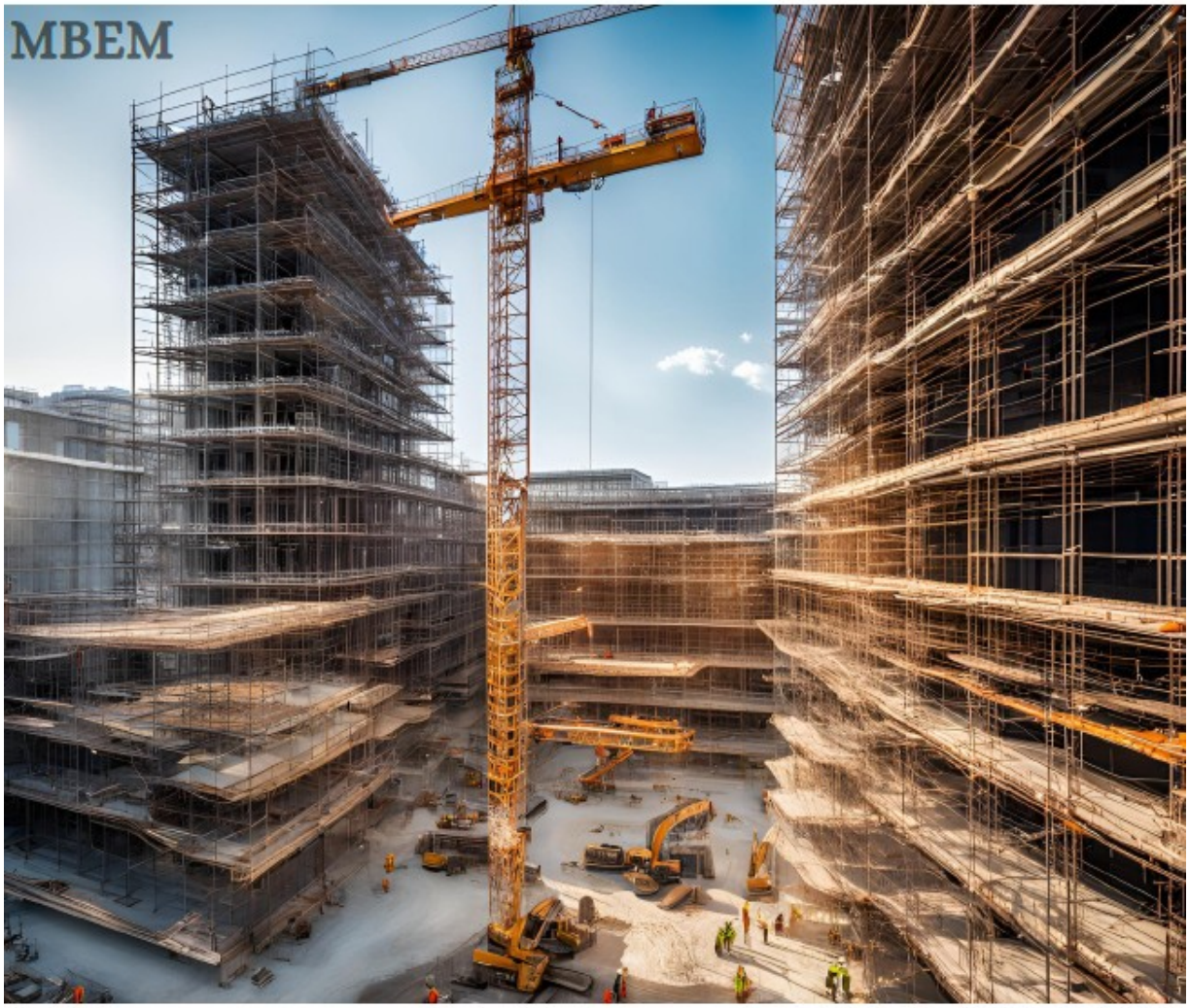
Two Year Post Graduate Programme

Master of Building Engineering & Management (MBEM)



Course Scheme and Syllabus

योजना एवं वास्तुकला विद्यालय, भोपाल
राष्ट्रीय महत्व का संस्थान, शिक्षा मंत्रालय, भारत सरकार
School of Planning and Architecture, Bhopal
An Institute of National Importance, Ministry of Education, Government of India

Master of Building Engineering and Management: MBEM

(Two-Year Programme)

A proud part of the premier Architecture and Planning Institutes, School of Planning and Architecture, Bhopal (SPA-Bhopal) carries forward the 'SPA legacy' of excellence and nation-building through its professionals in Architectural Engineering. Traversing global standards, the school nurtures the success trifecta: *Imagination, Implementation, and Sustenance*. Sense of inquiry, effective research, and eloquent expressions of thoughts prevail and propagate at the SPA-Bhopal.

The Department of Building Engineering and Management at SPA-Bhopal offers a platform for promising project managers to learn the techniques and practices of construction projects. Through collaborations with industry professionals and interdisciplinary education, students are trained for responsible roles and developing a decision-making skill set. A strong research program develops a habit of responsible, impactful understanding of the complexities and innovative solutions in the construction industry.

Moreover, MBEM is concerned with learning Construction Management Processes; Design Development and Management; Advanced Technology Adoption; Effective Procurement Management of Goods and Services; Sustainability; Energy Efficiency, And Climate Responsive Built Environment. The thrust of the course is to achieve the following objectives to enable students to acquire higher degree skills and academic abilities.

- To Foster an understanding of the workings of the Building Industry and its Associated Organizations to become effective in Techno-Managerial Tasks.
  - To equip students with the procedures and practice of the construction projects through a structured teaching approach.
  - Establishing impactful interdisciplinary skill sets and collaborative partnerships within the community to serve as exemplary models for project management expertise.
  - Fostering the development of decision-making skills, by engaging in scholarly and other responsibility roles that help in enhancing the decision-making-based skillset of a construction professional.
  - Providing service and outreach activities to enhance construction profession practice worldwide by providing innovative solutions.

School of Planning & Architecture-Bhopal

Department of Building Engineering & Management

An Institution of National Importance under an Act of Parliament (Ministry of Education, Govt. of India)

Neelbad Road, Bhauri, Bhopal-462030

Master of Building Engineering and Management: Course Structure

Semester-I

Course Category	Subject Code.	Subject	Classes				Credits	Examination Scheme	Marks				Duration of Written Exam
			Lecture Hrs/Week	Tutorial Hrs/Week	Studio Hrs/Week	Total Hrs/Week			Written Exam	Internal Assessment	Viva-Voce	Total Marks	
Core Subject	BEM-101	Construction Project Planning and Scheduling	2	0	6	8	8	Written Exam +Internal Assessment+ Viva-Voce	100	200	100	400	2 Hrs.
	BEM-102	Construction Technology and Materials	2	0	2	4	4	Written Exam + Internal Assessment	100	100	0	200	2 Hrs.
	BEM-103	Advanced Building Services	2	0	0	2	2	Internal Assessment	0	100	0	100	-
	BEM-104	Building Performance Management	2	0	0	2	2	Written Exam	100	0	0	100	2 Hrs.
	BEM-105	Quantitative Techniques and Operational Research	2	0	0	2	2	Internal Assessment	0	100	0	100	-
Institute Elective (Any Two)													
	BEM-106	Automation and Mechanization in Construction	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-107	Infrastructure Project Development and Management	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-108	Site Logistic Management	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-109	Inter-Institutional Elective (Online)	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
		TOTAL				**22**	**22**		**400**	**500**	**100**	**1000**	

Semester-II

Course Category	Subject Code.	Subject	Classes				Credits	Examination Scheme	Marks				Duration of Written Exam
			Lecture Hrs/Week	Tutorial Hrs/Week	Studio Hrs/Week	Total Hrs/Week			Written Exam	Internal Assessment	Viva-Voce	Total Marks	
Core Subject	BEM-201	Construction Project Cost Planning, Control and Monitoring	2	0	6	8	8	Written Exam +Internal Assessment+ Viva-Voce	100	200	100	400	2 Hrs.
	BEM-202	Structural Systems and Management Process	2	0	2	4	4	Written Exam + Internal Assessment	100	100	0	200	2 Hrs.
	BEM-203	Construction Marketing	2	0	0	2	2	Internal Assessment	0	100	0	100	-
	BEM-204	Digitalization In Construction	1	0	1	2	2	Internal Assessment	0	100	0	100	-
	BEM-205	Construction Finance Management	2	0	0	2	2	Written Exam	100	0	0	100	2 Hrs.
Institute Elective (Any Two)													
	BEM-206	Research Method: Statistics and Construction Data Analysis	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-207	Construction Material Management	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-208	Construction Quality Assurance and Quality Control	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-209	Inter-Institutional Elective (Online/Physical Mode)	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
		TOTAL				**22**	**22**		**400**	**500**	**100**	**1000**	

School of Planning & Architecture-Bhopal

Department of Building Engineering & Management

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Master of Building Engineering and Management: Course Structure

Semester-III

Course Category	Subject Code.	Subject	Classes				Credits	Examination Scheme	Marks				Duration of Written Exam
			Lecture Hrs/Week	Tutorial Hrs/Week	Studio Hrs/Week	Total Hrs/Week			Written Exam	Internal Assessment	Viva-Voce	Total Marks	
Core Subject	BEM-301	Construction Contract Procurement Management	4	0	6	10	10	Written Exam +Internal Assessment+ Viva-Voce	100	200	100	400	2 Hrs.
	BEM-302	Dissertation	2	0	4	6	6	Internal Assessment+ Viva-Voce	0	200	100	300	-
	BEM-303	Quality Management Systems	2	0	0	2	2	Written Exam	100	0	0	100	2 Hrs.
Institute Elective (Any Two)													
	BEM-305	Digital Twin in Built Environment	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-306	Building Adaptation	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-307	Construction Innovation and Entrepreneurship	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
	BEM-308	Inter-Institutional Elective (Online/Physical Mode)	2	0	0	2	2	Written Exam	50	0	0	50	2 Hrs.
Industrial Training	BEM-304	Industrial Training (06 Week after Semester-II)	0	0	0	0	2	Internal Assessment	0	100	0	100	
		TOTAL				**22**	**22**		**300**	**500**	**200**	**1000**	

Semester-IV

Course Category	Subject Code.	Subject	Classes				Credits	Examination Scheme	Marks				Duration of Written Exam
			Lecture Hrs/Week	Tutorial Hrs/Week	Studio Hrs/Week	Total Hrs/Week			Written Exam	Internal Assessment	Viva-Voce	Total Marks	
Core Subject	BEM-401	Thesis	2	0	14	16	16	Internal Assessment+ Viva-Voce	0	500	300	800	-
	BEM-402	Construction Health and Safety Management	2	0	0	2	2	Written Exam	100	0	0	100	2 Hrs.
Online Elective - Any one [SWAYAM/NPTEL/As approved]	BEM-403	Elective [Online]	2	0	0	2	2	Internal Assessment	0	100	0	100	-
		TOTAL				**20**	**20**		**100**	**600**	**300**	**1000**	
		TOTAL All Semester				**86**	**86**					**4000**	

First Semester

(M.B.E.M.)

BEM - 101: Construction Project Planning and Scheduling

The course intends to familiarize the students about the application of Project Management and its various concepts in the construction industry. The emphasis of this module is towards the planning processes involved in the various phases of the Project life cycle i.e. from the Inception phase to the Post-construction phase. It also covers the various knowledge areas of Construction Project Management in brief and these areas will be taken up in detail in the subsequent semesters. The course intends to identify the various stakeholders involved in construction projects and the roles, responsibilities, scope and services of various members involved in the project organisation. In this module, the various concepts, tools and techniques regarding Construction Time Management will be taken up in detail.

Course Content

- Introduction to Project life Cycle.
    - What is a Project?
    - Study of Project Life Cycle.
    - Different phases involved in Project life cycle i.e. from inception phase to the Post-construction phase.
    - Various stakeholders in construction industry and their roles and responsibilities.
    - Project team organisation and the roles, responsibilities, scope and services of various members of the organisation.
    - Organisational setups and their influences.
- Introduction to Construction Project Management.
    - Study of various Project Management Processes and their Interactions.
    - Introduction to Project Management Knowledge Areas.
- Project Formulation.
    - Generation and Screening of Project Ideas-Project identification.
    - Preliminary Analysis, Market, Technical, Financial, Economic and Ecological-Pre-Feasibility Report and its Clearance.
    - Project Estimates and Techno-Economic Feasibility Report.
    - Detailed Project Report.
    - Different Project Clearances required.
- Construction Time management.
    - Identification of Work Packages.
    - Preparation of Work Break Down Structures.
    - Sequencing of Activities.
    - Activities Resource and Duration Estimating.
    - Preparation of Schedules (using CPM, PERT, Gantt charts, precedence diagrams and other networking techniques.
    - Monitoring and controlling the schedules.
    - Application of Quantitative techniques and computer applications.

References

i. *A Guide to the Project Management Body of Knowledge, Fourth Edition by Project Management Institute, USA.*
ii. *A Management Guide to PERT/CPM by J.D. Weist& F.K. Levy – Prentice Hall of India Pvt. Ltd.*

iii. *Techniques for Construction Network Scheduling by J.D. Stevens - Tata McGraw-Hill.*
iv. *Construction project management: a practical guide to field construction management by S. Keoki Sears, Richard Hudson Clough, Glenn A. Sears - John Wiley and Sons.*
v. *Construction project management: planning, scheduling and controlling by K. K. Chitkara - Tata McGraw-Hill Education.*
vi. *Construction scheduling: principles and practices by Jay S. Newitt – Prentice Hall of India Pvt. Ltd.*
vii. *Construction Project Scheduling and Control by Saleh Mubarak - John Wiley and Sons.*
viii. *Construction Project Management: A Managerial Approach by JF McCarthy.*
ix. *Construction Planning, Equipment, and Methods by Robert L. Peurifoy, Clifford J. Schexnayder, Aviad Shapira, Robert Schmitt - Tata McGraw-Hill.*

BEM - 102: Construction Technology and Materials

This course intends to give an overview of the modern concrete construction techniques that can be used for the construction of various types of structures, the understanding of which is essential for the construction managers. This course basically aims to identify the various parameters that govern the selection of a particular structural solution for a given building in the given set of parameters. It covers the various geo-technical aspects of soil mechanics required for designing the sub-structure for various buildings. It includes the study of various types of foundation system, their design consideration, application, construction processes and the required construction equipment. It also intends to study the various systems that can be used for construction of super structures in modern buildings and how various services are integrated in a given system.

Module – 2 i covers various techniques which can be used for the construction of large span structures and high-rise buildings. In this module, the steel, composite and pre-engineered construction techniques will be dealt in dealt. It also covers the cost and quantity modelling for various types of buildings having concrete structures; the analysis of this data can be used as reference for the preparation of preliminary cost and quantity estimates for future projects. It emphasises on the integration of these modern structural systems with the modern service and civil finishing systems.

Module - 3 includes the study of modern construction materials like concrete, plastics, metals, FRP, cork, etc. that can be used for the construction of contemporary buildings. It aims to study the production, composition, usage, detailing, properties, testing, transportation, performance, maintenance and repair aspects for the optimal usage of the above mentioned materials. The course also emphasises on the art of specification writing for these materials so that the design, procurement, implementation, installation, maintenance, control, contract formulation, and dispute resolution operations can be undertaken in a better way. It covers the recent developments in the field of plastics and other lighter materials that can be used as a replacement for concrete in some of the applications. It also intends to identify and study the various eco-friendly construction materials.

Course Content

Module - 1

- Site Investigation and its various stages.
- Process for identifying construction variables and constraints for a given set of conditions and finding the appropriate solution.
- Soil Investigation and Sub-soil Exploration.
    - Soil classification for Engineering purposes and its behaviour under different circumstances.
    - Various methods and tests for soil investigation.
    - Determination of Soil Bearing Capacity.
    - Study of soil test reports for various projects.
- Modern Concrete Technology.
    - Advancements in concrete systems – RMC, pre-cast, pre-stressed, etc.
    - Advancements in formwork systems – tunnel form, aluminium forms, slip forms, jump forms, flying forms, ganged forms, etc.
    - Advancement in steel reinforcement.
    - Construction Chemicals.
    - Their applications, pros & cons, time, cost and quality implications in construction.

- Sub-structure construction.
    - Introduction to foundation design based on soil characteristics.
    - Types of foundations.
    - Foundations in special conditions.
    - Basement Construction.
    - Waterproofing in basements.
- Super-structure construction.
    - Types of Floor slab systems.
    - Their design considerations, characteristics and behaviour.
    - Their applications in construction of various types of buildings.
- Equipment for Concrete Construction.
- Repair techniques for concrete structures.
    - Symptoms and diagnosis of Distress.
    - Distress in fire damaged structures.
    - Selections of Repair Process.
    - Common types of Repairs.
    - Repairs in special circumstances.

Module - 2

- Introduction to Large span structures.
    - Space frames.
    - Pneumatic structures.
    - Shells and folded plate construction.
    - Suspended Membrane Structures.
    - Their applications, construction technologies, time, cost and resource requirements.
    - Case studies.
- Introduction to High-rise Buildings.
    - Evolution of high-rise buildings.
    - Various structural systems that can be used.
    - Design considerations, construction technologies, time, cost and resource requirements.
    - Construction planning, scheduling, implementation and control.
    - Special equipment and machinery for high rise construction.
    - Services for high rise buildings.
- Steel and composite construction.
    - Types of steel and composite constructions.
    - Design characteristics, detailing and applicability of these systems in various types of buildings.
    - Construction planning, scheduling, implementation, control and resource requirements.
    - Provision for Services in buildings with steel construction.
    - Introduction to Pre-engineered construction.
- Cost and quantity modelling for a variety of buildings having concrete structural systems.

- Co-ordination of architectural, services and the above mentioned structural systems for a variety of building types.

Module - 3

- Identifying the various modern construction materials.
- Concrete as a building material.
    - Evolution of concrete as one of the most important construction materials.
    - Properties of constituent materials.
    - Properties of fresh and hardened concrete.
    - Concrete Mix design.
    - Special types of concrete.
    - Mass Concreting.
    - Concrete structures in special circumstances.
    - Performance, maintenance and repair techniques for concrete structures.
    - Innovative materials that can be used as substitute to concrete.
    - Future trends in Concrete technology.
- Other construction materials.
    - Various types of plastics like PVC, FRP, PPR, UPVC, etc. – their classification, composition, production, properties, usage and performance.
    - Asphalt, Bitumen, Tar, Cork, Rubber, Gypsum, Ceramics, Glass, Fibre Glass, etc. - Specifications, use and tests.
    - Iron and Steel – Pig Iron, Cast Iron, Wrought Iron, Stainless Steel, Mild Steel, Fe 415 & Fe 500 bars – Properties, treatment, specifications, use as reinforcement and structural steel.
    - Non Ferrous Metals – Aluminium, Copper, Brass, Bronze, Lead, Magnesium – Specifications and use.
    - Glass, Paints, Varnishes, Distempers – Types, composition, specification and usage.
    - Study of the application of the above mentioned materials in construction industry.
- Green building materials.
    - Introduction to green building materials.
    - Identifying various such materials and their application in construction.
    - Study of their specifications, usage, properties, cost-benefit analysis and environment friendly behaviour.
    - Standards regarding green materials.
    - Future trends in green building materials.
- Writing specifications.
    - Introduction to construction specifications and their importance.
    - Relationship between drawings, construction and specifications.
    - Types of specifications.
    - Specification writing procedures and principles.
    - Contractual provisions regarding material and process specifications.
    - Study of various specifications from IS Codes, British standards and ASTM standards.

- Construction managers approach towards construction using these materials.
    - Incorporation of design considerations; preparation of WBS; planning, sequencing & scheduling activities; preparation of proper specifications &tender documents; implementation and control.
    - Cost, time and quality implications.
    - Resource requirements- materials, man power, equipment, etc.

References

i. *Concrete Technology by Neville - Pearson Education India.*
ii. *Concrete Technology by A.R. Santhakumar - Oxford University Press.*
iii. *Construction technology for tall buildings by M. Y. L. Chew, Michael Chew Yit Lin - World Scientific.*
iv. *Construction Technology: Analysis and Choice by Tony Bryan - John Wiley and Sons.*
v. *Advanced Construction Technology by Roy Chudley, Roger Greeno - Pearson Prentice Hall.*
vi. *Construction Technology by R. Chudley - Heinemann Educational Books.*
vii. *Construction Planning, Equipment, and Methods by Robert L. Peurifoy, Clifford J. Schexnayder, Aviad Shapira, Robert Schmitt - Tata McGraw-Hill.*
viii. *Towards safer long-span buildings by Stephen A. Kliment, American Institute of Architects. Long-Span Building Panel - American Institute of Architects.*
ix. *Innovative large span structures by Naren K. Srivastava, A. N. Sherbourne, John Roorda, Canadian Society for Civil Engineering, International Association for Shell and Spatial Structures - The Canadian Society for Civil Engineering.*
x. *Building anatomy: an illustrated guide to how structures work by Iver Wahl - Tata McGraw-Hill.*
xi. *Supersheds: the architecture of long-span, large volume buildings by Chris Wilkinson - Butterworth Architecture.*
xii. *Super Structures: The Science of Bridges, Buildings, Dams, and Other Feats ... by Mark Denny - JHU Press.*
xiii. *On span and space: exploring structures in architecture by Bjørn Normann Sandaker - Routledge.*
xiv. *Steel structures: recent research and developments by N. E. Shanmugam, S. L. Lee - Taylor & Francis.*
xv. *Composite construction in steel and concrete: proceedings international conference - American Society of Civil Engineers.*
xvi. *Composite construction by D. A. Nethercot- Spon Press.*
xvii. *Composite construction methods by John Philip Cook - Krieger Pub. Co.*
xviii. *Composite steel and concrete construction by Peter Reginald Knowles - John Wiley and Sons.*
xix. *Concrete-steel construction (Der eisenbetonbau) by Emil Mörsch, E. P. Goodrich - The Engineering news publishing company.*
xx. *The architecture of steel: site planning and building type in the nineteenth-century American Bessemer steel industry by Mark M. Brown - University of Pittsburgh.*
xxi. *Architecture and construction in steel by Alan Blanc, Michael McEvoy, Roger Plank - Taylor & Francis.*
xxii. *Design of modern high rise reinforced concrete structures by Hiroyuki Aoyama - World Scientific.*
xxiii. *Planning and control of high-rise building construction by Arash Ranjbaran - Concordia University (Canada).*
xxiv. *High-rise manual: typology and design, construction and technology by Johann Eisele, Ellen Kloft - Birkhäuser-Publishers for Architecture.*

xxv. *Fire fighting Operations in High-Rise and Standpipe-Equipped Buildings by David M. McGrail - PennWell Books.*

xxvi. *Cost analysis of City services for high-rise buildings by Gerald Allen, John Miller, Seattle (Wash.) - City Council, Seattle (Wash.). Office of Economic Development.*

xxvii. *Materials in construction: an introduction by Geoffrey D. Taylor – Longman.*

xxviii. *Construction Materials: Their Nature and Behaviour by J. M. Illston - Taylor & Francis.*

xxix. *Construction project management: a practical guide to field construction ... by S. Keoki Sears, Richard Hudson Clough, Glenn A. Sears - John Wiley and Sons.*

xxx. *Construction Specifications Writing: Principles and Procedures by Mark Kalin, Robert S. Weygant, Harold J. Rosen, John R. Regener - John Wiley and Sons.*

xxxi. *Green Building Materials: A Guide to Product Selection and Specification by Ross Spiegel, Dru Meadows - John Wiley and Sons.*

xxxii. *IS – 456: Indian Standard for Plain & Reinforced Concrete.*

xxxiii. *SP – 36: Compendium of Indian Standards on Soil Engineering.*

BEM – 103: Advanced Building Services

This course intends to provide exposure to students about planning, design and execution of building services like water supply, sanitation, storm water drainage, electrical, illumination, fire fighting, HVAC, vertical transportation, security systems, etc. so as to enable them to effectively co-ordinate pre-construction and construction phase of projects. It also involves the study of low-side, high-side and city level layouts for the above mentioned services. It also includes the materials and their specifications for the provision of these building systems. It covers the co-ordination between architectural, structural and service layouts for a variety of building types. It also covers the basics of building automation system and their importance in modern large scale complex buildings; with an introduction to the concept of intelligent buildings.

Course Content

- Water supply, sanitation and storm water drainage services.
    - Sources of water supply.
    - Calculation of water consumption.
    - Quality of water and purification systems.
    - Distribution systems for water and metering systems.
    - Domestic hot and cold water supply systems.
    - Material and sizes of water supply pipes and fixtures and their connection details.
    - Calculation of sewage quantity and design & construction of sewer and sewer appurtenances.
    - Designing and selection of appropriate water and sewage treatment plants.
    - Sizing and layout of storm water lines.
    - Design considerations for water supply, sanitation and storm water drainage layouts at domestic, large premises and city level and their construction.
- Electrical services.
    - Principles of electricity.
    - Power distribution systems – urban and rural, overhead and underground lines, electric sub-stations and connection to individual projects.
    - Standby and alternate power supply system.
    - Wires, bus bars and cable trays - specifications, carrying capacity, layouts and calculation of electrical loads.
    - Types of switches, sockets and fixtures.
    - Distribution boards, circuit breakers, fuses, electrical meters, DG sets, transformers, back-up systems and their layout.
    - Protection against overload, short circuit, earth fault, lightening conductors and other safety measures for buildings.
    - Design considerations for electrical installations.
- Illumination.
    - Light and its propagation, reflection, radiation, transmission and absorption.
    - Definitions and units of flux, solid angles, luminous intensity, brightness.
    - Laws of illumination.
    - Lighting design process and considerations – day lighting and electric lighting.
    - Types of appliances for interior and exterior lighting.

    - Introduction to lighting design software.

- Fire fighting services.
    - Causes and spread of fire.
    - Fire detection and fire fighting equipment- smoke detectors, monitoring devices, alarm systems, extinguishers, etc.
    - Design for fire resistance and smoke control.
    - Design of Fire escapes for high-rise buildings.
    - Lighting protection.
    - Fire codes, authorities and standards.
- Heating, ventilation and air conditioning services.
    - Basic principles of air conditioning.
    - Occupant comfort and health.
    - Sizing of air conditioning systems.
    - Types of air conditioning systems.
    - Design considerations, provisions, selection criteria, energy requirements for various types of air conditioning systems.
    - All-air and all-water air conditioning systems.
    - Performance evaluation mechanisms.
    - Codes and standards.
- Vertical Transportation systems.
    - Elevators, escalators and walkways.
    - Various suppliers for these systems and their specifications.
    - Their design considerations, provisions, selection criteria, initial / operational costs and energy requirements.
    - Programming elevator banks as per building requirements.
- Security systems.
    - Building security through planning and design.
    - Security requirements for various types of buildings.
    - Various types of security systems and their installations.
- Innovative solutions for the above mentioned services in order to reduce energy consumption.
- Building Automation system.
    - Introduction to BAS and BMS.
    - Components and functioning of BAS.
    - Control and optimisation of various building services through BAS.
    - Introduction to Intelligent buildings.
- Study of civil infrastructure services for various types of buildings - planning, design, construction and maintenance of external development works.
- Managing the design and construction co-ordination of these infrastructure services through various project management techniques.

References

i. *Illustrated encyclopaedia of building services by David Kut – Taylor & Francis.*
ii. *Building Services Handbook by Fred Hall, Roger Greeno - Butterworth-Heinemann.*
iii. *Mechanical and Electrical Equipment for Buildings by Walter T. Grondzik, Alison G. Kwok, Benjamin Stein - John Wiley and Sons.*
iv. *Mechanical and electrical systems in buildings by Richard R. Janis, William K. Y. Tao - Pearson Prentice Hall.*
v. *Mechanical and electrical systems in buildings by Richard R. Janis, William K. Y. Tao - Pearson Prentice Hall.*
vi. *The water supply, sewerage and plumbing of modern city buildings by William Paul Gerhard - John Wiley and Sons.*
vii. *Energy Management in Buildings by Keith J. Moss - Taylor & Francis.*
viii. *Practical Handbook on Energy Conservation in buildings – Indian building Congress.*
ix. *Water supply and sanitary Engineering by Rangwala – Charotar Publishing house.*
x. *Energy Conservation Building Code – Bureau of Energy Efficiency.*
xi. *Fundamentals of air conditioning systems by Billy C. Langley - The Fairmont Press, Inc.*
xii. *Air-conditioning system design manual by Walter T. Grondzik - Butterworth-Heinemann.*
xiii. *Air Conditioning Systems: Performance, Environment and Energy Factors by Tobias Hästesko, Otto Kiljunen - Nova Science Pub Inc.*
xiv. *Building construction: service systems by James E. Ambrose - Springer.*
xv. *Development trends in building services engineering by Tin Tai Chow - City University of HK Press.*
xvi. *Vertical transportation for buildings by Rodney R. Adler - American Elsevier Pub. Co.*
xvii. *Integrated security systems design: concepts, specifications, and implementation by Thomas Norman - Butterworth-Heinemann.*
xviii. *Intelligent buildings and building automation by Shengwei Wang - Taylor & Francis.*
xix. *Smart Buildings Systems for Architects, Owners and Builders by James M Sinopoli - Butterworth-Heinemann.*
xx. *NFPA, NBC and relevant IS Codes.*

BEM - 104: Building Performance Management

The course aims to develop an attitude to critically evaluate the building w.r.t. functional and environmental performance of buildings. The buildings can be assessed on the basis of various parameters like thermal performance, noise control, fire fighting systems, illumination, energy efficiency, carbon foot-print, embodied energy, IAQ, etc. and the cost benefit analysis for achieving better building performance. It also covers the study of basic minimum standards that are desirable for any building as per good practices and national / international codes / standards. It provides an introduction to various computer applications that can be used for designing the above mentioned systems and also to evaluate their performance.

Course Content

- Introduction to concept of Total Building Performance.
- Study of various parameters for assessing a building's functional performance.
    - Thermal performance of buildings.
    - Building performance according to Indoor Air and sound Quality standards.
    - Efficiency of water supply, sanitation, fire fighting, vertical transportation, noise control and illumination systems.
    - Assessing the energy efficiency and energy conservation aspects of a building.
    - Introduction to concepts of carbon foot-print and embodied energy for evaluating the performance of a building.
    - Introduction to EIA and SIA studies for building projects.
- Study of minimum desirable building performance standards and energy consumption standards as per good practices and national / international codes /standards.
- Enhancing the performance of various systems installed in a building to desired levels and the cost benefit analysis.
- Role of BIM and BAS for improving the overall performance of buildings.
- Energy auditing mechanisms to assess and improve the energy efficiency of buildings.
- Green building approaches and building performance rating systems.
- Computer applications for design and efficiency evaluation of various building systems.

References

i. *Enhancing Building Performance by Shauna Mallory-Hill, Wolfgang P. E. Preiser, Christopher G. Watson - John Wiley & Sons.*
ii. *Assessing building performance by Wolfgang F. E. Preiser, Jacqueline Vischer – Elsevier.*
iii. *Building Performance: Function, Preservation, and Rehabilitation by Gerald Davis - ASTM International.*
iv. *Building evaluation techniques by George Baird - Tata McGraw-Hill.*
v. *Building evaluation by Wolfgang F. E. Preiser – Springer.*
vi. *Post-Occupancy Evaluation by Wolfgang F. E. Preiser, Harvey Z. Rabinowitz, Edward T. White - Van Nostrand Reinhold.*
vii. *Performance of buildings and serviceability of facilities by Gerald Davis, Francis T. Ventre, ASTM Committee E-6 on Performance of Building Constructions, ASTM Subcommittee E06.25 on Whole Buildings and Facilities - ASTM International.*

BEM - 105: Quantitative Techniques and Operational Research

The course intends to empower the students with the basic knowledge of various quantitative techniques; the application of which can reduce an otherwise complex problem to a manageable dimension. It also covers the OR methodology i.e., collection, interpretation, analysis and presentation of data, thereby helping in decision making. These analytical methods can provide a logical, rational & quantitative basis for actions and decisions throughout the various phases involved in the life cycle of a project. It also covers an introduction to compute applications for the application of OR techniques.

Course Content

- Introduction to Operations Research.
    - History of Operations Research
    - Definitions of Operations Research
    - Phases of Scientific Method in OR Approach
    - Common Managerial Problems
    - Applications of Operations Research
    - Advantages and disadvantages of Operations Research Study
    - Computer Software for Operations Research
- Common Operations Research models in practice.
    - Acceptance and Allocation models.
    - Analytic Hierarchy Process (AHP).
    - Fish Bone Analysis or Cause – Effect Diagram.
    - Control Charts.
    - Decision tables, trees and analysis models.
    - Failure Modes and Effects Analysis (FMEA).
    - Forecasting, Fuzzy Set Model and Game theory.
    - Inventory and Network models.
    - Pareto Analysis.
    - Replacement, Sequencing and Simulation models.
    - Vendor rating system (scoring model)
    - Waiting line (or Queuing) models.
- Identifying and applying the various techniques that can be used for solving the critical decision making problems in an analytical manner related to:
    - Time Management.
    - Cost Management.
    - Quality Management.
    - Resource Management.
    - Risk Management.
    - Contracts Management.
    - Value Engineering.
    - Procurement Management.
    - Building Performance Evaluation.

- Application of various computer applications like SPSS, Minitab, etc. to ease the mathematical complexities involved in these techniques.
- Application of the above mentioned techniques in construction industry.

References

i. *Operations Research: An Introduction, by Taha - Pearson Education India.*
ii. *Introduction to operations research by Frederick S. Hillier, Gerald J. Lieberman - Tata McGraw-Hill.*
iii. *Quantitative techniques In Management by N. D. Vohra - Tata McGraw-Hill.*
iv. *Operations research in construction management by Brian Haisman - University of N.S.W.*
v. *Decision Making and Operations Research Techniques for Construction Management by C. M. Tam - City University of HK Press.*
vi. *Quantitative Techniques for Decision Making in Construction by S. L. Tang, Irtishad U. Ahmad, Syed M. Ahmed, Ming Lu - Hong Kong University Press.*

BEM - 106: Automation and Mechanization in Construction

The intent of the course is to familiarize the students with the various types of construction equipment that can be used to improve the cost, time, quality and resource performance of a given project. It covers the estimation of equipment ownership and operating costs and determination of economic life and replacement policy. It also includes listing of equipment that can be used for the different activities involved in the construction process. It also deals with the productivity information related to these equipment and machinery.

Course Content

- Evolution of construction equipment.
- Ownership and operating cost of equipment.
- Equipment economic life and replacement policy.
- Types of equipment.
    - Equipment for earthwork.
    - Equipment for concreting.
    - Lifting equipment.
    - Piling equipment.
    - Equipment for pumping water.
- Methods for estimating and optimising construction equipment productivity.
- Buy, lease or rent decision.
- Construction equipment maintenance and safety.
- Impact of using construction equipment and machinery for various construction activities on cost, time, quality and resource performance of the project.
- Impact of using construction equipment and machinery on managerial functions like construction planning, scheduling, monitoring and control.
- Automation and Robotics in construction industry.

References

i. *Construction Planning, Equipment, and Methods by Robert L. Peurifoy, Clifford J. Schexnayder, Aviad Shapira, Robert Schmitt - Tata McGraw-Hill.*
ii. *Construction Equipment Management for Engineers, Estimators and Owners by Douglas D. Gransberg, Calin Popescu, Richard C. Ryan – CRC Taylor & Francis.*
iii. *Construction equipment guide by David A. Day, Neal B. H. Benjamin - Wiley-IEEE.*
iv. *Allis-Chalmers Construction Machinery & Industrial Equipment by Norm Swinford - MBI Publishing Company LLC.*

BEM - 107: Infrastructure Project Development and Management

This course intends to give an overview of the advanced infrastructure construction methods used for construction. To understand the government policies for infrastructure management. This subject is the amalgamation of policies, construction, and infrastructure project management. The development of infrastructure includes the study of highways, bridge construction, culverts, storm water drainage systems, elevated highways, and various other kinds of construction related to infrastructure projects. This course aims to identify the reasons for selecting a particular project. It has to cover the various aspects that how the screening of project ideas was done in a project.

Course Content

- Infrastructure
    - Definitions and steps followed in developing an infrastructure. Planning of major infrastructure projects. Screening of project ideas and life cycle analysis of projects.
- Infrastructure alternatives
    - Multi-criteria analysis for infrastructure projects
    - Strategies followed in infrastructure projects
    - Procurement strategies
    - Scheduling and management strategies
- Economic analysis
    - Principal and methodologies for economic analysis
    - Concepts and applications followed in a project.
    - Analysis of public works
    - Time value of money
    - Cash flows
    - Revisiting the Net present value, Investment Rate of Return, and benefit-cost ratio in terms of infrastructure projects.
    - Curves and trade-offs, demand curves, price elasticities, and shadow pricing.
- Risk and uncertainties
    - Types of risks in infrastructure project
    - Basic concepts and models
    - Investment criteria

- Estimation
    - Basic principles of estimation
    - Financial estimates and projections
    - Cost of capital
    - Project risk analysis
- Political and social perspectives of infrastructure planning, case studies associated with the infrastructure projects.

References

i. *Prasanna and Chandra, Projects: Planning, analysis selection, financing, implementation, and review.Tata McGraw-Hill, New Delhi.*

ii. *J. D. Finnerty, Project financing - Asset-based financial engineering, John Wiley & Sons, New York.*

iii. *J. Parkin and D. Sharma, Infrastructure planning, Thomas Telford, London, 1999*

iv. *L. Squire and H. G.van der Tak, Economic analysis of projects, John Hopkins University Press, London, 1975.*

v. *T. J. Webster, Managerial economics: Theory and practices, Elsevier, New Delhi.*

BEM - 108: Site Logistic Management

The intent of the course is to make the students understand with the various types of methods used in managing the inventory from the site level to headquarter level. To understand warehouse management fundamentals including ownership, number, size, stocking, and location, that is, what type, organization, how many, what size, what products, and where things need to stocked.. To understand recent developments in warehouse management system. To understand inventory software's and new Enterprise Resource planning methods to make the management of inventory smoother.

Course Content

- Introduction-meaning and definition of inventory
    - Management of inventories
    - Objectives of inventory management
    - Problems faced by management
    - Inventory control
    - Inventory control techniques.

- Concepts of Logistics
    - Site logistics.
    - Temporary Structures
    - Factors affecting the inventory
- Procurement
    - Introduction
    - Prioritize for procurement
    - ABC Classification
    - XYZ-FSN Classification
    - SDE and GOLF Methods
    - Multi variable methods
    - Econometric methods
- Economic Order Quantities
    - Stock out
    - Stock out costs
    - Inventory carrying costs
    - Ordering costs
    - EOQ
    - Economic lot size

References

i. *Logistics management by S.L. Ganapathi and S K Nandi*
ii. *Handbook of Logistics Shipping and Commercial technologies by Benny John*
iii. *IBO-4 Export Import Procedures And Documentation by Sudhir Kochhar*
iv. *International Trade and Finance by Indian Institute of Banking & Fianance*
v. *Introduction to Financial Planning by Indian Institute of Banking & Finance*

BEM-109-Inter-Institutional Elective (Online /Physical Mode)

The underlying fundamental of this elective is for the student to identify and pursue any unique course of study related to STEM (Science, Technology, Engineering, and Management) in physical or online mode. The student can select a course that may be directly or indirectly relevant to the building or its related infrastructure works. The objective of this course is to enhance the exposure of students in an unrestricted manner and to aid their learning through varied methods. The course enables students to acquire skills to develop their ideas into physical form and encourages startups. This elective intends to achieve the concept of multidisciplinary and cross-collaboration to the other areas of specialization.

Course Content

The course may be linked to the built environment, construction, architecture, planning, project management, or related to the topic of research. Encouraging a multi-disciplinary approach through the subject as well as its contents, the course work should include a theoretical understanding of the subject, learning through case studies and real-world projects, and future methods of application in the industry/ research. The use of analytical tools and techniques is encouraged.

Upon completion of this course, the student should be able to

- Learn foundational concepts of the topic
- Establish a link between the learnings and their projects/ research
- Apply the skills in their research/ projects/ future career
- Share the insights with fellow classmates
- Earn a certificate from the online learning platform or certificate from other Department of studies

References

i. *National Programme on Technology Enhanced Learning (NPTEL) initiated by Ministry of Education.*
ii. *Courses offered by IIT, IIM, ISSER, NIT's, SPA's, NITTTR and other reputed Universities/Institution*
iii. *Courses offered by reputed National and International Universities.*

Second Semester

(M.B.E.M.)

BEM - 201: Construction Project Cost Planning, Control and Monitoring

In this module, the focus will be on the Construction Integration, Scope and Cost Management processes. It covers the processes required for the development of an integrated management plan i.e. a guideline that governs the functioning of all the stakeholders, personnel, processes and activities involved in the project life cycle, so the project can be executed in the desired manner. It also covers the processes that help in defining, managing and controlling a project's scope i.e. what is and is not included in the project. In cost management, the processes involved in estimating, budgeting and controlling costs so that the project can be completed within the approved budget are dealt with. It intends to study the interactions of these management processes with the processes involved in other Management Knowledge Areas that have been covered in the previous semester. The practical application of these concepts in construction industry during the various phases of construction projects will also be covered. It tries to create a theoretical base for the practical training that has to be undertaken after this semester.

Course Content

- Construction Integration Management.
    - Preparation of Project Management Plan which can provide guidelines for the preparation of management plans pertaining to various knowledge areas of project management and their:
        - Functioning, management, updating and control during implementation phase.
        - Interactions with each other.
- Construction Scope Management.
    - Defining and documenting stakeholder's requirements.
    - Preparation of preliminary scope statement for a project.
    - Breaking the project into smaller manageable work packages and verifying the preliminary scope.
    - Finalising scope statement and acceptable project deliverables.
    - Monitoring the scope baselines during implementation phase, updating the baselines and managing the changes.
- Construction Cost Management.
    - Types of Estimates and their preparation.
    - Determination of budgetary requirements and planning for them.
    - Monitoring the cost baselines during implementation phase, updating the baselines and managing the changes.
    - Concept of earned value.
    - Use of computer applications for project cost management.
- Study of interactions between Construction Interaction, Scope, Cost management processes and other Management Knowledge Areas, and how these interactions are dealt with in the practical field environment.
- Applications of OR techniques and computer applications for processes related to these management areas.

References

i. *A Guide to the Project Management Body of Knowledge, Fourth Edition by Project Management Institute, USA.*
ii. *Construction project management: a practical guide to field construction management by S. Keoki Sears, Richard Hudson Clough, Glenn A. Sears - John Wiley and Sons.*
iii. *Construction project management: planning, scheduling and controlling by K. K. Chitkara - Tata McGraw-Hill Education.*
iv. *Construction Project Management: A Managerial Approach by JF McCarthy.*
v. *Construction Planning, Equipment, and Methods by Robert L. Peurifoy, Clifford J. Schexnayder, Aviad Shapira, Robert Schmitt - Tata McGraw-Hill.*
vi. *Construction cost management: learning from case studies by Keith F. Potts - Taylor & Francis.*
vii. *Construction cost engineering handbook by Anghel Patrascu - M. Dekker.*
viii. *Construction cost analysis and estimating by Phillip F. Ostwald - Prentice Hall.*
ix. *Construction Scheduling, Cost Optimization and Management by Hojjat Adeli, Asim Karim, Asim Salimul Karim - Taylor & Francis.*
x. *Introduction to Project Management by Kathy Schwalbe - Cengage Learning.*

BEM - 202: Structural Systems and Management Process

This course intends to cover the basic concepts of structural design and its methodology. These concepts and design process will help the construction managers to select the appropriate structural system for a given building w.r.t. its spatial, structural, aesthetic and service requirements. It includes the study of various codal provisions regarding the structural design process and the detailing of various structural components. It also covers the broad study of various computer applications that can be used for the structural analysis and design of structural systems.

Course Content

- Introduction to structural design process.
- Introduction to working stress and limit state design concepts.
- Study of structural requirements of buildings.
- Loads on building structures.
    - Types of loads.
    - Load Combinations.
    - Loading Conditions.
- Structural elements and systems.
    - Types of structural members.
    - Structural systems and selection criterion.
    - Architectural considerations for these systems.
    - Their applications, pros & cons, time, cost and quality implications in construction.
    - Earthquake resistant design of structures.
    - Planning and design for durability of structures.
- Codal provisions regarding:
    - Design process of structures.
    - Safety factors and load combinations.
    - Detailing of various structural elements.
    - Detailing for earthquake resistance of structures.
- Introduction to computer aided structural analysis and design process.
    - Computer aided design and detailing process.
    - Introduction to computer applications like STAD, GT STRUDL, etc.
    - Modelling of structural elements and their analysis using these software.
- Co-ordination between structural, architectural and building service systems.

References

i. *Architectural engineering design: structural systems by Robert Brown Butler - Tata McGraw-Hill.*
ii. *Structural Design: A Practical Guide for Architects by James R. Underwood, Michele Chiuini - John Wiley and Sons.*
iii. *Conceptual structural design: bridging the gap between architects and engineers by Olga Popovic Larsen, Andy Tyas – Thomas Telford.*
iv. *IS – 456: Indian Standard for Plain & Reinforced Concrete.*
v. *Design for earthquakes by James E. Ambrose, Dimitry Vergun - John Wiley and Sons.*

BEM - 203: Construction Marketing

This course aims to cover the specific strategies and tactics used to promote construction services and attract new clients in the competitive construction industry. It includes the importance of segmentation and targeting for effective strategic planning, understanding and outlining the ways in which markets are segmented, the factors that make some markets more attractive targets than others, the different market-segmenting strategies companies pursue, understanding how a product can be positioned and mapped, and the purpose of repositioning.

Course Content

- Marketing environment
  - Impact of internal and external environment
  - Socio-economic, demographic, political, technological and legal environment
  - Nature and impact of competition
  - Marketing strategy
- Basics of marketing
  - Features of marketing of consumer goods
  - Industrial products and services
  - Product and marketing
  - Marketing organization structures
  - Societal role of marketing
- Marketing projects I
  - Characteristics of construction projects
  - Sources of information
  - Pre-qualification documents
  - Bid preparation – estimating, provision for overheads and profit, bidding models, bidding strategy, pre-bid meetings, negotiation
- Marketing projects II
  - Legal aspects
  - Impact of joint ventures, collaborations and alliances
  - Impact of globalization and privatization
  - Strategies for project export
- Marketing real estate
  - Characteristics of real estate
  - Demand and supply relationship
  - Segmentation
  - Product mix
  - Pricing strategies
  - Advertising strategies
  - Legal aspects
- Marketing products for construction
  - Characteristics of construction materials and equipment
  - Strategies for marketing of materials and equipment for construction
  - Demand
  - Surveys

    - Advertising strategies, communication, exhibitions and product demonstrations.
- Pricing strategies, financing arrangements for marketing products for construction

References

i. *Construction Business Development: Meeting New Challenges, Seeking Opportunities, Christopher Peerce and Paul Smith (2003), A Butterworth-Heinemann publisher.*
ii. *Marketing Management by G Philip Kotler*
iii. *The 1 page Marketing Plan by Allan Dib*
iv. *The 22 Immutable laws of Marketing by Al Ries and Jack Tout*
v. *Marketing by Philip Kotler*

BEM - 204: Digitalization In Construction

Digitalization in Construction plays a significant role in making construction projects efficient, sustainable and resilient. Since digitalization is now the backbone of the service industry, construction specialists are required to comprehend and connect with contemporary development of information technologies. The cutting edge of this subject helps students to develop expertise in the fundamentals of digital tools and techniques to deliver the best Architectural, Engineering and Construction solutions. The thrust of this subject is to develop competencies in information technologies of AEC industry and comprehend the possibilities of adapting recent technologies effectively. It also provides a vital platform to work on interdisciplinary technologies to manage all critical stages of development of the built environment and provide industry-oriented solutions.

Course Content

- Building Information Modelling (BIM)
- Primavera
- Microsoft Project
- Geoinformation Systems (GIS)
- Remote Sensing
- Human-Computer Interaction
- AI & Machine Learning

References

i. *Manuals of Information Technology in Construction*
ii. *Building code and Building Information Modelling Standards*

BEM - 205: Construction Finance Management

This course aims to cover the financial aspects of a construction project i.e. the basic concepts of financial management and their applications during various phases of a construction project life cycle. It covers the various types of financial statements and their evaluation techniques. It includes the various types of business organisations that operate in Indian construction industry in order to meet the financial demands for different types of building and infrastructure projects. It intends to study the need of financing in construction projects and the different sources that are available for their financing. It also covers the techniques for ascertaining the financial viability of various projects.

Course Content

- Evolution of Financial Management.
- Study of various types of financial decisions that occur during the various phases of a construction project life cycle.
- The Financial System.
    - Need for financing of building and infrastructure projects.
    - Study of various types of business organisations that operate in Indian construction industry.
    - Various ties in construction industry - joint ventures, consortiums, public private partnerships, etc.
    - Study of various sources (financial institutions) for acquiring construction finance and the different forms of available financial assistance.
    - Role of government in construction finance.
    - Laws and regulations for managing construction finance.
- Study of TVM concept and its applications regarding financial decisions in construction.
- Study of financial statements – balance sheet, profit & loss statement, cash & fund flow statements, etc. and their analysis using various financial ratios.
- Evaluation of financial statements of various construction firms using ratio analysis.
- Concepts of taxation, depreciation, inflation, valuation, return, payback, etc.
- Study of capital budgeting techniques – net present value, cost benefit analysis, internal rate of return, modified internal rate o return, payback period, accounting rate of return, etc.
- Study of various investment appraisal methods in practice.
- Estimation of cash & fund flows, preparation of cash & fund flow statements, their monitoring, control and management processes.
- Working Capital and liquidity management.
- Study of international financing options and financial management aspects of international projects.
- Risk management in financial transactions related to construction projects.
- Value engineering as tool for project finance management.
- Application of quantitative techniques and computer applications in financial management of construction projects.

References

i. *Financial Management by Prasanna Chandra - Tata McGraw-Hill.*
ii. *Finance and Control for Construction by Chris March - Taylor & Francis.*
iii. *Project Finance in Construction: A Structured Guide to Assessment by Tony Merna, Anthony Merna, Yang Chu, Faisal F. Al-Thani - John Wiley & Sons.*
iv. *Project finance for construction & infrastructure: principles & case studies by Frederik Pretorius, Arthur McInnes, Paul Lejot, Berry-Fong Chung-Hsu, Douglas Arner - John Wiley & Sons.*
v. *Housing finance policy in emerging markets, Volume 842 by Loïc Chiquier, Michael J. Lea - World Bank Publications.*
vi. *International Loans, Bonds, Guarantees and Legal Opinions by Philip R. Wood - Sweet & Maxwell.*
vii. *Essentials of Real Estate Finance by David Sirota, Doris Barrell - Dearborn Real Estate.*
viii. *Fundamentals of Financial Management by Eugene F. Brigham, Joel F. Houston - Cengage Learning.*
ix. *Managing finance: a socially responsible approach by David Crowther - Elsevier Butterworth-Heinmann.*
x. *Financial Management Theory and Practice by Eugene F. Brigham, Michael C. Ehrhardt - Cengage Learning.*
xi. *Multinational Financial Management by Alan C. Shapiro - John Wiley and Sons.*

BEM - 206: Research Method: Statistics and Construction Data Analysis

It aims to develop the aptitude of students to conduct academic research by studying the various steps and methods involved in any research work. The aim of the course is to empower the students with tools to conceptualize their research in terms of research questions, methodology, data collection and qualitative analysis. It also covers the methodology and tools for writing a formal report. The overall objective of the course is to prepare the students for the research works they are supposed to do in MBEM (dissertation and thesis) and they will undertake in future.

Course Content

- Introduction, definition, aims and objectives of research.
- Types of research: descriptive vs Analytical, applied vs fundamental, quantitative vs qualitative, conceptual vs empirical
- Research Process: problem formulation, literature survey, development of working hypothesis, preparation of research design, determination of sample, data collection and analyses, hypothesis testing, generalization and interpretation, report preparation.
- Hypothesis- nature, characteristics, basic concepts- null and alternative hypotheses, level of significance, types of errors. Hypothesis testing.
- Research Design- main concepts: dependent and independent variables, extraneous variable, control, research hypothesis. Types of research designs- exploratory, descriptive & diagnostic, experimental.
- Collection of Primary data: methods, observations, structured - unstructured interview, schedules and questionnaires. Applications, advantages and disadvantages of each type.
- Sampling: criteria of selecting samples, probability sampling, non-probability sampling. Characteristics and sub categories in each type.
- Data Tabulation: editing, coding, classification, tabulation
- Preparation of Report /Thesis: prefatory part, main body, supplementary part, referencing and bibliography.
- Computer applications and Quantitative techniques.

References

i. *Introduction to Research Methods: A Practical Guide for Anyone Undertaking a Research Project by Catherine Dawson - How To Books.*
ii. *Research Methodology by R. Panneerselvam - PHI Learning Pvt. Ltd.*
iii. *How to write a research paper by Ralph Berry - Pergamon Press.*

BEM - 207: Construction Material Management

This course intends to familiarise the students with the various aspects associated with processes of planning, organizing and controlling the flow of construction materials such as planning for construction materials, their procurement, transportation, storage, inventory management, on-site handing and quality control. It also includes various inventory models that can be utilized in construction industry

Course Content

- Concept of Integrated Materials Management System.
- Importance and functions of material management.
- Classification and Codification of materials.
- Procurement - identification of sources of procurement and vendor analysis.
- Tendering - Scrutiny of material indents, preparation of tender documents, evaluation of bids and awarding contracts.
- Issues associated with foreign purchase and Governmental buying.
- Stock Verification and Store Accounting. Disposal of scrap.
- Stores and Inventory Management – safety stocks and stock outs.
- Forecasting techniques. Application of ABC, XYZ, VED, GOLF, FSN, HML, etc. and EOQ analysis in inventory management.
- Material handling and transportation. Materials Handling Systems and Equipment.
- Application of OR techniques in Materials Management.
- Quality Control and Quality Assurance procedures.
- Use of MIS and BIM in Materials Management Systems.

References

i. *Materials Management in Sustainable Construction Engineering by Alistair Doyle.*
ii. *Construction Planning, Equipment, and Methods by Robert L. Peurifoy, Clifford J. Schexnayder, Aviad Shapira, Robert Schmitt - Tata McGraw-Hill.*
iii. *Construction Equipment Management for Engineers, Estimators and Owners by Douglas D. Gransberg, Calin Popescu, Richard C. Ryan – CRC Taylor & Francis.*
iv. *Construction Materials Management (Cost Engineering) by George Stukhart.*
v. *Inventory Management Explained: A focus on Forecasting, Lot Sizing, Safety Stock, and Ordering Systems by David J. Piasecki.*
vi. *Inventory Management: Principles and Practices by P NarayanJaya Subramania.*

BEM - 208: Construction Quality Assurance and Quality Control

In today's construction industry, it's essential to implement effective quality control programs to ensure that the desired levels of construction quality are achieved at optimal costs. This course aims to familiarize students with different approaches to construction quality control and quality assurance. Covering everything from integrating and approving quality control measures during the design phase to selecting materials and implementing construction methods, quality control plays a crucial role in the approval and execution of every project. These measures are applicable to both design-build and design-bid-build projects.

Course Content

- History of evolution of Quality Management Concepts - Quality Inspection, Quality Control, Quality Assurance, Quality Management, Total Quality Management, ISO Certification, etc.
- Principles by Quality Gurus such as Philip B. Crosby, W. Edwards Deming, etc.
- Statistical Quality Control – Population and sampling techniques, measures of variability and central tendency and prescribed / accepted tolerances.
- Quality Control and Quality Assurance in Construction.
    - Common issues associated with concrete and steel construction.
    - Frequency of material testing and reporting of commonly used construction materials such as cement, sand, coarse aggregate, bricks, steel, etc.
    - Norms for accepting and rejecting criteria these materials as per relevant IS codes.
- On-site Quality Management.
    - Setting quality standards for different stages of construction.
    - Preparation of checklists and other such tools.
    - On-site quality assessment techniques and equipments for commonly used construction materials. Introduction to advanced testing procedures.
    - Post handover quality control.
- Application of quantitative techniques, automation and computer applications.

References

i. *A Guide to the Project Management Body of Knowledge, Fourth Edition by Project Management Institute, USA.*
ii. *Construction project management: a practical guide to field construction management by S. Keoki Sears, Richard Hudson Clough, Glenn A. Sears - John Wiley and Sons.*
iii. *Construction quality management by Siu-lam Tang, Syed M. Ahmed, Raymond T. Aoieong, S. W. Poon - Hong Kong University Press.*
iv. *Quality management in construction by Brian Thorpe, Peter Sumner - Gower Publishing, Ltd.*
v. *Construction Quality Management: Principles and Practice by Paul Watson, Tim Howarth - Taylor and Francis.*
vi. *Quality Management in Construction Projects by Abdul Razzak Rumane - Taylor and Francis.*
vii. *Understanding quality assurance in construction: a practical guide to ISO 9000 for contractors by H. W. Chung - E & FN Spon.*

viii. *Quality assurance in construction: proceedings of the conference Quality assurance for the chief executive, organized by the Institution of Civil Engineers and held in London on 14 February 1989 by Institution of Civil Engineers (Great Britain) – Telford.*

ix. *Quality assurance in construction by Brian Thorpe, Peter Sumner, John M. Duncan - Gower Publishing, Ltd.*

x. *ISO 9000 in construction by Paul A. Nee - John Wiley & Sons.*

BEM - 209: Inter-Institutional Elective
(Online/Physical Mode)

The underlying fundamental of this elective is for the student to identify and pursue any unique course of study related to STEM (Science, Technology, Engineering, and Management) in physical or online mode. The student can select a course that may be directly or indirectly relevant to the building or its related infrastructure works. The objective of this course is to enhance the exposure of students in an unrestricted manner and to aid their learning through varied methods. The course enables students to acquire skills to develop their ideas into physical form and encourages startups. This elective intends to achieve the concept of multidisciplinary and cross-collaboration to the other areas of specialization.

Course Content

The course may be linked to the built environment, construction, architecture, planning, project management, or related to the topic of research. Encouraging a multi-disciplinary approach through the subject as well as its contents, the course work should include a theoretical understanding of the subject, learning through case studies and real-world projects, and future methods of application in the industry/ research. The use of analytical tools and techniques is encouraged.

Upon completion of this course, the student should be able to

- Learn foundational concepts of the topic
- Establish a link between the learnings and their projects/ research
- Apply the skills in their research/ projects/ future career
- Share the insights with fellow classmates
- Earn a certificate from the online learning platform or certificate from other Department of studies

References

i. *National Programme on Technology Enhanced Learning (NPTEL) initiated by Ministry of Education.*
ii. *Courses offered by IIT, IIM, ISSER, NIT's, SPA's, NITTTR and other reputed Universities/Institution*
iii. *Courses offered by reputed private Universities.*
iv. *Courses offered by reputed National and International Universities.*

Third Semester

(M.B.E.M.)

BEM - 301: Construction Contract Procurement Management

In this module, the focus will be on the Construction Procurement (contract) and Communications Management processes. It covers the processes required to purchase products or services from outside the project team. It aims to disseminate the knowledge about the application of Project Management processes during the "Bid and Award Phase" of the project life cycle. In communications management, it covers the processes required to ensure generation, collection, distribution, storage, retrieval and disposition of project information timely and efficiently to the various concerned parties with least efforts of the project team. It also covers the change management processes i.e. how the changes in design, specifications, techniques, schedules, etc. due to any of the reasons will be communicated to the concerned persons. The practical application of these concepts in construction industry during the various phases of construction projects will also be covered. It also tries to create a theoretical base for the practical training that has to be undertaken after this semester.

Course Content

- Construction Procurement Management.
    - Identifying the products and services that need to be procured.
    - Types of contracts.
    - Pre-qualification of contractors, Preparation of contract documents, Evaluation of contract bids and Award.
    - Dispute resolution mechanisms.
    - Study of procurement guidelines and contract documents of international institutions such as World Bank, ADB, FIDIC, CPWD, MES, etc. and their comparison.
    - Preparation of contract documents for the procurement of various services.
- Construction Communications Management.
    - Identifying the project stakeholders with whom a particular type of information needs to be shared.
    - Devising appropriate communication systems and formats.
    - Distribution of project information through proper channels to meet the expectations of the stakeholders.
    - Generation of reports at various project stages.
- Project change control – study of processes for managing, control and communicating any changes in project design, specifications, techniques, schedules, etc. due to any of the reasons during implementation phase.
- Project closure – administrative and contractual closure.
- Post construction management - maintenance management, preparation of maintenance manual, organisational and contractual aspects of maintenance management and financial aspects of maintenance activities.
- Joint venture of professional teams and public private partnerships.
- Environmental Management System Standards and their application in construction.
- Applications of OR techniques for processes related to these management areas.

- Study of interactions between Construction Procurement, Communications management processes and other Management Knowledge Areas, and how these interactions are dealt with in the practical field environment.

References

i. *A Guide to the Project Management Body of Knowledge, Fourth Edition by Project Management Institute, USA.*
ii. *Construction project management: a practical guide to field construction management by S. Keoki Sears, Richard Hudson Clough, Glenn A. Sears - John Wiley and Sons.*
iii. *Construction project management: planning, scheduling and controlling by K. K. Chitkara - Tata McGraw-Hill Education.*
iv. *Construction Planning, Equipment, and Methods by Robert L. Peurifoy, Clifford J. Schexnayder, Aviad Shapira, Robert Schmitt - Tata McGraw-Hill.*
v. *Introduction to Project Management by Kathy Schwalb - Cengage Learning.*
vi. *Construction Contracts: Law and Management by John Murdoch, Will Hughes - Routledge.*
vii. *International construction contract management by D. Bryan Morgan - Ashgate Pub Co.*
viii. *Fundamentals of Building Contract Management by Thomas E. Uher, Philip Davenport - UNSW Press.*
ix. *Contracts and their Management by B. S. Ramaswamy - LexisNexis Butterworths India.*
x. *Construction Contract Administration by Charles S. Phillips - SME.*
xi. *CPWD, MES, FIDIC, JCT, ADB, World bank, etc.: General & Special conditions of contract and standard operating procedures.*
xii. *Construction communication by Stephen Emmitt, Christopher A. Gorse - John Wiley & Sons.*
xiii. *Construction Stakeholder Management by Ezekiel Chinyio - John Wiley & Sons.*
xiv. *Construction jobsite management by William R. Mincks, Hal Johnston - Cengage Learning.*
xv. *Construction change orders: impact, avoidance, documentation by James J. O'Brien - Tata McGraw-Hill.*
xvi. *Managing Change in Construction Projects: A Knowledge-Based Approach by Sepani Senaratne, Martin Sexton - John Wiley & Sons.*
xvii. *Construction management: new directions by W. D. McGeorge, Angela Palmer, Kerry London - John Wiley & Sons.*

BEM - 302: Dissertation

The objective of the dissertation work is to develop a detailed understanding of the various concepts related to a chosen topic in the area of Building Engineering and Management through an extensive literature study, data collection from the field, research work and their analysis. The complete dissertation work has to be assimilated in the form of a formal report at the end of the semester. It intends to develop a detailed knowledge among the students regarding the topics of their choice. This research work undertaken in dissertation in expected to form the basis for Thesis topic selection.

Course Content

- Selection of any topic in the area of Building Engineering and Management. The suggestive list of the areas is as follows:
    - Building Engineering, Construction technology and Structural systems.
    - Energy efficient building materials & techniques.
    - Construction project management.
    - Time management.
    - Cost management.
    - Quality management.
    - Safety management.
    - Contract Administration.
    - Design co-ordination and management.
    - Construction Finance.
    - Investment Analysis and portfolio Management.
    - Real Estate management.
    - Value Engineering.
    - Risk Management.
    - Construction Equipment.
    - Impact Assessment.
    - Human resource management.
    - Quantitative techniques.
    - Energy management.
    - Building services.
    - Green Buildings.
    - Building Performance Evaluation Systems.
    - Building automation and management systems.
    - Infrastructure services.
    - Management information systems.
- Framing of aims, objectives, scope and methodology.
- Literature study and data collection.
- Field research work and data collection.
- Analysis of collected data and concluding the dissertation.
- Periodic reviews and guidance from the review panel.
- Final review by a panel of internal faculty and eminent professionals from field.
- Compilation of dissertation report and submission.

BEM – 303: Quality Management Systems

In quality management, it covers the processes involved in ascertaining and controlling the quality of various activities, processes and resources relevant to planning, design & construction of buildings. It also covers the different concepts and standards related to quality management. The practical application of these concepts in construction industry during the various phases of construction projects will also be covered. It also tries to create a theoretical base for the practical training that has to be undertaken after this semester.

Course Content

- Construction Quality Management.
    - Evolution of modem concept of Quality management process approach.
    - Standard definition of quality; Deming's principles; Concepts by Juran, Ishikawa, Crosby, Taguchi etc.
    - Quality concepts, quality assurance & control and ISO requirements.
    - Concept and philosophy of TQM, Quality circle and cost of quality.
    - Introduction to concept of quality in building design, construction and project management. Managing Quality in various projects stages from concept to completion.
    - Inspection of incoming material and machinery.
    - Quality of building facilities and stakeholders concerns, quality responsibilities and commitment of Architect, consultant, project managers and contractors.
    - Study of various Quality Standards in Construction : Related to building materials and other inputs for construction processes, methods and techniques for construction outputs, products and services, such as BIS, BS, Indian standard, British, American, German & Japanese standards.
    - Designing of quality manuals, checklists and inspection reports, installing the quality assurance system, monitoring and control.
    - OR techniques for quality management.

References

xi. *A Guide to the Project Management Body of Knowledge, Fourth Edition by Project Management Institute, USA.*

xii. *Construction project management: a practical guide to field construction management by S. Keoki Sears, Richard Hudson Clough, Glenn A. Sears - John Wiley and Sons.*

xiii. *Construction quality management by Siu-lam Tang, Syed M. Ahmed, Raymond T. Aoieong, S. W. Poon - Hong Kong University Press.*

xiv. *Quality management in construction by Brian Thorpe, Peter Sumner - Gower Publishing, Ltd.*

xv. *Construction Quality Management: Principles and Practice by Paul Watson, Tim Howarth - Taylor and Francis.*

xvi. *Quality Management in Construction Projects by Abdul Razzak Rumane - Taylor and Francis.*

xvii. *Understanding quality assurance in construction: a practical guide to ISO 9000 for contractors by H. W. Chung - E & FN Spon.*

xviii. *Quality assurance in construction: proceedings of the conference Quality assurance for the chief executive, organized by the Institution of Civil Engineers and held in London on 14 February 1989 by Institution of Civil Engineers (Great Britain) – Telford.*

xix. *Quality assurance in construction by Brian Thorpe, Peter Sumner, John M. Duncan - Gower Publishing, Ltd.*

xx. *ISO 9000 in construction by Paul A. Nee - John Wiley & Sons.*

BEM – 304: Industrial Training
(06 Week after Semester-II)

An internship of 6 weeks is to be carried out by the students during their summer vacations after second semester in order to understand the practical application of various project management and construction concepts studied in last two semesters. The students are supposed to submit a report of the work done by them during their training period.

Course Content

The structuring of the report should be as follows:

- Name of student.
- Duration of training.
- Placement of Training.
- Nature of organizational enterprise.
- Organization structure and position of Trainee.
- General information regarding the project.
- Chronological list of responsibilities assigned to the Trainee.
- List of the Works done during training (enclose typical work outputs).
- Experiences and inferences drawn during Training regarding:
    - Project work stages followed.
    - Time management process adopted.
    - Cost management process adopted.
    - Quality management process adopted.
    - Scope management process adopted.
    - HR management process adopted.
    - Communication system and management between various stakeholders.
    - Change management process adopted.
    - Procurement management process adopted.
    - Health, safety and environment management process adopted.
    - Risk management process adopted.
    - Value engineering processes adopted.
    - Good practices adopted on site.
- Special features of the project / work (enclose documents to explain and highlight peculiarities)
- Any other information.
- Comparison between concepts studied in classroom and their practical applications.

BEM - 305: Digital Twin in Built Environment

A digital twin is a digital replica of a real-world physical entity (El Saddik 2018). The digital twin is effectively synchronized with the physical built environment using real-time data collection tools to assess the function and challenges of existing buildings. The subject enables students to comprehend, access and analyse the life cycle of a building under operation. Students shall also understand the method of analysis and reduction of carbon footprint; improvement of efficiency; resilience and sustainability of built environment using data-driven digital technology.

Course Content

- Definition framework of Digital Twin; Significance and Challenges
- Opportunities and Benefits of Digital Twin
- Method of generating Digital Twin; Analytics and Simulation
- Technology transfer and Market Analysis
- Application area and Case studies

References

i. *Centre of Digital Built Britain, The Gemini Principles, 2018.*
ii. *Digital Twins in the Built Environment: Fundamentals, principles and applications authos(s): Qiuchen Lu, Xiang Xie, Ajith Parlikad, Jennifer Schooling and Michael Pitt.*
iii. *M. Grieves, Digital Twin: Manufacturing Excellence through Virtual Factory Replication 2015.*
iv. *Vanzi, Digital Built Australia. [Online]. Available: www.vanzi.com.au [Accessed: 16-Sep-2019].*

BEM - 306: Building Adaptation

The subject significantly focuses on the importance of Building Adaptation and its associated techniques. Building Service Life is considered a global concern to retain the built environment safe, efficient and functional for its occupants. To achieve these objectives, certain methods of intervention are essential to understand by using concepts of Building Retrofitting; Building Rehabilitation; Building Renovation; and Adaptive reuse. The subject enables students to determine the right method and process of Building Adaptation and to understand the techno-managerial approach to facilitate the construction industry.

Course Content

- Concept of Building Service Life
- Method of extension of Building Service Life
- Building Adaptation Process and Management Tools
- Comprehend challenges in managing Building Adaptation works
- Construction management approach to deal with implementation challenges.

References

i. *Building Adaptation Paperback (2006) by James Douglas (Author)*
ii. *Strengthening and Retrofitting of Existing Structures (Building Pathology and Rehabilitation Book 9) by Aníbal Costa, António Arêde, et al.*
iii. *Adaptive Reuse: Extending the Lives of Buildings by Liliane Wong*

BEM - 307: Construction Innovation and Entrepreneurship

The intent of the subject is to provide a thorough/in-depth knowledge of innovations in construction methods and techniques/technologies pertinent to building projects, knowledge of critical considerations when starting a new business, as well as factors crucial for its daily operation. This understanding should enable the selection of suitable technology & technique for building& infrastructure projects.

Course Content

- Foundation, Scaffolding and Formwork
  - Methods and Equipment's for foundation
  - Timber formwork
  - Metal formwork
  - Plastic formwork
- Reinforcement technology
  - Pre-tensioning concrete &Post-tensioning
  - Pre-cast
- Financing Agencies
  - Infrastructure, land, machinery, raw materials
  - Role and function of Government departments
- Industrial Legislation and Taxes
  - Industrial and labour laws
  - Local taxes
  - Excise duty
  - Income Tax
- Project Report
  - Components of project report: Land, Building and Utilities
  - Materials and Resources
  - Project Report preparation
  - Provisional Registration
  - Financial Planning and Funding
  - Plan for Acquiring Finance

References

i. *School of Civil Engineering Handbook, Reva university, 2022-24*
ii. *MBEM Syllabus, SPA Delhi*
iii. *Construction Management, Accounts & Entrepreneurship development Civil, BTEUP Syllabus, 2017*
iv. *Tradition and Innovation in Construction Management by Yogijian Ke, Jingxiao*

The Creative construction: The DNA of sustained innovation by Gary P. Pisano

BEM-109-Inter-Institutional Elective (Online /Physical Mode)

The underlying fundamental of this elective is for the student to identify and pursue any unique course of study related to STEM (Science, Technology, Engineering, and Management) in physical or online mode. The student can select a course that may be directly or indirectly relevant to the building or its related infrastructure works. The objective of this course is to enhance the exposure of students in an unrestricted manner and to aid their learning through varied methods. The course enables students to acquire skills to develop their ideas into physical form and encourages startups. This elective intends to achieve the concept of multidisciplinary and cross-collaboration to the other areas of specialization.

Course Content

The course may be linked to the built environment, construction, architecture, planning, project management, or related to the topic of research. Encouraging a multi-disciplinary approach through the subject as well as its contents, the course work should include a theoretical understanding of the subject, learning through case studies and real-world projects, and future methods of application in the industry/ research. The use of analytical tools and techniques is encouraged.

Upon completion of this course, the student should be able to

- Learn foundational concepts of the topic
- Establish a link between the learnings and their projects/ research
- Apply the skills in their research/ projects/ future career
- Share the insights with fellow classmates
- Earn a certificate from the online learning platform or certificate from other Department of studies

References

iv. National Programme on Technology Enhanced Learning (NPTEL) initiated by Ministry of Education.

v. Courses offered by IIT, IIM, ISSER, NIT's, SPA's, NITTTR and other reputed Universities/Institution

vi. Courses offered by reputed National and International Universities.

Fourth Semester

(M.B.E.M.)

BEM – 401: Thesis

The objective of the Thesis is to provide the students with an opportunity to conduct an independent research in the areas of their interest. The thesis topics may be conceptual or practical but pertaining to Building Engineering and Management. It intends to develop a detailed understanding of the selected areas through an extensive literature study, data collection from the field, research work and their analysis. The complete thesis work has to be assimilated in the form of a formal report at the end of the semester. This research work can be in continuation to the work done in seminar -1& seminar - 2 or a different topic can be chosen for thesis.

Course Content

- Selection of any topic in the area of Building Engineering and Management. The suggestive list of the areas is as follows:
    - Building Engineering, Construction technology and Structural systems.
    - Energy efficient building materials & techniques.
    - Construction project management.
    - Time management.
    - Cost management.
    - Quality management.
    - Safety management.
    - Contract Administration.
    - Design co-ordination and management.
    - Construction Finance.
    - Investment Analysis and portfolio Management.
    - Real Estate management.
    - Value Engineering.
    - Risk Management.
    - Construction Equipment.
    - Impact Assessment.
    - Human resource management.
    - Quantitative techniques.
    - Energy management.
    - Building services.
    - Green Buildings.
    - Building Performance Evaluation Systems.
    - Building automation and management systems.
    - Infrastructure services.
    - Management information systems.
- Framing of aims, objectives, scope and methodology.
- Literature study and data collection.
- Field research work and data collection.
- Analysis of collected data and concluding the thesis.
- Periodic reviews and guidance from the review panel.
- Final review by a panel of internal faculty and eminent professionals from field.
- Compilation of thesis report and submission.

BEM – 0402: Construction Health and Safety Management

It covers the aspects of modern HRM and how these aspects can be managed by various construction organisations in the most complex, risky and dynamic project environments. It aims to impart knowledge regarding various concepts of risk management and their relevance in construction industry. It includes the various processes and techniques that can be used during risk identification, evaluation and response stages of construction risk management.
In construction safety management, it deals with the strategies that the project manager can adopt to create a safe working environment, so that the workers can be expected and motivated to perform the assigned tasks in a safe and productive manner.

Course Content

- Construction Risk Management.
    - Construction projects and involved risks.
    - Risk and uncertainty.
    - Identifying the risks involved during the various phases of a construction project life cycle.
    - Risk identification, analysis, prevention, response and mitigation strategies.
    - Qualitative and quantitative methods for Risk Analysis.
    - Risk allocation in the various processes involved in construction.
    - Managing financial risks in construction projects.
    - Development of Risk Register and Risk Management Plan.
- Construction Health and Safety Management.
    - Introduction to construction site conditions.
    - Construction accidents –Types, Causes, Health hazards, Prevention methods, Cost of safety and their human impacts.
    - Site safety – Preparation of Safety Management Plan and its implementation on site.
    - Personal Protective Equipment.
    - Safety trainings and audits.
    - Legal, contractual and other guidelines for construction safety.
    - Impact of safe working environment on HR performance and their productivity.
- Applications of OR techniques for processes related to these management areas.
- Study of interactions between the knowledge areas covered so far and how these interactions are dealt with in practical field environment.

References

i. *A Guide to the Project Management Body of Knowledge, Fourth Edition by Project Management Institute, USA.*
ii. *Construction project management: a practical guide to field construction management by S. Keoki Sears, Richard Hudson Clough, Glenn A. Sears - John Wiley and Sons.*
iii. *Practical risk management in the construction industry by Leslie Edwards - Thomas Telford.*
iv. *Risk management and construction by Roger Flanagan, George Norman - Wiley-Blackwell.*
v. *Managing risk in construction projects by Nigel J. Smith, Tony Merna, Paul Jobling - Wiley-Blackwell.*

vi. *Construction insurance, bonding, and risk management by William J. Palmer, James M. Maloney, John L. Heffron - Tata McGraw-Hill Education.*
vii. *Risk and Financial Management in Construction by Simon A. Burtonshaw-Gunn - Gower Publishing, Ltd..*
viii. *Modeling Risk Management in Sustainable Construction by Desheng Dash Wu - Springer.*
ix. *Risk management and insurance by Scott E. Harrington, Greg Niehaus - Tata McGraw-Hill.*
x. *Risk Management and Insurance: Perspectives in a Global Economy by Harold D. Skipper/w. Jean Kwon - John Wiley and Sons.*
xi. *Construction safety management by Raymond E. Levitt, Nancy Morse Samelson - John Wiley and Sons.*
xii. *Construction safety management by Tim Howarth, Paul Watson - John Wiley and Sons.*
xiii. *Construction Safety Management, A Systems Approach (Knowledge Management Edition) by Jose Perezgonzalez - Lulu.com.*
xiv. *Construction health and safety management by Alan Griffith, Tim Howarth – Longman.*
xv. *Construction safety manual by Dave Heberle - Tata McGraw-Hill.*
xvi. *Principles of construction safety by Allan St. John Holt - Wiley-Blackwell.*
xvii. *Occupational health and safety in construction project management by Helen Lingard, Stephen M. Rowlinson - Taylor & Francis.*
xviii. *Introduction to Health and Safety in Constructionby Phil Hughes, Ed Ferrett - Routledge.*

BEM – 403: Elective [Online]

The underlying fundamental of this elective is for the student to identify and pursue any unique course of study related to STEM (Science, Technology, Engineering, and Management) in physical or online mode. The student can select a course that may be directly or indirectly relevant to the building or its related infrastructure works. The objective of this course is to enhance the exposure of students in an unrestricted manner and to aid their learning through varied methods. The course enables students to acquire skills to develop their ideas into physical form and encourages startups. This elective intends to achieve the concept of multidisciplinary and cross-collaboration to the other areas of specialization.

Course Content

The course may be linked to the built environment, construction, architecture, planning, project management, or related to the topic of research. Encouraging a multi-disciplinary approach through the subject as well as its contents, the course work should include a theoretical understanding of the subject, learning through case studies and real-world projects, and future methods of application in the industry/ research. The use of analytical tools and techniques is encouraged.

Upon completion of this course, the student should be able to

- Learn foundational concepts of the topic
- Establish a link between the learnings and their projects/ research
- Apply the skills in their research/ projects/ future career
- Share the insights with fellow classmates
- Earn a certificate from the online learning platform or certificate from other Department of studies

References

i. *National Programme on Technology Enhanced Learning (NPTEL) initiated by Ministry of Education.*
ii. *Courses offered by IIT, IIM, ISSER, NIT's, SPA's, NITTTR and other reputed Universities/Institution*
iii. *Courses offered by reputed private Universities.*
iv. *Courses offered by reputed National and International Universities.*