies and interaction with the construction professionals and consultants.

STUDIO BRIEF

Time Management; Development of Construction Logic; Work out alternatives of construction sequence logic considering project and site constraints, design requirement, services interaction, resource requirement etc.; Study of existing approach to construction logic; Analyse strengths and weaknesses; Preparation of Work Breakdown Structure (WBS).

Visualizing strategic breakdown of project into work packages; Identify approach of work breakdown for the project considering ease of coordination, cost savings etc.; Developing and presenting WBS of respective projects as a hierarchy of deliverables that collectively constitute the project; Presenting WBS in MS-Project with appropriate linkages; Project Planning & Scheduling; Identification of Activities, Milestones and Construction Sequencing considering: Activities, Non work activities, Characteristics of repetitive activities and projects, Typical and non-typical activities, Repetitive and non-repetitive activities.

Development of hierarchy of networks showing detailed activities, milestones using MS project; Calculation of quantities, cost and productivity data; Determine activity durations based on productivity data; Determining activity durations through deterministic and probabilistic durations; Parametric Estimating; Analogous Estimating (Top Down Estimating); Expert Judgement; Three Point Estimates etc.; Determining time duration and labour/equipment resources of all activities in the project using MS project; Utilization of network techniques for project planning, scheduling and control like; Time calculation of AON Network, PERT, PNET, Line of Balance Method and Monte Carlo simulation; Developing Project Schedule on MS Project.

Time Cost Analysis; Calculation of costs related to activities for calculating the cost of crashing a project; Determining costs associated with activities over a time graph; Calculate the costs associated with crashing the activities; Develop project and activity costing schedule on MS Project; Earned Value Management; Developing Planned Value, Actual Cost, Earned Value and Variances; EVM application for project progress; Resource and Material Management; Resource Histograms and Resource levelling; Developing resource histograms for projects; Achieve uniform resource allocation; Application of Multiple Resource Allocation Procedure, PACK method, Branch and Bound Method; Developing a revised resource based schedule; Application of MS Project.

TQM approach for the projects using quality parameters for the project; develop / devise project specific specifications; role of BOQ / contract conditions / special conditions / make of materials; develop quality check parameter for activities / trade packages; activities to be followed for ensuring quality in project execution. Discussion on the current practices and proposal for new techniques to be employed / suggested for quality. Quality test procedures for various construction activities – Site test – Lab test – Interpretation of test results. Procedure for rejecting non-quality / Non-conforming works. NCN procedures.etc.

DELIVERABLES

The students shall define and record the case study documentation in project management context with reference to buildings and related services, infrastructure considering different project phases. The final report to comprise in-depth analysis of project management approach and preparation of schedule using MSP, Cost Analysis, EVM, Resource Analysis and balancing, schedule crashing with time cost tradeoff. Students should also analyze and prepare the quality control / quality assurance plan for the selected project & services studied to have better quality standards, compare and infer the quality management system adopted for the investigated project.

TEXT / REFERENCE BOOKS

1. National Building Code of India 2016 (NBC Volume 1 & 2)
2. National Fire Prevention Association standards
3. Bureau of Indian Standards (BIS)
4. British Standards (BS)
5. Energy conservation building code (ECBC)
6. Bureau of Energy Efficiency (BEE)
7. American Society of Heating, Refrigeration and Air conditioning Engineers (ASHRAE)
8. SP 72: National Lighting Code 2010.

SARA5301	CONSTRUCTION OPERATIONS MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To acquire vital competencies in production, operations & distribution management, leading to an improvement in job skills.
- Apply concepts of operations management such as Warehouse Planning, Operations & Supply Chain Strategies, and New Product Development.
- Learn to create a balance between operations and supply expertise and general business knowledge by disseminating new techniques in the area of operations management.

UNIT 1	OPERATIONS PLANNING	9 Hrs
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Introduction to OM, facilities and capacity planning plant lay-out design SLP, ALDEP, CORELAP, learning curves and location analysis; Production shop - types, assembly line, and theory of constraints; Material requirement planning (MRP) - master production schedule (MPS), bill of material (BOM), and planning process; Aggregate planning - medium term capacity management, manipulation of demand and supply, chase and level strategies; Business Economics.

UNIT 2	OPERATIONS SCHEDULING	12 Hrs
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Operations scheduling - job order scheduling, heuristics for decision rules, Decision Analysis & Modelling, Moore's, Johnson's procedure, Economic Common Cycle Scheduling (ECC scheduling).

UNIT 3	INVENTORY MANAGEMENT	9 Hrs
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Introduction to inventory management - ABC analysis, Economic Order Quantity (EOQ) Models and its variants, inventory control under uncertainty; Logistics Management, Supply Chain Management, Warehouse Management, Value Engineering Concepts,

UNIT 4	PRODUCTIVITY	9 Hrs
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Productivity and work-study - time study, Just in Time (JIT), Kanban System, method study, wage incentive plans, work sampling; Break even analysis; Forecasting.

UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
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ABC analysis for a small project and logistics planning with application of relevant concepts.

Max. 45 Hours

COURSE OUTCOMES

CO1	Interpret the planning of operations as per demand and supply.
CO2	Predict the flow of materials and effectively take decisions for streamlining operations.
CO3	Skillfully plan and control the process of transformed resources as they move through supply networks, and operations.
CO4	Demonstrate the application of the strategic concepts from the perspective of an organization or business unit level.
CO5	Assess productivity with different methods and analysis.
CO6	Analyze and evaluate business operations using basic quantitative analysis techniques.

TEXT / REFERENCE BOOKS

1. Stephen P. Adams, E., Ebert, R. (1994). *Production and operations management*. Delhi: Prentice Hall of India.
2. Bedi, K. (2004). *Production and operation management*. New Delhi : Oxford University Press.
3. Buffa, E., Sarin, R. (2007). *Modern production / Operations management*. New Delhi : John Wiley & Sons.
4. Chase, R., Jacobs, R. and Aquilano, N. (2012). *Operations Management or Competitive Advantage*, New Delhi : Tata McGraw - Hill.
5. Goldratt, E., Cox, J. (1992). *The Goal*. Barrington: North River Press.
6. Krajewski, L., Ritzman, L. (2005). *Operations management-Strategy and analysis*. New Delhi : Pearson Education.
7. Mahadevan, B. (2015). *Operations Management: Theory and Practice*, New Delhi : Pearson India Education Services Pvt. Ltd.
8. Panneerselvam, R. (2012). *Productions and Operations Management*, New Delhi: PHI Learning Pvt. Ltd.
9. Stevenson, W. (2012). *Operations management*. New York : McGraw-Hill.

**End semester examination question paper pattern
(To be distributed uniformly among all the units)**

Max. Marks: 100

Exam Duration: 3 Hrs

PART A : 2 questions from each unit, each carrying 4 marks

: 08 x 05 = 40 Marks

PART B : 2 questions from each unit with an internal choice, each carrying 15 marks

: 04 x 15 = 60 Marks

SBAA5341	COST MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- > The objective of the course is to familiarize the fundamentals of cost concepts and their applications in the various phases of the project cycle of construction projects.
- > To provide a basic knowledge to carry out the evaluation of projects, computation of Profit on projects, systems and equipment and evaluation of project investment decisions.

UNIT 1	FUNDAMENTALS OF COSTING	9 Hrs
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Cost concepts- cost, costing, cost accounting, cost unit, cost centre. Elements of cost, Classification of cost. Methods of costing. Techniques of costing . Cost Sheet.

UNIT 2	COST ESTIMATES	9 Hrs
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Methods of estimating cost of construction for various work, cost indices, rate of labour and material, analysis of rates , preparation of abstract of estimated cost, use of CPWD schedule of rates, Deriving construction cost as per Bill of quantities .Construction Economics-Elasticity of demand, theory of production, costs analysis, contractors costs, perfect competition, monopoly, monopolistic.

UNIT 3	PREREQUISITES OF CONTRACT COSTING	12 Hrs
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Definition, Essential Requirements, Trade usages, Forms of contract, Termination of Contracts, Labour Contract Negotiated Contracts, Schedule of Prices Contracts, Package Deal Contracts, Demolition Contracts, Responsibilities of the Engineer, Contractor and Owner, Earnest Money and Security Deposits, Mobilization Fund, Tender, Opening of Tenders, Scrutiny of Tenders, Acceptance of Tender, Revocation of Tender, Tender form, Unbalance Tender, Liquidated Damages, Advertisement, contract Documents, Qualification of Contractors, Direct and Indirect Costs, Basic price Contracts. Conditions of Contract: Definition, Object, Importance, Peculiarities, General Provisions, Typical Clauses of the Conditions of Contract, Conditions of Contract in Outlines. Rate Analysis: Purposes of Rate Analysis, Factors affecting, importance, Schedule of Rates, Task works per Day, Rate analysis of typical Items.

UNIT 4	CONTRACT COSTING	9 Hrs
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Contract costing- procedure for recording costs, methods of calculating profit on an incomplete contract. Cost plus contract- escalation clause- retention money- -Percentage completion method – completed contract method.

UNIT 5	CONSTRUCTIVE LEARNING	6 Hrs
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Assignments on Risk Associated with national and international contracts.

Max. 45 Hours

COURSE OUTCOMES

CO1	Interpret cost component and computation of cost of a service or a project.
CO2	Predict the cost of the component of a project after considering qualitative and quantitative factors.
CO3	Skillfully able to compute the profitability of a project
CO4	Demonstrate how to be a successful entrepreneur
CO5	Assess best and successful project
CO6	Analyse and evaluate domestic and global competition in building management.

TEXT / REFERENCE BOOKS

1. Rangwala S.C. (2004) *Estimating ,Costing and Contracts*. Charotar Publications.
2. Dutta B.N.(2006) *Estimating and Costing in Civil Engineering: Theory and Practice, including Specifications and Valuation*. UBS Publication.
3. M. Chakraborty. (2006) *Estimating and Costing*. Authors' Publication.
4. Namavati R.(2010) *Theory & Practice of Valuation*. Lakhani Book Depot.
5. Ramachandran. R. & Srinivasan R. (2004) *Cost Accounting*. Chennai: Sriram publication.
6. Ghosh T. Banerjee & Bansal K. (2001) *Principles and Practice of Accounting*. New Delhi: Galgotia Publishing Company.
7. Hansen, M..(2007). *Managerial accounting*. Haryana: Thomson Publishing House.
8. Mittal, D. and Luv M. (2001) *Cost accounting*. New Delhi : Galgotia Publishing Company.
9. Shankararayana, H.&Ramanath, H. (2011) *Financial Accounting for management*. New Delhi : Cengage India.
10. Singh H. (1993). *Construction management and accounts*. New Delhi : Tata McGraw Hill.
11. Venkatasivakumar V. (2011) *Cost accounting management*. Chennai : Pearson.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100

Exam Duration: 3 Hrs

PART A : 2 questions from each unit, each carrying 4 marks

: 08 x 05 = 40 Marks

PART B : 2 questions from each unit with an internal choice, each carrying 15 marks

: 04 x 15 = 60 Marks

S84APT	PROFESSIONAL TRAINING	L	T	P	Credits	Total Marks
		0	0	0	3	100
Continuous Assessment		University Viva			Min Pass Marks	
50		50			50	

COURSE OBJECTIVES:

- To undergo professional training in a project a management firm to get an on-site experience of handling services in under construction high rise projects.
- To utilize the forum to discuss key issues in the projects, keep track of the different scheduled activities and communicate with the stakeholders.
- To get an overall view of the contract administration.

COURSE CONTENT

A candidate has to undergo practical training for 30 working days in an approved Project management organization, reputed in property development or infrastructure and established not less than five years. Companies for practical training are carefully selected.

The organizations train the students in specialised core areas of Building Services / Management and assist the candidates in identifying the area of study for dissertation. During this period the student is advised to study the live projects of the concerned company / industry. The training internship is intended to provide students with practical insights into the world of real business of the construction industry. The Institute looks for meaningful and supervised work experience for the student. The final project report will comprise of an in-depth research and analysis of activities in the form of drawings & relevant details, schematic charts & reports, photographs, documentation of the project, comments, suggestions, etc to appraise the efficiency in progress of work.

COURSE OUTCOMES:

CO1	Accumulate concepts or skills with access to leading experts with specialized knowledge and experience.
CO2	Obtain basic knowledge using an effective performance management system in managing technical projects effectively.
CO3	Manage projects using a proven, effective performance measurement technique.
CO4	Analyze and recommend project decisions concerning scope, cost and schedule parameters faster, more effectively and more confidently.
CO5	Stay on top of schedules, budgets, workloads and human resources issues and delegate practically and fairly.
CO6	Learn to avoid the pitfalls of project management by quickly identifying potential project risks and mitigate them as early as possible.

S84APROJ1	DISSERTATION	L	T	P	Credits	Total Marks
		0	2	10	6	300
Continuous Assessment		University Viva			Min Pass Marks	
200		100			150	

COURSE OBJECTIVES:

- To critic the existing practices in building management / services based on the previous modules and question existing industry practices, formulate new thought process in improving the efficiency of the construction scenario.
- To provide students an opportunity to cultivate specialization in the areas of their own interest and undertake academic research independently.

COURSE CONTENT

Research Content: The Dissertation is an individual research project that is a major piece of work undertaken by the students. At the beginning of the third semester the students are required to be associated with a firm (Architects, engineers, project managers) for a period 30 working days within which they are expected to identify the topic of interest.

It starts with an introduction to the importance of basic competencies in industry, when working as techno managers. The aim is to prepare state of art report on the chosen topic and develop hypothesis to be tested through the research methodology designed for the purpose. Students are required to test their outcome proposals through various methods, including questionnaire surveys and case studies. It is encouraged that students identify topics for the Dissertation work which can be further developed into a Thesis Project with research in the next semester for more in-depth research. Alternatively, this Dissertation Project can be an independent research topic. Students must create an innovative insight on the specific issues.

Research Process: Dissertation work includes processes such as: Research area identification; hypothesis of research topic; literature sourcing and search; aim and objective definition; formulation of methodology; field study planning; survey data collection, analysis and result presentation; literature study; conceptual an empirical :compilation and inference drawing; research study validation through case studies, field application and simulation models; discussion of findings of research findings; study conclusion and recommendation formulations.

The progress of the Dissertation work is presented and discussed by the student periodically in the classroom environment and progress monitored continuously. This work develops the comprehension and presentation skills of the students. The students are provided guidance from the faculty to channelize their thoughts.

Area of Research: Some of the area for Dissertation is land use and planning, financial management, lean construction, quality control and safety procedures, real estate regulations and laws, advanced technologies, project management knowledge areas, PPP projects and business environment.

Presentation: The final presentation is in the form of state of art report and poster size display sheets.

COURSE OUTCOMES:

CO1	Pursue an idea of research with depth of inquiry, criticality and logic and carry out an in-depth investigation of an area of building services or management that he/she is interested
CO2	Be able to demonstrate a high level of technical understanding of the design of buildings and associated construction processes and solutions.
CO3	Understand a broad range of management theories underpinning its practical application in the delivery of construction projects to meet the client's cost, time and quality.
CO4	Recognize and understand how projects are evaluated, structured and delivered.
CO5	Develop an ability to research, analyze, evaluate and discuss a wide range of construction tools, technologies and management strategies applicable to the practice of construction management.
CO6	Propose alternative updated strategies to improve efficiency of construction scenario.

TEXT / REFERENCE BOOKS

1. Iain Borden, Katerina Ruedi, (2000) *The Dissertation: An Architecture Student's Handbook*, MA: Architectural Press.
2. Pilcher R (1994) *Project Cost Control in construction*. Maryland: Wiley-Blackwell.
3. Duncan, Thorpe & Sumner -*Quality Assurance in Construction*. New York: Gower Publishers.
4. Prasanna Chandra (2017) *Projects: Appraisal, Analysis, Financing, Implementation & Review*; New Delhi: McGraw Hill Education India Pvt Ltd.
5. Qiying Kiki Cai (2017) *Business Process Model for Process Improvement: An Investigation of the Tendering Process in a Construction Company*. Hong Kong :Open Dissertation Press.
6. Elizabeth Laycock, Tim Howarth, Paul Watson(2016) *The Journey to Dissertation Success: For Construction, Property, and Architecture Students*. Oxfordshire: Routledge.

S84APROJ2	PRE THESIS	L	T	P	Credits	Total Marks
		0	2	4	3	200
Continuous Assessment		University Viva			Min Pass Marks	
100		100			100	

COURSE OBJECTIVES:

- The objective of the Pre- thesis is to provide an opportunity to the students select a topic for Thesis and to prepare independent and original study of special project of his/her own choice.
- Offers scope to adopt a fresh approach in formulating a concept of developing a methodology effective and useful.

COURSE CONTENT**Research Content:**

The intent of pre thesis is to initiate the selection of Thesis topic in the beginning of the third semester itself. The students shall work three alternative topics by studying and analysing the published research papers of their interest area and give justification for the selection of the topics which will be assigned to him / her to proceed to the next phase.

Research Process:

Each student will prepare the Pre-Thesis with regular reviews by the faculty of the department. . It is encouraged that students identify topics for the Pre Thesis work which can be further developed into a Thesis Project with research in the next semester for more in-depth research. .

The Pre Thesis will be presented in the accepted form of a Pre-thesis report duly supported by copious references, sketches, graphs, proposed statistical data, proposed details of survey, tools and techniques and methodology to be adopted and detailed account of experimental analytical procedures to be adopted.

Each student is required to defend his/her Pre-Thesis at a Viva Voce Examination by jury. The Pre-Thesis shall consist of literature, survey on the topic chosen in the relevant field, theoretical and or experimental work based on the literature and discussion.

Area of Research:

The subject for special study may be conceptual or practical but should pertain to building design and construction management like BIM, construction management procedures, land use and planning, financial management, lean construction, quality control, value engineering and safety procedures and construction Laws.

Presentation:

The final presentation is in the form of a state-of-art report.

COURSE OUTCOMES:

CO1	Comprehend application of knowledge, techniques, skills, and tools of the construction industry in construction activities.
CO2	Perform standard tests, organize and interpret test data, and apply test results to improve construction processes.
CO3	Demonstrate a disposition to engage in self-directed continuing professional development,
CO4	Understanding of professional and ethical responsibilities and commitment to quality, timeliness, and continuous improvement.

TEXT / REFERENCE BOOKS

1. Ranjith Kumar (2005.) *Research Methodology- A step by step guide for beginners*, California : Sage Publications.
2. John W Creswell, (2002). *Research design: Qualitative, Quantitative and Mixed method approaches*. California : Sage Publications.,.
3. Kate Turabian. (2018) *A Manual for Writers of Research Papers, Theses, and Dissertations*. Chicago: Chicago Guides to Writing, Editing, and Publishing.

SARA5401	COST BENEFIT ANALYSIS FOR BUILDING & INFRASTRUCTURE PROJECTS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the financial and economic analysis of projects and concept of individual versus social welfare in large infrastructure and construction projects.
- To understand the various parameters and process for Social Cost benefit Analysis.
- To explore the different tools and techniques for financial and economic appraisal.

UNIT 1	SCOPE OF CBA	9 Hrs
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Concept and rationale - social and economic perspective -welfare criterion. Scope of CBA, SCBA, objectives of CBA, steps/procedures of CBA;

UNIT 2	PARAMETERS OF CBA	12 Hrs
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Issues involved in CBA, SCBA -shadow price and externalities, distribution of project net benefits (referent and non-referent groups); Consumer and producer surplus, valuation of rated goods and services, methods of non-market valuation;

UNIT 3	PROCESS OF CBA	9 Hrs
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Process of CBA, SCBA- least cost analysis (Life Cycle Costing); With and without project analysis, Deriving social cost of project using conversion factor; Identifying and deriving benefits to society; Social discount rate.

UNIT 4	FINANCIAL AND ECONOMIC APPRAISAL	9 Hrs
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Calculating ENPV or EIRR; Applying distribution analysis, risk analysis; Case studies -road, power, investment region. Financial and economic appraisal.

UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
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Exercises will be in the form of group work/and or individual assignments. Each group shall have its own unique real life ongoing project for study. Groups are encouraged to have diverse projects so that peculiarities in specific projects are explored by entire class. All group members are encouraged to deliver presentations along with written assignments

Max. 45 Hours**COURSE OUTCOMES**

CO1	Outline the scope of SCBA.
CO2	Get exposure to the issues in SCBA, its various components and valuation.
CO3	Understanding the process of SCBA and its benefits to society.
CO4	Apply quantitative techniques for financial appraisal.
CO5	Formulate a real analysis model after analysis.
CO6	Perform an economic appraisal.

TEXT / REFERENCE BOOKS

1. Anthony, E.(2001). *Cost benefit analysis- Concepts and practices*. New Delhi.: Boardman, Prentice-Hall of India,
2. Asian Development Bank (2013) *Cost-benefit analysis for development: A practical guide*. Mandaluyong City, Philippines: Asian Development Bank.
3. Campbell H., Brown, R. (2003). *Benefits-cost analysis- financial and Economic appraisal using spreadsheets*, Singapore: Cambridge,
4. Campbell, H., Brown R.(2016) *Cost- Benefit Analysis - Financial and economic appraisal using spread sheets*, Oxfordshire: Routledge.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**Exam Duration: 3 Hrs****PART A : 2 questions from each unit, each carrying 4 marks****: 08 x 05 = 40 Marks****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****: 04 x 15 = 60 Marks**

S84APROJ3	THESIS	L	T	P	Credits	Total Marks
		0	4	20	12	600
Continuous Assessment		University Viva			Min Pass Marks	
400		200			300	

COURSE OBJECTIVES:

- The objective of the thesis is to provide an opportunity to the students to prepare independent and original study of a special project of his/her own choice.
- The project provides students an opportunity for academic research to cultivate specialization in the areas of their own interest under the overall guidance of the faculty.
- The objective of the seminar work is to train the students to prepare state of art report by assimilation of concepts / ideas on a chosen topic in the area of Building Engineering and Management.

COURSE CONTENT

Research Content: The Thesis is an individual research project that is a major piece of work undertaken by the students. It is a continuation of the Pre Thesis of the previous semester. They are expected to select a topic on a live problem in the industry or a macro-issue having a bearing on performance of the real estate, construction or urban infrastructure industry. The topic should be researchable and involve scientific design of a study, collection and analysis. The aim is to prepare state of art report on the chosen topic and develop hypothesis to be tested through the research methodology designed for the purpose.

The thesis proposal should include an overview of the proposed plan of work, including the general scope of your project, your basic research questions, research methodology, and the overall significance of your study. In short, the proposal should explain what to study, how to study this topic, why this topic needs to be studied.

Thesis proposals are designed to

- Justify and plan (or contract for) a research project.
- Show how your project contributes to existing research.
- Demonstrate to your advisor and committee that you understand how to conduct discipline specific research within an acceptable time-frame.
- Recommend future study areas for research.

Research Process: Students are required to test their outcome proposals through various methods, including questionnaire surveys and case studies. Students must create an innovative insight on the specific issues.

Thesis work includes processes such as: Research area identification; hypothesis of research topic; literature sourcing and search; aim and objective definition; formulation of methodology; field study planning; survey data collection, analysis and result presentation; literature study; conceptual an empirical :compilation and inference drawing; research study validation through case studies, field application and simulation models; discussion of findings of research findings; study conclusion and recommendation formulations. The progress of the Thesis work is presented and discussed by the student periodically in the classroom environment and progress monitored continuously. This work develops the comprehension and presentation skills of the students. The students are provided guidance from the faculty to channelize their thoughts.

Area of Research: The subject for special study may be conceptual or practical but pertaining to Building Engineering and Management in are Construction financial management, Human resource management, Quantitative techniques, Energy management, Building services, Building management systems, Infrastructure services , Management information systems , Project planning and feasibility and Disaster management

Presentation: The final presentation is in the form of state of art report and poster size display sheets.

COURSE OUTCOMES:

CO1	Perform an extensive literature study and data collection from the field and presentation in the form of drawings, relevant details/codes, schematic charts, reports and photographs.
CO2	Develop an hypothesis to be tested through the research methodology designed for the purpose with innovative insight on specific issues thereby undertaking academic research independently.
CO3	Experiment with research processes.
CO4	Identify areas for further research and development.

TEXT / REFERENCE BOOKS

1. Ranjith Kumar (2005.) *Research Methodology- A step by step guide for beginners*, California : Sage Publications.
2. John W Creswell, (2002). *Research design: Qualitative, Quantitative and Mixed method approaches*. California : Sage Publications.
3. Kate Turabian. (2018) *A Manual for Writers of Research Papers, Theses, and Dissertations*. Chicago: Chicago Guides to Writing, Editing, and Publishing.

ELECTIVES

SARA7304	INFRASTRUCTURE DEVELOPMENT AND MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To introduce the basic concepts related to large scale infrastructure development activities
- To develop awareness and expertise in effective management of infrastructure developments projects with the knowledge in planning, management and effective delivery of large scale infra projects.

UNIT 1	INTRODUCTION TO INFRASTRUCTURE	9 Hrs
Overview of infrastructure, Introduction to infrastructure business – Study of various types of infrastructure sectors – Energy (oil and gas, renewable energy, thermal power, hydroelectric power, nuclear power)- building infrastructure - transportation (highways, railways, water ways, airways) power and telecom sectors – Rural, Urban infrastructure and irrigation sectors (dam channels and canals etc.), players and phases in infrastructure projects.		
UNIT 2	PROJECT FINANCE AND APPRAISAL	12 Hrs
Infrastructure Project Feasibility – Appraisal and Due Diligence; Life cycle perspective of Infrastructure; Project Implementation approach - Project Finance and public private partnerships (PPP's) – Special Purpose Vehicle (SPV), VGP's; Cash Flow projections, Net Present Value (NPV), Internal Rate of Return (IRR) - social cost benefit assessment of infrastructure – short run cost functions; budget and revenues from usage - Life cycle costs, taxes and finance; Long run investment decisions and cost functions; Decision Analysis.		
UNIT 3	FINANCIAL INSTITUTIONS AND POLICIES	9 Hrs
Government policies and regulations; 5 year plan and impact on infrastructure development - Infrastructure institutions – Infrastructure financing; means; investment norms and regulations.		
UNIT 4	PROJECT STRUCTURING AND RISK	9 Hrs
Infrastructure Project Management; Project Planning and Management; Strategic Planning; Risk & Sensitivity Analysis techniques; Typical DPR structures - Construction and Economic risks; Political and Social Risks; Project Life cycle, approaches project formulation and structuring, elements of Bids Process Management and risk management.		
UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
Analysing and presenting various types of infrastructure projects for a hypothetical situation with the financial proposal and the execution strategy. List and present the various financial institutions with their investment strategies for the infrastructure projects		

Max. 45 Hours**COURSE OUTCOMES:**

CO1	Familiarizing the various types of infrastructure projects and their nature compared to building projects.
CO2	In-depth understanding on project financing appraisal process for infrastructure projects
CO3	Analysing the project finance strategies for different types of projects with decision-making analysis as a process.
CO4	Knowledge on the various types of financial institutions and their policies on funding infrastructure projects.
CO5	Understanding and application of various planning and management techniques to mitigate risks in the execution of infrastructure projects.
CO6	Comprehensive understanding of planning, bidding, funding and execution of infrastructure projects through case study and analysing the investment strategies.

TEXTS / REFERENCE BOOKS

1. Prof.Ashish H. Makwana, Prof. Yogesh K. Alwani, Prof.Kunal. P. Shukla, Dr.Jayeshkumar and R.Pitroda, Infrastructure Engineering and Management, LAP Lambert Academic Publishing, 2008.
2. Donald Coffelt and Chris Hendrickson, Fundamentals of Infrastructure Management, 2017. Pittsburgh, Pennsylvania, USA.
3. S. Goodman and M. Hastak, Infrastructure planning handbook: Planning, engineering, and economics, McGraw-Hill, New York, 2006.
4. Grig N.S., "Infrastructure Engineering and Management", Wiley – Interseience, 1988.
5. P. Chandra, Projects planning, analysis, selection, financing, implementation, and review, Tata McGraw-Hill, New Delhi, 2009.
6. Alvin S. Goodman and MakarandHastak, ASCE Infrastructure Planning, Engineering and Economics, second Edition., McGraw-Hill Professional, 2015.
7. Hendrickson, C. and Mathews, H.S., 2011. Civil Infrastructure Planning, Investment and Pricing. Pittsburgh. PA: Carnegie-Mellon University
8. India Infrastructure Reports (latest as available) from various agencies such as CRISIL, Knight Frank, EY and PWC.
9. Department of Commerce, Ministry of commerce and Industry, Government of India. Sectorwise report from India. Brand Equity Foundation (IBEF); Available at <http://www.ibef.org/industry.aspx>

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100**PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs.****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks.**

SARA7306	FACILITIES PLANNING AND MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To introduce the fundamentals of facilities planning and an effective management.
- To develop students capability to manage various building services in the built facility to increase safe and healthy utilisation of building properties.

UNIT 1	INTROUCTION	9 Hrs.
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Principle duties of a facility manager - Business aspects of facilities management - Diverse responsibilities and decision-making processes from building infrastructure to fleet services – Architectural Programming.

UNIT 2	FACILITIES DESIGN AND SPACE PLANNING	12 Hrs.
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Applications of facilities design in defining the requirements of a project- Developing design strategies, implementing corporate philosophies and methodologies, and understanding the Project Development Process - Flexibility and facilities planning - Optimal space planning and cost minimization through facility layout.

UNIT 3	FACILITY PLANNING AND DECISION SUPPORT SYSTEM	9 Hrs.
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Knowledge based facility planning and decision support system - Application of artificial intelligence – Graphical & theoretic approach to multi-floor building design - Facility layout algorithm using graphics - Simulation in facility planning and efficiency analysis.

UNIT 4	FACILITY MANAGEMENT DURING CONSTRUCTION PHASE AND HANDOVER	9 Hrs.
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Types of facility management options - Functionality of Building Automation systems - Wear and Tear of technical installations, recording operating costs, safety concepts, energy supply and waste management - Service tenders and contracts.

UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs.
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Understand and present the importance of design and space planning requirement in building facilities. To analyse and present the facility planning aspects to be considered in design and space planning of large building facility and discuss / debate on the various facility management aspects required during post occupancy of building facilities.

Max.45 Hours**COURSE OUTCOME:**

CO1	Understand the concept of facilities planning of large building facilities.
CO2	Comprehensive understanding of building and other services for the better management of facilities.
CO3	Explore the best space planning measures to be taken during design stage for the best built facilities
CO4	Analyse the importance of facilities planning requirements during construction and handing over phase of buildings
CO5	Critical analysis of facilities planning and its impact over the post occupancy of buildings.
CO6	Comprehend the understanding with the recommendation of best practices for effective functioning of building facilities.

TEXT / REFERENCE BOOKS

1. David G. Cotts, Kathy O. Roper, *The Facility Management Handbook*, Amacom, 2009
2. Bernard Lewis and Richard Payant, *Facility Manager's Maintenance Handbook*, McGraw Hills, 2007
3. Keith Alexander, Brian Atkin, Jan Bröchner, and Tore Haugen, *Facilities Management: Innovation and Performance*, Routledge, 2004
4. Eric Teicholz, *Facility Design and Management Handbook*, McGraw Hill Professional, 2001
5. Frank Booty, *Facilities Management Handbook*, Fourth Edition, Butterworth- Heinemann, 2006

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs.****: 08 x 05 = 40 Marks****: 04 x 15 = 60 Marks**

SARA7403	LEAN CONSTRUCTION MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To provide exposure to the students on the principles and techniques of lean construction.
- To enhance their skills by training in lean project management software.
- To appreciate Lean management and develop a lean culture.

UNIT 1	INTRODUCTION TO LEAN PRINCIPLES	9 Hrs
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Introduction — productivity measurement in projects and work diagnostics; Mapping of lean principles into construction; Lean construction — fundamental concepts; Lean thinking and culture;

UNIT 2	PROJECT LIFE CYCLE AND LEAN PROJECT DELIVERY SYSTEM	9 Hrs
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Project life cycle and lean project delivery system; Lean tools, techniques and measures; Collaborative planning and last planner system; Location based management system;

UNIT 3	LEAN IN DESIGN AND LEAN TOOLS	12 Hrs
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Lean in design and supply chain management; Lean enablers and integration; Application in lean project management software - Master planning; Value Stream Mapping, Visual Management, 5S

UNIT 4	PLANNING AND PROJECT PERFORMANCE	9 Hrs
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Framework for pull planning and constraint analysis; Look ahead planning, weekly work plans , Standup Meetings, Learning PPP, Key performance indicators for plan reliability and project performance.

UNIT 5	CONSTRUCTIVE ASSIGNMENTS	6 Hrs
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Design of pull planning charts, weekly work plans and look ahead charts for display using a case study.

Max. 45 Hours

COURSE OUTCOMES

CO1	Develop lean thinking and map lean culture in project delivery.
CO2	Interpret the Lean delivery systems.
CO3	Demonstrate skill in applying Lean planning tools.
CO4	Develop pull planning and other visual charts for follow up of project schedules and targets.
CO5	Understand Lean in supply chain management.
CO6	Investigate the key performance indicators and analyze project performance after implementation of lean management techniques.

TEXT / REFERENCE BOOKS

1. Alston, F. (2017), *Lean implementation; Applications & hidden costs*. London: CRC Press.
2. Fidelis, A. Emuze, Tare is io A. Saurin (2015). *Value and waste in lean construction*. London : Routledge, Taylor and Francis.
3. Forbes, L., Ahmed, S. (2011). *Modern construction – Lean project delivery and integrated practices*. CRC Press, New York.
4. Luis Alarcón (1997). *Lean construction*. New York: Routledge, Taylor and Francis.
5. Shang Gao, Sui Pheng Low (2014). *Lean construction management: The Toyota Way*. Springer.
6. Tapping, D., Luyster, T. and Shuker, T. (2002). *Value stream Management*, New York:Productivity Press.
7. Rafael Sacks , Samuel Korb , Ronen Barak ((2017) *Building Lean, Building BIM: Improving Construction the TidharWay*.London : Routledge, Taylor and Francis.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100

PART A : 2 questions from each unit, each carrying 4 marks.

PART B : 2 questions from each unit with an internal choice, each carrying 15 marks

Exam Duration: 3 Hrs.

: 08 x 05 = 40 Marks

: 04 x 15 = 60 Marks