

COURSE STRUCTURE FOR M.TECH (CIVIL ENGINEERING)
SEMESTER II (Infrastructure Engineering and Management) w.e.f. 2013-2014

Sr. No	Course Code	Course Name	Teaching Scheme					Exam Scheme					
			L	T	P	C	Hrs/wk	Theory			Practical		Total
								MS	ES	IA	LW	LE/Viva	Marks
1	CE 521T	Infrastructure Planning & Engineering- II	3	1	-	7	4	30	60	10	-	-	100
2	CE522T	Technology for Infrastructure Construction	3	1	-	7	4	30	60	10	-	-	100
3	CE 523T	Infrastructure Financing & Management	3	-	-	6	3	30	60	10	-	-	100
4	CE524P	Project Design Studio-II	-	-	6	6	6	-	-	-	75	25	100
5	CE 525T	Elective-III(Earthquake Engineering)	3	-	-	6	3	30	60	10	-	-	100
6	CE526T	Elective IV (Real Estate Valuation & Management)	3	-	-	6	3	30	60	10	-	-	100
7	CE527T	Successful Research Development Programme	2	-	-		2	-	-	-	-	-	PP/NP
		TOTAL	17	2	6	38	25						600

MS = Mid Semester, ES = End Semester; IA = Internal Assessment (like quiz, assignments etc)

LW = Laboratory Work; LE = Laboratory Exam

CE521T Infrastructure Planning and Engineering-II

Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	-	7	4	30	60	10	-	-	100

Unit I

| 14 hrs

Transportation and Infrastructure Engineering Systems

Introduction: Goals and objectives, Scope of traffic and transport planning, Transport network and characteristics, Hierarchical levels of transport planning, traffic forecasts, Inventory of land use

Transport Planning Process: Approaches to transport planning process, Conventional vs recent approaches, Transport demand surveys and studies, Trip generation, Trip production and Trip distribution models, Multi-regression models, Case studies of transportation planning for underground and elevated corridor construction of metro rail projects.

Unit II

| 12 hrs

Transportation and Engineering Economics: Application of time value of money, Analysis of series with arithmetic or geometric gradient; Rate of Return analysis, Breakeven analysis, Financial models for PPP projects.

Decision Making Models: Social benefit cost ratio analysis, Life cycle costing analysis (LCC), Multicriteria decision making models, Methods of valuation and town planning concepts

Preparation of Alternative Plans: Evaluation techniques, Plan implementation, Monitoring,

Unit III

12 hrs

Environmental Engineering Systems

Introduction: Definitions, Environmental ecology, Description of environmental settings, Environmental audit procedures, Pre audit activities, Post audit activities

Environmental Impact Assessment : Prediction and assessment of impacts on the air environment , surface water environment, soil and ground water environment; Environmental management systems –ISO 14000, Audit procedures, Certification

Unit IV

| 10 hrs

Case Studies: Environmental impact assessment of infrastructure projects such as road and highway projects, solid waste disposal sites, and other infrastructure projects

Reference Books:

1. L. R. Kadiyali "Traffic Engineering and Transportation Planning" Khanna Publishers, Delhi, 2005
2. K Khanna and Justo CEG "Highway Engineering" Khanna Publishers, Roorkee, 2001
3. MetCalf and Eddy Inc "Waste Water Engineering Treatment, Disposal, Reuse " Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2003
4. Manual on Water Supply and Treatment" Central Public Health and Environmental Engineering, Organization Ministry of Urban Development, New Delhi
5. Namavati, H. Roshan. Theory and Practice of Valuation, 1998 – Lakhani Book Depot Mumbai 400004.
6. George, A. Taylor. Managerial and Engineering Economy – Van Nostrand Reinhold Company; Affiliated East-West Press (Pvt.) Ltd. East-West Student Edition 1969.
7. Degarmo, E. Paul. Engineering Economy, Prentice Hall International Inc., 1997, New Jersey.
8. Chawla, Kishan. Social Cost – Benefit Analysis: An Introduction to Financial and Economic Appraisal of Projects. Mittal Publishers, 1987.

CE522T Technology for Infrastructure Construction										
Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	-	7	4	30	60	10	-	-	100
<p>Unit I 12 hrs Construction of Underground Corridor for Metro Rail: Soldier piles and king piles; Timber lagging; Deep excavation; Diaphragm walls; Strutting; Construction decks; Rock excavation; Shotcreting; Rock bolting; Rock anchors; Sub floor drainage; Waterproofing; Dewatering; Traffic diversion; Utility diversion; Construction of RCC single & twin boxes; Tunneling by TBM; Tunneling by NATM.</p> <p>Unit II 10 hrs Modern Construction Materials: Ready mixed concrete; High Performance concrete; Fibre reinforced concrete; Light weight concrete; Ferrocement; Polymer concrete; Self compacting concrete; Applications of geosynthetics (geotextiles, geogrids, geomembranes and geocomposites) in construction; Green building materials.</p> <p>Unit III 10 hrs Formwork & Scaffolding: L & T – Doka Total formwork system; Aluminium formwork; Slipform; Jump formwork Deep foundations and Enabling Structures : Caissons; Wells; Piles; Rafts; Cofferdams; Strutting; Tunneling: By tunnel boring machine (TBM); By New Austrian tunneling method (NATM); Tunnel form technology</p> <p>Unit IV 16 hrs Precasting & Prestress concrete: Precasting; Prestressing (pre-tensioning & post tensioning); Elevated corridor construction for metro rail operations</p> <p>Highway Construction: Construction of flexible and rigid pavements; Highway maintenance and drainage.</p> <p>Modern Construction Equipments: Selection of equipments; Owning & operating costs; Compacting & stabilizing equipments; Excavating equipments; Hauling equipments; Cranes.</p> <p>Site Safety Management: Personal protective equipments; Work place structural integrity; Safe working of cranes and other construction equipments.</p>										
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Peurifoy RL (2006) Construction Planning Equipments and Methods, 3rd Edition, McGraw Hill Limited Kogakusha 2. Kaushik SK, Asawa GL & Ahuja AK (1998) Civil Engineering Practices Volume-III, New Age International Publishers 3. CE & R (1998) Development in Concreting Technology in India – A Compilation of Reprints from CE&R (1991-97), Civil Engineering & Construction Review New Delhi 4. Dewar JD and R Anderson (2008) Manual of Ready Concrete, Blackie Publishers Glasgow/ London. 5. Sushil Kumar (2007) Building Construction, Standard Publishers Delhi 										

CE523T Infrastructure Financing and Management										
Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	6	3	30	60	10	-	-	100
<p>Unit I 08 hrs Introduction: Project finance, Nature and scope of project finance, Goals of financial management, Sources of financing infrastructure, Preparation and interpretation of cash flow statement</p> <p>Unit II 08 hrs Sources of Finance: Long term finance, Ordinary shares, Equity shares, Preference shares, Debentures, Term loans, Asset based financing, Securities</p> <p>Unit III 12 hrs Working Capital Management: Policy for working capital, Estimating working capital needs, Sources, procedures and practices in infrastructure construction industry</p> <p>Capital Investment Decisions: Techniques of capital budgeting, Types of budgets, Procedure for master budget, Cash flow forecast, Preparing a project financing plan</p> <p>Unit IV 12 hrs Trends in Project Finance: Infrastructure development through Public Private Partnership (PPP), PPP-models for infrastructure projects, Ownership structures like BOT, BOT, BOOT, BOLT, DBFO etc., Government's role in successful PPP, Life cycle- Contractual package of PPP projects, Bankable concession agreements, Model concession agreements on highway and urban infrastructure projects Case Studies in Project Finance: Case studies of Power sector, Highway sector, Mass Rapid Transit Systems, Water supply projects</p>										
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Prasana Chandra (2008) Financial Management: Theory & Practice, Tata McGraw Hill New Delhi 2. JC Van Horne (1997) Fundamentals of Financial Management, Prentice Hall, New Delhi 3. Degarmo E Paul (1997) Engineering Economy, Prentice Hall Inc New Jersey 4. Chawla Kishan (1987) Social Cost Benefit Analysis: An Introduction to Financial and Economic Appraisal of Projects, Mittal Publishers Jaipur 5. MY Khan & PK Jain (2008) Financial Management, Tata McGraw Hill New Delhi 										

CE524P Project Design Studio-II										
Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	6	6	6	-	-	-	75	25	100

In this exercise students will work in small groups and undertake studies on traffic engineering and transportation planning for a city or a region. The project design studio carries out two exercises viz. Perception studies and Large area planning project. This aims to make student aware on infrastructure requirements and standards required for large urban areas or urban-rural regions.

Unit I

| 26 hrs

Perception Studies: To carry-out quick perception study on road networks pertaining to national highways, state highways, urban roads and rural roads. Students will prepare a small note, situation notes and sketches, photographs, drawings and flow charts based on regional analysis of transportation sector. This exercise will equip them for better understanding and analyzing various design issues for next stage of project work.

Unit II

| 52 hrs

Large Area Planning Project: Area planning project is designed to make student get indepth knowledge on physical infrastructure for traffic engineering, transport planning and highways for integrated townships or special economic zones or special investment regions (say around 5000 ha). The area planning project demonstrates how regional and urban infrastructure plans for transport and other infrastructure sectors are prepared? What are design standards for basic service provisions for Indian cities? How to ensure equitable distribution, and how to create a synergy between resources availability and resources use? Finally, using modern software tools such as Vissim, TransCAD, PTV-Visum & PTV-Visam or Trapeze for infrastructure plan for selected area to be prepared. Also students need to be given the exposure about the application of Primavera software for project planning & scheduling. Transportation simulation exercises need to be carried out. In addition strategies for financial resources also need to be worked out.

The final plan will include components such as detailed objectives, detailed road network, trip generation and trip destination matrix, heirarchy of road networks, distribution of open spaces, development and control regulation, design standards, infrastructure plan, preliminary costing and financing strategy.

Reference Books:

CE525T Elective-III Value Engineering and Management**

Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	6	3	30	60	10	-	-	100

Unit I

| 10 hrs

Introduction: History, Basic approach, Role of value engineering & management, Effect of cost on design parameters, Purpose & application to construction industry, Application to design, Market value

Value Management Job Plan: Role& purpose of VM job plan; steps of VM job plan; General phase; Project selection phase; Information phase; Function phase; Judicial phase; evaluation phase; Recommendation phase; Implementation phase.

Unit II

| 10 hrs

Function Analysis: Functions; Relationships; Function Analysis systems Technique (FAST): rules for FAST diagramming; Application in value management; Improvement in systems; Case studies Fundamental of Engineering Economics: Time value of money: simple, compound, nominal, effective, continuous interests, Present worth analysis, Annual worth analysis, Future worth analysis; Sinking fund; Capital recovery; Analysis of series with arithmetic or geometric gradient; Rate of return analysis; Benefit-Cost ration analysis; Breakeven analysis

Unit III

| 10 hrs

Life Cycle Costing: Life cycle cost elements; LCC logic; Application to facilities; Analysis of the total cost of ownership; Escalation & its impact; Cost analysis concepts; Cost matrix in LCC analysis. Costing & Cost modeling: Cost estimation system; Use of cost models; Establishing cost targets; Objectives of costing; Cost target team & organization; Classification of costs based on complexity; Datum creation; Matrix & Functional cost model; Case studies – Quality cost model; Equipment cost model; Building cost model.

Unit IV

| 09 hrs

Methods of Valuation: Rental method – essential ingredients; Forms of rent; Years purchase; Capitalized value; Shares and debentures; Bonds or Gilt-edged securities; Life of structures; Case studies in rental method of evaluation; Land and Building method – Cost of construction; Estimate on area basis; Estimate on cubic basis; Estimate by cost index; Residual or demolition value of old buildings; Case studies.

Reference Books:

1. Dellisola J Alphonse (2004) Value Engineering in the Construction Industry, Smith-Hinchman & Grylls Publisher Washington DC.
2. Namavati H Roshan (1998) Theory and Practice of Valuation, Lakhani Book Depot Mumbai
3. Lomash S (1997) Value Management: A Text book, Sterling Publishers New Delhi
4. George A Taylor (1969) Managerial and Engineering Economy, East-West Press London
5. Degarmo E Paul (1997) Engineering Economy, Prentice Hall International Inc New Jersey
6. Chawla Kishan (1987) Social Cost–Benefit Analysis: An Introduction to Financial and Economic Appraisal of Projects, Mittal Publishers Jaipur

CE525T Elective-III # Earthquake Engineering for Infrastructure										
Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	6	3	30	60	10	-	-	100
Unit I										10 hrs
Introduction: General effects of an earthquake, terminology, structure of earth, causes of an earthquake, plate tectonic theory, seismic waves, magnitude and intensity, methods of measurement, energy released, seismograph, strong motion earthquakes, accelerogram, soil liquefaction, prominent earthquakes of India.										
Unit II										10 hrs
Seismotectonics and Seismic Zoning: Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Zonation Concepts and codal provisions										
Unit III										09 hrs
Free Vibrations Of Single Degree-Of-Freedom Systems: Dynamic loads and dynamic analysis, degrees of freedom, Undamped free vibrations, multiple elastic forces, viscously damped vibrations, equations of motion and solution, logarithmic decrement.										
Unit IV										10 hrs
Forced Vibrations Of Single Degree-Of-Freedom Systems: Forced vibrations (harmonic loading) of single degree of freedom systems. Undamped and viscously damped vibrations, equations of motion and solution, Force transmitted to foundation, transmissibility, response to harmonic support excitations										
Reference Books:										
<ol style="list-style-type: none"> 1. Newmark N.M. and Rosenblueth E. "Fundamentals of earthquake engineering" 2. Kramer, S.L "Geotechnical Earthquake Engineering" 3. Wai-Fah Chen & Scawthorn, Charles. " Earthquake Engineering Handbook", CRC Press London. 										

CE525T Elective-III** Highway and Road Construction											
Teaching Scheme					Examination Scheme (audit course)						
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks	
					MS	ES	IA	LW	LE/Viva		
3	-	-	6	3	30	60	10	-	-	100	

Unit I

| 06 hrs

Introduction: Definitions, Components of pavement structure, importance of sub-grade soil properties on pavement performance, Functions of sub-grade, sub-base, base course and wearing course

Unit II

| 14 hrs

Flexible Pavements: Stresses, Stresses in homogeneous masses and layered systems, Deflections, Shear failures, equivalent wheel and axle loads, Elements in design of flexible pavements, Loading characteristics-static, impact and repeated loads, effects of dual wheels and tandem axles, area of contact and tyre pressure, modulus or CBR value of different layers, equivalent single wheel load, equivalent stress and equivalent deflection criterion, equivalent wheel load factors, climatic and environmental factors.

Design Methods for Flexible Pavements: California bearing ratio (CBR) , U.S. Navy method, Triaxial method, Mcleod method, Boussinesq's and Burmister's analysis and design method, IRC method for Flexible Pavement Design

Unit III

| 14 hrs

Rigid Pavements: Wheel load stresses, Westergaard's analysis, Bradbury's approach Arlington test, Pickett's corner load theory and charts for liquid, elastic and soil of finite and infinite depths of subgrade. IRC Method of rigid pavement design; Temperature Stresses: Westergaard's and Thomlinson's analysis of warping stresses, Combination of stresses due to different causes, Effect of temperature variation on Rigid Pavements

Reinforced Concrete Slabs: Prestressed concrete slabs-general details, Design of Tie Bars and Dowel Bars

Unit IV

| 06 hrs

Road Construction: Bituminous road construction procedures and specifications, Quality control requirements. Concrete Road construction: Construction methods, Quality control requirements, Joints in cement concrete pavements, reinforced cement concrete road construction, IRC & MORTH recommendations for construction of Bituminous and Concrete roads, Present practices being followed for quality assurance and speedy construction in the country like by NHAI, Pavement analysis, design and construction without joints and in integral bridges, case studies of such construction adopted in the country including that in Delhi Metro.

Reference Books:

1. Papagiannakis AT and Masad EA (2008) Pavement Design and Materials, John Wiley & Sons Inc New York
2. Fwa TF (2006) The Hand Book of Highway Engineering, CRC Press Taylor & Francies Group
3. O'Flaherty Coleman (2006) Highways : The Location, Design, Construction and Maintenance of Road Pavements, 4th Edition Elsevier
4. Khanna SK and Justo CEG (2005) Highway Engineering, Nem Chand Jain & Bros Delhi

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CE525T Elective-III** Environmental Impact Assessment of Infrastructure Projects										
Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	6	3	30	60	10	-	-	100

Unit I | 08 hrs
 Introduction: Definitions, Developmental Activity and Ecological factors, EIA, EIS, FONSI, Need for EIA studies in infrastructure projects, Baseline information, Step by step procedure for conducting EIA, Data collection and analysis, Limitations of EIA

Unit II | 12 hrs
 Development Projects: Frame work of Impact Assessment, Environmental setting, Objective and scope of EIA, Contents of EIA, Methodologies techniques of EIA
 Assessment and Prediction of Impacts: Impact on attributes such as air, water noise, land ecology soil, cultural and socio- economic environment, IAA guidelines for development projects, REIA-CEIA

Unit III | 12 hrs
 Public Participation in Environmental Decision Making: Role of citizens and public, Practical considerations in preparing Environmental Impact Assessment and Statements, Consultations Features: Salient features of the infrastructure project activity, Environmental parameter, Activity relationships matrices

Unit IV | 06 hrs
 Case Studies: EIA for water resource development projects, Nuclear power plant project, Mining project, (Coal, Aluminum, iron ore, Bauxite) Thermal Power Plant (Coal Based) project, Pharmaceutical industries etc.

Reference Books:

1. Peter Morris, Riki Therivel and Andrew Chadwick (2005) Methods of Environmental Impact Assessment, (The Natural And Built Environment Series), 3rd Edition, Spon Press London.
2. Wenzel Henrik, Hauschild MZ, Alting L (2003) Environmental Assessment of Products: Methodology, Tools and Case Studies in Product Development, Vol 1, Springer Verlag

CE526T Elective-IV## Finite Element Methods

Teaching Scheme					Examination Scheme (audit course)					
	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	6	3	30	60	10	-	-	100

Unit I

| 10 hrs

Introduction: Brief History of the Development, Advantages & Disadvantages of Finite Element Method, Finite Element Method- The Displacement Approach One Dimensional Finite Elements: Stiffness Matrix for the basic Bar & Beam Element Representation of Distributed Loading, The Assembly Process within the PMPE Approach, Element Stresses

Unit II

| 10 hrs

Finite Elements for Two Dimensional Planar Bodies: Triangular Elements for Plane Stress or Strain Conditions, Higher Order Triangular Elements, Rectangular Elements for Plane Stress or Strain Conditions

Unit III

| 12 hrs

Isoparametric element: Quadrilateral element, Shape functions, Numerical Integration, Subparametric and super parametric elements, 3D problems, Tetrahedral elements, Jacobian matrix, Stiffness matrix

Unit IV

| 09 hrs

Dynamic considerations: Dynamic equations, Consistent mass matrix, Eigen Values, Eigen Vectors, natural frequencies, Mode shapes, Modal Analysis Introduction to Non linearity: Non-linear problems, Geometric Non-linearity, Material Non-linearity, Non-linear dynamic problems, analytical problems

Reference Books:

1. Gokhale NS, SSDeshpande, SV Bedekar and Anand N (2004) Practical Finite Element Analysis Nirali Prakashan Pune
2. Reddy J N (2008) An Introduction to Nonlinear Finite Element Analysis, Oxford University Press New Delhi
3. Tirupathi K Chandrupatla & AD Belegundu (2007) Introduction to Finite Elements in Engineering, Pergamon, New York

CE526T Elective-IV## Law and Legislation for Infrastructure										
Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	6	3	30	60	10	-	-	100
<p>Unit I 08 hrs Introduction: Infrastructure development stages, stakeholder participation in infrastructure development, Private participation- BOO, BOT, BOLT etc, Regulations, Disinvestment</p> <p>Unit II 10 hrs Legal Aspects of Infrastructure Development: Relevance and significance, Constitutional, Grant of rights, Environmental aspects, Joint venture and shareholders agreement</p> <p>Unit III 12 hrs Financial Legislation: Bankability of projects, General security and financial transaction, Enforcement of lenders interest, Restructuring of project finance transaction</p> <p>Unit IV 10 hrs Case Studies: Sector specific case studies for pipeline projects, highway and road projects, Airport and Port projects will be delivered and discussed</p>										
Reference Books:										
1. Joshi Piyush (2003) Law Relating to Infrastructure Projects, 2 nd Edition, Lexis-Butterworth New Delhi										

CE526T Elective-IV## Real Estate Valuation and Management

Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	6	3	30	60	10	-	-	100

<p>Unit I</p> <p>Real Estate Scope; Classification of real estate activities and peculiarities; Factors affecting real estate market; Role of Government in real estate market; Statutory provisions, laws, rules and regulations application, land use controls in property development, registration and licensing requirements; Functions of real estate projects, risk management, facilities management, marketing/advertising, post construction management etc.; Interests in real estate; Documentation in real estate processes; Transfer of titles and title records; Real Estate appraisal and valuation; Role scope, working characteristics and principal functions of real estate participants and stakeholders.</p>	10 hrs
<p>Unit II</p> <p>Real estate consultants and their activities; Types of agreements between the consultants and principal; knowledge base for assessment and forecasting the Real Estate market; Role and responsibilities of property managers; Real estate investment, sources and related issues; Code of ethics for Real Estate participants; Environmental issues related to Real Estate transactions; Closing the Real Estate transactions Good practices and managerial responsibilities.</p> <p>Environmental Laws Applicable To Real Estate Development ; Environmental Audit In Real Estate ;</p>	12 hrs
<p>Unit III</p> <p>Valuation for sale and purchase of freehold & leasehold properties; Valuation for mortgage, valuation for acquisition, valuation for taxation of properties contemporary trends of valuation of property, Disputes and arbitration in real estate properties.</p>	08 hrs
<p>Unit IV</p> <p>Case Studies of real estate development, valuation, investment in Indian context</p>	09 hrs

Reference Books:

1. Goeters, J.E, "Environmental Issues in Real Estate" Amazon Books
2. Kahr J. and Thomsett, M.C. (2005), R.E. Market Valuation and Analysis, Wiley Publishers
3. Gelbtuch, H.C. Mackmin, D. and Milgrim, M.R., Real Estate Valuation in Global Markets Amazon Books.

E527T Successful Research Program Development										
Teaching Scheme					Examination Scheme (audit course)					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	-	2				--	--	(Pass/fail)
<p>Unit I 10 hrs</p> <p>The Research Organization: Objectives & Goals of a Research Organization, Components of a research organization, Contracting & Operational Support Activities, Indirect Support Activities, Direct Support Activities, Costs & Infrastructure Accounting, General & Administration Activities, Market & Business Development Activities, Profit & Non-Profit Entity Implications, Business Case for R&D, R&D Structures & Costs for Selected Industry Segments, Success stories.</p> <p>Research Staff: Research & Academic Faculty, Scientists & Technologists, Research Associates, Graduate Students, Visiting Researchers, Employment Laws, Contracts, & Implications, Workplace Regulations.</p>										
<p>Unit II 10 hrs</p> <p>Sponsors & Funding Agencies: Funding Agencies – Types, Types of Interface with Funding & Sponsor Agencies, Call for Proposals & Opportunity Tracking, Types of Proposals & Grants, Contracting Vehicles & Arrangements, Deliverables, Interim & Final Reviews, Cost & Performance Audits, Contract Laws & Enforcement, Ethics & Lobbying, Conflict of Interest & its Management.</p> <p>Proposals for Research Program Funding: Center & Consortia Proposals, Individual Principal Investigator Proposals, Continuation & Renewal Proposals, Prime/Subcontractor Relationships & Contracting, Cost Accounting, Laws and Regulations.</p>										
<p>Unit III 10 hrs</p> <p>Research Program Contracts: Types of Contracts – IDIQ, Cost-Sharing, Cost-Plus, Intellectual Property & Patent Laws, Export Control & Arms Regulations Compliance, Academic versus Commercial Contracts, Technology Transfer, Overhead & Indirect Costs, Federal & Government Cost & Accounting Regulations (FAR), Case Studies.</p> <p>Writing a Successful Research Proposal: Technical Proposal, Management Proposal, Cost Proposal, Technology Proposal, Statement of Work & Deliverables, Case Studies.</p>										
<p>Unit IV 09 hrs</p> <p>The Research Process – I: Steps in development of successful research program, Quality and Cost consideration, Laboratories and infrastructure setup, Staffing & Support Models, Peer-Review, Independent Verification & Validation, Internal & External Review processes, Ethics & Regulatory Laws & Guidelines, Case Studies.</p> <p>The Research Process – II: Problem Definition, Background Study, Valuation & Current Practice, Proposal Writing, Deliverables & Timelines Development, Results Projection, Staffing, Costs & Progress Tracking, Quality Management, Publication & Patents, Intellectual Property & Licensing, Technology Transfer, Validation & Test.</p> <p>Deliverables & Audits: Technical Reports, Software, Hardware, Systems, Qualification, Cost Reports, Test Reports, Papers & Publications, Patents, Case Studies.</p>										
Reference Books:										