M.Tech Open Elective

Sr.No	Department Name	Course Name	Eligibility
1	Civil	Statistical Methods in Climate Science	All eligible
2		Solid waste Management Technologies	
3	Computer	Security of Information Systems	Except Computer & Information Security
4	Electrical	Engineering Optimization	Except Embedded Control Systems,Power Electronics and Power Systems, Power Electronics and Machine Drives
5	E&TC	Image Processing and Applications	Except Digital Systems, Signal Processing, VLSI and Embedded Systems,Wired and Wireless Communication
6	Instrumentation	Smart Sensors	Except Biomedical & Process Instrumentation
7	Mechanical	Hybrid and Electric Vehicle	Expect Automotive Technology
8	Metallurgical	Powder Metallurgy	All eligible
9		Advanced Composite	
10		NanoMaterials & NanoTechnology	
11	Production	Supply Chain and Logistics Management	Expect Project Management
12		Reliability Engineering	Expect Mechatronics
13		Project Planning and Control	Expect Manufacturing Engineering and Automation
14		Robot Dynamics and Analysis	

Statistical Methods in Climate Science

Teaching Scheme
Lecture: 3 hrs / week

Course Outcomes: Students will be able to:

A. Analyze the data in the statistical framework.
B. Execute bias correction procedures
C. Analyze extreme events
D. Perform statistical downscaling to obtain future climate data
E. Analyze and link different climate phenomena

1. **Applied Statistics**
   Introduction
   RV and probability distribution
   Empirical distribution and exploratory data analysis
   Hypothesis testing
   Forecast with regression and verification metrics
   Dimensionality reduction techniques
   MATLAB programming for applied statistics

2. **Climate and Climate Change: Basics and data availability**
   Introduction to climate, climate change: Statistical point of view
   Intergovernmental panel on climate change
   Geography of the Earth, latitude and longitude, spatial and temporal resolutions
   Reanalysis datasets
   Climate models (GCM, coupled GCM, Earth system models)
   Forecast, projections, predictions
   CMIP5 scenarios
   Data processing: Bias and bias correction approaches

3. **Climate Extremes**
   Introduction to extremes
   Rainfall extremes
   Indices to quantify extremes
   Temperature extremes and mortalities
   MATLAB programming for the calculation of indices

4. **Statistical downscaling for impacts assessment**
   Introduction
   Downscaling and its types
   Linear Regression based downscaling
   Assumption of Stationarity
   Uncertainties

5. **Climate wonders and future research prospects**
   Indian summer monsoon
   Thermohaline circulation
   Teleconnections
   Atmospheric rivers
   Research problems and publications

Types of Assignments

Problem solving on applied statistics with real data
Theoretical questions
MATLAB codes to read netcdf files, process climate data, quantify climate extremes
Mini-projects

ILOE for MTech. 1st Semester

Solid Waste Management Technologies

Solid Waste Legislation, Solid Waste Characteristics, Type of solid Waste, Technologies related to: Source Reduction, Collection of Solid Waste, Recycling, Incineration, Composting of Municipal Solid Wastes, Landfilling, Equipments used for these technologies

SEMESTER - I

OEC: Security of Information Systems

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

1. Analyze functional and non-functional requirements to produce a system architecture that meets those requirements.
2. Use secure medium in Information System.

Unit 1: Introduction **(07 hrs)**

Define and understand the term information systems (IS). Technology, people, and organizational components of an information system, various types of information systems nature of information systems in the success and failure of modern organizations, understand and plan for the future of managing IS. Information systems for automation, organizational learning and strategic support, Formulate and present the business case for a system

Unit 2: Security in Databases **(07 hrs)**

Databases, Large Databases, Big Data, Security of this data

Unit 3: E-commerce and their security **(07 hrs)**

Business to Customer e-commerce, Business to Business e-commerce, Customer to Customer e-commerce, Advantages and disadvantages of e-commerce, E-Commerce System Architecture, Payment schemes in e-commerce, Cash transactions in e-commerce, e-commerce applications and security.

Unit 4: Information Systems Ethics **(07 hrs)**

Impact of computer ethics on information systems, Issues associated with information privacy, accuracy, property and accessibility.

Unit 5: Computer Crime, and Security **(07 hrs)**

Computer crime and list several types of computer crime, computer virus, worm, Trojan horse, and logic or time bomb, various methods for providing computer security, I T Act 2000

Unit 5: Internet and its security **(07 hrs)**

Use of internet in Information Systems, Security while using internet

Text books:

1. "Information Systems Today, Managing in the Digital World", Third Edition by Leonard M. Jessup; Joseph S. Valacich, Publisher: Prentice Hall
2. "Introduction to Information Technology", V. Rajaraman, PHI

Reference books:

1. "Information Systems Management in Practice" Barbara C. McNurlin, Ralph H. Sprague, and Publisher: Pearson Education.

OEC: Engineering Optimization

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each
End-Sem Exam – 60

Course Outcomes:

Upon successful completion of this course students will be able to,

A. Explain and use the basic theoretical principles of optimization and various optimization techniques.
B. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them using appropriate techniques
C. Analyze and solve complex optimization problems in engineering
D. Design optimization models and use them in solving real life problems
E. To develop and Implement optimization algorithms and use software tools to solve problems in engineering
F. Make sound recommendations based on these solutions, analysis and limitations of these models.

Syllabus Contents:

Introduction to optimization, classical optimization: single variable, multivariable optimization techniques, linear programming: simplex method, duality, transportation problems, non-linear programming: one dimensional minimization methods, unconstrained optimization, dynamic programming: development of dynamic programming, principle of optimality, practical aspects of optimization: reduced basic techniques, sensitivity of optimum solution to problem parameters, modern optimization techniques

References:

1. R. Fletcher, "Practical Optimization", Second edition, John Wiley and Sons, New York, 1987.
2. S. S. Rao, "Engineering Optimization-Theory and practice", Fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and System Analysis", New age International Publishers, Third edition, 1996.
4. Gillette, "Computer Oriented Operation Research", Mc-Graw Hill Publications.
5. Bazaraa M. S., Sherali H.D. and Shetty C. "Nonlinear Programming Theory and Algorithms", John Wiley and Sons, New York 1993.
6. Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.

(OEC) Image Processing and applications

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand basic image processing techniques.
2. Identify applications of each of the techniques.
3. Apply image processing techniques for real life interdisciplinary applications (based on student's specialization)

Syllabus Contents:

- Image representation: Types of Images, Image acquisition, Fundamental steps in Image processing, Image enhancement, Filtering in spatial and frequency domains
- Image Segmentation: Edge Detection, thresholding, region based segmentation, motion in segmentation.
- Image Morphology: Need of morphology, Morphological applications
- Image Compression: lossy and lossless compression techniques, JPEG standard.
- Reconstruction from projections. Thermal imaging. Color Image Processing
- Case studies: Image Processing Applications in various disciplines.

References:

1. S. Sridhar, "Digital Image Processing", Oxford University Press, 2011
2. Gonzalez and Woods :Digital Image Processing, Pearson Education, Third Edition, 2008

(OEC) Smart Sensors and Systems

Teaching Scheme:

Lectures: 3 hrs/week

Examination Scheme:

T1, T2 – 20 marks each, End-Sem Exam - 60

Course Contents:

Unit 1 (06)

Basic characteristics of measuring devices: Introduction to smart sensors and emerging trends, measurement techniques, static & dynamic characteristics, Interface electronics and measurement for smart sensor systems, Sensing elements and their parasitic effects,

Unit 2 (08)

Data Acquisition for dynamic sensors: Introduction, DAQ boards, Microcontrollers and digital Signal Processors for Smart Sensor Systems, case studies

Unit 3 (06)

Positioning sensors: piezoelectric technique, smart sensing technology for measurement of force, torque Sensors, pressure, and case studies of its applications

Unit 4 (06)

Thermal sensors: functional principle of thermal sensors, Heat-transfer mechanisms, Temperature-difference-sensing elements, Smart temperature sensors and systems, Case studies of smart-sensor applications

Unit 5 (07)

Chemosensors : chemosensing using sensing techniques such as thin metal films, zinc oxide and polymeric films, silicon sensors, biosensors , optical sensors , applications : Silicon sensors: an introduction 3

Unit 6 (07)

MEMS and microsensors, construction and its applications as smart sensing devices, concept of intelligent instrumentation based on neural networks and fuzzy logics

Text books:

1. Chapman, P., "Smart Sensors", ISA Publications, 1995.

Reference Books:

1. G. Gautschi, Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
2. Krzysztof Iniewski, "Smart Sensors for Industrial Applications", CRC Press , 2013(ISBN :9781466568105) * Gerard Meijer (Editor),"Smart Sensor Systems", Willey Publications, 2008 (ISBN: 978-0-470-86691-7

Hybrid and Electric Vehicles

(MTech. Institute Open Elective)

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Unit I : Conventional automobile vehicles **[7hrs]**

Various resistances to vehicle motion. Forces and power required at wheels for various running conditions. Development of driving and braking forces at wheels. Construction and working of 4-stroke S.I. and C. I. engines. Engine characteristics – torque, brake power, brake specific fuel consumption and brake thermal efficiency. Combustion of fuel in engine and pollution due to combustion.

Unit II : Power train **[7hrs]**

Function of clutch, gear box, final drive and differential in automobile power train. Their construction and working. Effects of sprung mass and unsprung mass on vehicle performance. Braking system.

Unit III : Alternative fuels and alternative vehicles **[7hrs]**

Properties and sources of alternative fuels like CNG, LPG, alcohols, bio-diesel, bio-gas, hydrogen gas, solar energy, electricity and fuel cells, compressed air, flywheel. Possibility of their use in automobile vehicles. Storage of the fuels in vehicles. Their advantages and disadvantages as automobile fuels.

Unit IV : Electric machines **[7hrs]**

Characteristics and controls of DC machines, induction machines, permanent magnet machines and switched eluctance machines.

Unit V Architecture of electric and hybrid electric vehicles **[7hrs]**

Architecture of electric vehicles. Classification of architecture of hybrid electric vehicles based on path of energy flow, degree of hybridization and charge- sustaining. Series HEV power train. Parallel HEV power train.Series-parallel combination HEV power train. Series-Parallel 2X2 architecture. Power-split pre-transmission hybrid configuration. Parallel post-transmission hybrid configuration. Plug-In hybrid electric vehicle.

Unit VI : Power train component sizing **[6hrs]**

EV and HEV power train component sizing for required initial acceleration, maximum velocity and maximum radability. Generator sizing and battery sizing.

Text Books:

1) – The Motor Vehicle – K. Newton, W. Steeds, T.K. Garrett
2) – Internal Combustion Engines – Edward F. Obert
3) – Handbook of Air pollution from I.C. Engine, Pollutant formation and Control – Eran Sher
4) – A text book of Electrical Technology – B.L. Theraja
5) – Electric and Hybrid Vehicles: Design Fundamentals – Eqbal Husain
6) – Modern Electric, Hybrid Electric, and Fuel Cell Vehicles – Mehrdad Ehsani, Yimin Gao, Ali Emadi

(OEC/ILE) Powder Metallurgy

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2/Assignments – 20 marks each,
End-Sem Exam – 60

Course Outcomes:

The student will be able to learn the Powder Manufacturing methods,

CO1: The student will be able to know the powder and finished PM product's characterization techniques,

CO2: The student will be able to understand the powder conditioning and consolidation methods to obtain the finished products

CO3:The student will be able to comprehend various methods of consolidation and the secondary operations performed on PM parts

CO4: The student will be able to develop awareness on manufacturing and applications of a few important P/M components: properties and their dependence on processing and microstructure.

Syllabus Contents:

Manufacture of metal powders: Conventional and modern methods, Powder characterization techniques, Powder Conditioning (mixing. blending, granulation etc.), Powder compaction: Mechanical, thermal and thermo-mechanical compacting processes, New methods of consolidation, Sintering theories, mechanisms, types, variables, Secondary operations Performed on Powder Metallurgical components, Heat treatment of PM components, Manufacturing and applications of important P/M components (Porous PM bearing, Cemented carbide tools, Electrical contact materials etc.)

Text Books:

1. Anish Upadhayaya , Gopal S. Upadhayaya, Powder Metallurgy: Science, Technology, and Materials, Universities Press, 2011.
2. Randall German, Powder Metallurgy Science, Metal Powder Industry; 2 Sub edition, 1994.
3. Randall German, Powder Metallurgy & Particulate Materials Processing, Metal Powder Industry, 2005
4. F. Thumler, R. Oberacker, An Introduction to Powder Metallurgy, Institute of Materials (Great Britain), 1993.
5. Cemented Tungsten carbide Production, properties & testing – Gopal S. Upadhayay

Reference Books:

1. Randall German, Sintering Theory and Practice, Wiley-Interscience; 1 edition, 1996.
2. ASM Handbook: Volume 7: Powder Metal Technologies and Applications, 2nd edition, 1998.
3. Claus G. Goetzel, Treatise on Powder Metallurgy, VOLUME II, III, Applied and Physical Powder Metallurgy, Interscience Publishers Inc., New York, 1950.
4. L. Sands, C. R. Shakespeare, Powder Metallurgy - practice and applications, Newnes, 1966.

(PCC 2) Advanced Composites

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2/Assignments – 20 marks each
End-Sem Exam – 60

Course Outcomes:

At the end of the course, students will be able to apply :

CO1 : Basic knowledge, the major constituents & types of composite materials

CO2 :Knowledge of metallic, ceramic and polymeric materials as matrix materials and their properties and characteristics.

CO3 : Knowledge of processing methods used for PMC, MMC, and CMC manufacturing, their advantages and disadvant

CO4 : Knowledge of composite materials for structural, electrical, electromagnetic, dielectric, optical and magnetic applications

Syllabus Contents:

Composite materials in engineering, reinforcements and the reinforcement matrix interface - natural and synthetic fibers, synthetic organic and inorganic fibers, particulate and whisker reinforcements, reinforcement-matrix interface. Polymer matrix composites(PMC) – polymer matrices, processing of polymer matrix composites, characteristics and applications, composites with metallic matrices - metal matrix composites processing (MMC), Interface reactions, properties of MMCs, characteristics and application, Ceramic matrix composites (CMC)- processing and structure of monolithic materials, processing of CMCs, some commercial CMCs. Mechanical properties in composites, large particle composites and the rule of mixtures for elastic constants, Mechanical properties of fiber reinforced composites, Effect of fiber length, Critical fiber length, Strength of continuous and aligned fiber composites, Discontinuous and aligned fiber composites, Toughening Mechanism, Impact Resistance, Fatigue and Environmental Effects. Structural Composites: Cement matrix composites, Steel Reinforced Concrete, Pre-stressed concrete, Thermal Control, Vibration reduction. Polymer matrix composites- vibration damping. Composite materials for Electrical, Electromagnetic and Dielectric applications, Microelectronics and Resistance heating, Electrical insulation, capacitors, piezoelectric, ferroelectric functions, electromagnetic windows, solid electrolytes, microwave switching. Composite materials for optical and magnetic applications, optical waveguide, optical filters and lasers, multilayer for magnetic applications.

Text Books:

1. Principles of Materials Science and Engineering, William F. Smith, Third Edition, 2002, McGraw-Hill
2. Composite Materials: Engineering and Science, Matthews F.L., and Rawlings R. D., 1999, Woodhead Publishing Limited, Cambridge England.
3. Composite Materials-Functional Materials for Modern Technology, DDL Chung, Springer- Verlag Publications London
4. The nature and Properties of Engg. Materials, Jastrzebaski, John Wiley & Sons, New York.

Reference Books:

1. Composite Materials Handbook, Mel M. Schwartz (R), 2nd Edition, 1992, McGraw-Hill, New York.
2. Mechanics of Composite Materials, Autar K. Kaw, 1997, CRC Press, New York.
3. Fundamentals of Fiber Reinforced Composite Materials, A. R. Bunsell, J. Renard, 2005, IOP Publishing Ltd.
4. omposite Materials Science and Engg., Chawla K.K., Second Edition, 1998, Springer Verlag

Open Elective **Nano-materials & Nanotechnology**

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

Quiz/Assignment –20 marks

Quiz/Assignment – 20 marks

End Sem exam – 60 marks

OBJECTIVES:

- *To introduce students to nanoscience and nanotechnology*
- *To understand basics of synthesis, properties and applications of nanomaterials.*

Unit 1 **(06)**

Definition, Length scales, Importance of Nanoscale and Technology, Top down and bottom up approaches, Properties of selected nanomaterials including carbon nanotubes (CNT), metal nanoparticles, nanoclays, nanowires, colloidal semiconductors and concept of quantum dots.

Unit 2 **(06)**

Fabrication of Nanomaterials: Synthesis and purification of CNT, synthesis of expanded graphite (EG), clay, electro-ceramics, semi-conducting and magnetic nanoparticles, Fabrication of nano-composites : Clay-rubber, Clay-polymer, CNT-metal, CNT-polymer and EG-polymer,

Unit 3 **(06)**

Characterization of Nanomaterials: Scanning Probe Microscopy, Characterization and Particle size determination by X-ray diffraction, Transmission Electron Microscope (TEM), Atomic force microscope, UV-Visible spectroscopy.

Unit 4 **(06)**

Thin Films: Production of thin films by PVD, CVD, Film formation mechanisms, Epitaxial films, their growth, structure and their relevance in semiconductors, electrical properties of thin films, magnetic thin films for memory applications and protective coatings,

Open Elective Nano-materials & Nanotechnology

Unit 5 **(06)**

Biomaterials: Introduction, Property requirements of biomaterials, Classes of biomaterials used including metals, polymers and nanocomposites, hydrogels, thin films and coatings. Degradation of materials in biological environment,

Unit 6 **(06)**

Applications in medicine, dentistry and artificial organs and implants. Applications: Applications in structural, electronics, optical, magnetic and bio-medical fields, solar cells, LED, LCD, electrically conducting polymers, batteries, fuel cells, Nano-composites, Nano-SMART materials.

REFERENCE BOOKS:

- Nanomaterials: An introduction to synthesis, properties and applications, Editor-Dieter Vollath, Wiley-CVH
- Nanoscale Materials in Chemistry, Editor: Kenneth J. Klabunde, Publisher-Wiley-Interscience.
- Encyclopedia of Nanotechnology- Hari Singh Nalwa.
- Springer Handbook of Nanotechnology - Bharat Bhusan, Springer-Verlag Publ media.
- Handbook of Semiconductor Nanostructures and Nanodevices Vol 1-5- A. A. Balandin, K. L. Wang.
- Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong.

(ILE) Supply Chain and Logistics Management

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- Understand supply chain flows & supply chain strategies.
- Design the Supply Chain Network

Designing transportation network & analyze factors affecting transportation decisions.

Syllabus Contents:

- Introduction to supply chain and logistics management, concept, Supply chain stages and decision phases, process view of a supply chain. Supply chain flows. Competitive and supply chain strategies, importance in project Management
- Designing the Supply Chain Network, Distribution Network - Role, Design. Supply Chain Network (SCN) - Role, Factors, Framework for Design Decisions. Models for Facility Location and Capacity Allocation. Impact of uncertainty on SCN - Discounted Cash Flow Analysis, Evaluating Network Design Decisions using Decision Trees. Case studies & problems.
- Managing Multi-Echelon Cycle Inventory, Safety inventory determination. Impact of supply uncertainty aggregation and replenishment policies on safety inventory. Optimum level of product availability: Importance factors, managerial levers to improve supply chain profitability, supply chain contracts. Case studies & problems.
- Scoring & Assessment, Selection & Contracts. Design Collaboration.
- Role of Revenue Management in the Supply Chain, Revenue Management for : Multiple customer segments, Perishable assets, Seasonal demand, Bulk & spot contracts. Managerial levers to achieve co-ordination, Building strategic partnerships. The role of IT in Supply Chain, The Supply Chain IT Framework, CRM, Internal SCM, SRM. The role of E-business in a supply chain, The E-business framework, E-business in Practice. Case discussions
- Introduction to Logistic Management principles, operation, Design and administration
- System view of logistic co-ordination and transportation order processing, ware housing, material handling, customer service standards, cost analysis case studies,

Factors affecting transportation decisions. Modes of transportation and their performance characteristics. Designing transportation network.

- Risk management, Types of project risks in SCLM, Risk issues, performance, concept and importance

Introduction to Global Supply Chain Management. Globalization network design, Green SCLM, understanding supply chain excellence, case studies

References:

1. Sunil Chopra & Peter Mcindl, "Supply Chain Management -Strategy, Planning & Operation" Pearson Education Inc, 11th Edition, 2003
2. Douglas Lanibert & James Stock, "Strategic Logistics Management" McGraw Hill, 4th Edition, 2004.

(OEC) Reliability Engineering

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1/T2/ Assignments/ Quiz -40
End-Sem Exam- 60 marks

Course Outcomes:

1. Student will be able to understand the importance and application of reliability.
2. Student will be able to use the concepts of reliability in designing and maintenance of products.
3. Student will be able to simulate techno economic life which is very important for industry application.

Syllabus Contents:

Basic Probability, concept and various distributions.

Concept of Reliability and analysis of various configurations of assemblies and sub-assemblies. Series, Parallel and other grouping. System reliability. Set theory, optimal Cut Set and Tie Set, 'star-delta' method, matrix method etc. System reliability determination through 'Event Tree' analysis and Fault tree analysis.

Usage monitoring of plant and evaluation of reliability through failure data analysis.

Concept of loading roughness, probability in design including evaluation of safety margin. Reliability of Engineering Design; Mean, Median & K statistics for Reliability evaluation (non parametric, Short Sample).

Monte-Carlo simulation and Techno economic life.

Optimal allocation of component reliability to achieve maximum system reliability – various techniques and methods such as Proportional, Conditional, AGREE, ARINC etc.

Reliability, Availability and Maintainability of equipment.

A number of case studies done in Indian perspectives using Short Sample, nonparametric reliability.

Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), Failure Modes, Effects and Criticality Analysis (FMECA). R.P.N., Graph theory etc.

Diagnostic maintenance through ferrography, Vibration Signature, SOAP and other programme.

References:

1. C. Singh and C.S. Dhillon, Engineering Relaibility-New Techniques and Applications –John Wiley and Sons
2. K. C. Kapoor and L. R. Lubersome, Reliability in Engineering Design Willey Publication.
3. L. S. Srinath, Concepts in Reliability Engineering- Affiliated West Press.

(OEC) Project Planning and Control

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of course students will be able to:

1. Comprehensive fundamental and technical knowledge of Project Planning.
2. Leadership and decision making capabilities
3. Ability to handle the project through project planning steps.
4. Ability to analyze the projects through network techniques and handle financial aspects of project.

Syllabus Contents:

- Function of Project Planning –Inter dependency relationship, Generation and screening of project ideas, project rating index
- Characterization of the market, demand forecasting, market planning.
- Financial Analysis; Estimation of cost of project and means of financing, estimates of sales and production, cost of production
- Working capital requirement and its financing, estimates of working results, breakeven points – projected cash flow statement,
- Project cash flows; Basic principles of measurement of cash flows, components of the cash flow streams – viewing a project from different points of view, definition of cash flows by financial institutions and planning commission
- Forms of project organization, project planning, project control, human aspects of project management, prerequisites for successful project implementation.
- Project review and administrative aspects; Initial review, performance evaluation, abandonment analysis, administrative aspects of capital budgeting, evaluating the capital budgeting system of an organization.
- Network techniques for project management, development of project network, time estimation, determination of critical path, scheduling when resources are limited, PERT and CPM models.

References:

1. Prasanna Chandra, "Project Planning: Analysis, Selection, Implementation and Review", Tata Mc Graw Hill.
2. Narendra Singh, "Project Management and Control", HPH, 2003
3. John M. Nicholas and Herman Steyn, "Project Management for Business and Technology: Principles and Practice", Prentice Hall India
4. Clifford F. Gray & Eric W. Larson, "Project Management: The Managerial Process", Tata Mc Graw Hill

(OEC) Project Planning and control

5. Chitkara, "Construction Project Management, Planning, Scheduling and Control", Tata McGraw-Hill, ISBN: 9780074620625
6. Merdith & Gopalan, "Project Management", Wiley India (P) Ltd., ISBN: 8126509406

(MA-15005) Robot Dynamics and Analysis

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of course students will be able to:

1. Comprehensive fundamental and technical knowledge of Robotics
2. Ability to apply computing of design criteria's of robot elements
3. Ability to apply the knowledge of specifying the robot elements and selection of robots
4. Ability to analyze robots through Kinematic and Dynamic study & its programming
5. Ability to learn effective practices in uses of robots, robot economics and novel advancements in this area.

Syllabus Contents:

- Basic concepts, Robot anatomy, Robot configurations, Basic robot motions, Types of drives
- End effectors, Classification, Mechanical, Magnetic, Vacuum, and Adhesive. Force analysis and Gripper design
- Sensors in robot systems, non optical and optical position sensors, Velocity and Acceleration, Range, Proximity, touch, Slip, Force, Torque sensors
- Machine vision system, illumination techniques, image processing & analysis
- Translational transformations and Rotational transformations, Properties of transformation matrices-Homogeneous transformations and Manipulator
- Robot kinematics, Forward solution, Inverse solution , Control system concepts, Analysis , control of joints, Adaptive and optimal control, Trajectory Planning
- Robot Dynamics, Langragian formulation, D Alembert's principle
- Robot programming Methods - Robot programming languages - VAL Language, Computer controller and Robot communication,
- Economics of Robots, Robot Applications-Material handling, processing,-Assembly and Inspection, safety considerations. Telechiric robots.

References:

1. M. P. Grover, M. Weiss, R. N. Nagel, N. G. Odrey, "Industrial Robotics Technology", Mc Graw Hill book Co. 1995
2. Robert J. Schilling, "Fundamentals of Robotics-Analysis and Control", Prentice Hall India, 1990.
3. Fu K.S., Gonzalez R.C.., and Lee C.S.G., "Robotics control, sensing, vision, and intelligence", McGraw-Hill Book Co., 1987.

4. Klafter R.D., Chmielewski T.A. and Negin M., "Robot Engineering An Intergrated approach", Prentice Hall of India, New Delhi, 1994.
5. Deb S.R., "Robotics Technology and Flexible Automation", Tata McGraw-Hill Publishing Co., Ltd., 1994.
6. Craig J.J., "Introduction to Robotics Mechanics and Control", Addison-Wesley, 1999.