

Sir Syed University of Engineering and Technology

Postgraduate Programs

Updated Scheme of Studies and Curriculum as
approved in 51st Academic Council for MSCS,
MSCV, MSEE, MSEL, MSMA, MSSE, MSTE, MBA
PhDEE, PhDCE and PhDBM

(Effective From Batch 2021 Fall)

Preamble

The updation of Scheme of Studies and Curriculum is a regular practice and are revised when required. These Scheme of Studies and Curriculum were updated on the recommendations of 31st BASR and 51st Academic Council Meetings held on 29th June 2021 and 8th July 2021 respectively. In this document, there are ELEVEN changes in the Scheme of Studies and Curriculum of Masters program in MSCS, MSCV, MSEE, MSEL, MSMA, MSSE, MSTE, MBA PhDEE, PhDCE and PhDBM . The rest of the Scheme of Studies and Curriculum of all other programs will remain same.

The revised Scheme of Studies and Curriculum as approved in 51st Meeting of Academic Council, will be effective from Batch 2021 Fall onwards.

Scheme of Studies MSCS, MSCV, MSEE, MSEL, MSMA, MSSE, MSTE, MBA PhDEE, PhDCE and PhDBM (Batch 2021 Fall)

MS in Computer Science

Core Courses

Minimum Four core courses can be selected from the following list of five courses:

- CS6001 Advanced Operating Systems
- CS6003 Advanced Algorithms Analysis
- CS6004 Theory of Programming Languages
- CS6006 Advanced Theory of Computation
- CS6008 Advanced Computer Architecture

Compulsory Core

- CS-6005 Research Methodology

General Electives

- CS-6099 Thesis

Elective Courses

The fields of specialization offered are:

- **Information Management**
- **Software Design and Management**
- **Web Engineering**

ELECTIVE COURSES FOR SPECIALIZATION IN INFORMATION MANAGEMENT

- CS-6101 Advance Database Management System
- CS-6102 Advanced Data Warehousing
- CS-6103 Object Oriented Databases
- CS-6104 Web Based DBMS
- CS-6105 Topics in Databases Management Systems
- CS-6106 Database Security
- CS-6107 Advanced Data Mining
- CS-6108 User Interface Analysis and Design
- CS-6109 Intelligent Systems
- CS-6110 Advanced Machine Learning
- CS-6111 Big Data Analytics
- CS-6112 Deep Learning
- CS-6113 Tools and Techniques in Data Science

ELECTIVE COURSES FOR SPECIALIZATION IN SOFTWARE DESIGN AND MANAGEMENT

- CS-6201 Software Quality Assurance
- CS-6202 Requirements Engineering
- CS-6203 Software System Architecture
- CS-6204 Software Design
- CS-6205 Software Project management
- CS-6206 Information retrieval
- CS-6207 Software process improvement
- CS-6208 Software Risk Management
- CS-6209 Software Measurement & Metrics
- CS-6210 Software Configuration Management
- CS-6211 Component Based Software Engineering

ELECTIVE COURSES FOR SPECIALIZATION IN WEB ENGINEERING

- CS-6301 Semantic Web
- CS-6302 Web Services
- CS-6303 Cyber Crime and Security
- CS-6304 Mobile Commerce Technology
- CS-6305 Advanced Web Systems & Technologies
- CS-6306 Internet Banking
- CS-6307 E-Commerce Strategies and Technology
- CS-6308 Social Marketing and Social Networking Applications
- CS-6309 Multimedia Databases
- CS-6310 Web Mining
- CS-6311 Rich Internet Applications
- CS-6312 Social Network Analysis

MS in Electronic Engineering

(From Batch 2021 Fall)

The fields of specialization offered are:

- Industrial Automation
- Control and Artificial Intelligence

Core Courses

The candidate has to complete the following core courses.

EE-7101 Research Methodology

EE-7102 Simulation, Modeling and Optimization

EE-7107 Linear System Theory

EE-7110 Stochastic Processes

Specialization Electives:

From two specialization electives, Students need to select **three courses each**. While remaining from the electives, **students need to select three each**.

Industrial Automation

EE-6102 Industrial Control Systems

EE-6103 Advanced Digital Electronics and Interfacing Techniques

EE-6104 Electronic Design Automation

EE-6105 Measurement and Calibration of Electronic Systems

EE-6106 Intelligent Measurements and Instrumentation

EE-6107 Advance Power Electronics

EE-6108 Sensors and Systems

EE-6109 Robotics and its Application of Industrial Electronics

EE-6110 Selected Topics in Industrial Electronics

EE-7112 Design of Industrial Control Systems

Control and Artificial Intelligence

EE-6113 Fuzzy Logic and Intelligent Electronic Control Systems

EE-7104 Dynamics and Controls of Nonholonomic Systems

EE-7109 Advance Digital Signal Processing

EE-7116 Digital Image Processing and its applications

EE-7118 Artificial Intelligence and Advanced Neural Networks

EE-7119 Machine Learning

EE-7120 Selected Topics in Control and Artificial intelligence I

EE-7121 Selected Topics in Control and Artificial intelligence II

General Electives

EE-6114 Solid State Drives

EE-6115 FPGA Based Systems

EE-7103 Mechatronics

EE-7105 Embedded System Modeling
EE-7106 Advance Engineering Mathematics
EE-7108 Adaptive Systems
EE-7109 Advance Digital Signal Processing.
EE-6199 MS Thesis

MS in Civil Engineering (From Batch 2021 Fall)

The fields of specialization offered are:

- Structural Engineering
- Geotechnical Engineering
- Transportation Engineering and Management
- Construction Management
- Environmental Engineering

Compulsory Core

CV-7104 Research Methodology

Structural Engineering:

Core / Compulsory Courses

CV-6101 Advanced Reinforced & Pre-stressed Concrete
CV-6104 Structural Dynamics
CV-6001 Advanced Engineering Mathematics
CV-7102 Mechanics of Solids
CV-7103 Advanced Structural Analysis

Elective Courses

CV-6106 Structural Mechanics
CV-6108 Earthquake Resistant Design
CV-6109 Sustainable Construction
CV-6111 Design of High Rise Structures
CV-612 Bridge Engineering
CV-7105 Finite Element Methods
CV-7110 Plates and Shells
CV-7113 Advanced Concrete Technology
CV-7099 Thesis

Geotechnical Engineering:

Core / Compulsory Courses

CV-6201 Applied Soil Mechanics
CV-6203 Foundation Engineering & Design
CV-6205 Geology for Civil Engineers
CV-7202 Advanced Methods in Geotechnical Engineering
CV-7204 Advanced Analytical Geotechnical Engineering

Elective Courses

CV-6207 Soil Dynamics & Earthquake Engineering
CV-6208 Pavement Design
CV-6209 Geotechnical & Geo Environmental Engineering
CV-6210 Underground Excavating & Tunnelling
CV-6212 Pressure & Retaining Systems
CV-7206 Ground Improvement Techniques & Geo Synthetics
CV-7211 Rock Mechanics
CV-7099 Thesis
CV-7107 Advanced Steel Design

Transportation Engineering and Management:

Core / Compulsory Courses

CV-6301 Development of Transport Infrastructure
CV-6302 Urban Transportation Planning and Development
CV-6002 Probability and Statistics
CV-7303 Advanced Traffic Engineering and Management
CV-7304 Pavement Analysis and Design

Elective Courses

CV-6305 Geometric Design of Highways
CV-6307 Transport and Logistics Management
CV-6309 Highway Materials
CV-6310 Transport Economics
CV-6311 Public Transport Operations & Management
CV-7306 Sustainable Transportation Systems
CV-7308 Intelligent Transportation Systems
CV-7312 Supply Chain Management
CV-7099 Thesis

Construction Management:

Core / Compulsory Courses

CV-7401 Project Management
CV-7402 Total Quality Management
CV-7404 Construction and Industrial Law
CV-7403 Construction Operations and Productivity
CV-7405 Management of Design Process

Elective Courses

CV-7406 Statistics and Probability
CV-7407 Infrastructure Management in Public Sector
CV-7408 Human Resource Management in Construction Projects

CV-7409 Sustainability and the Built Environment
CV-7410 Information Technology Applications
CV-7099 Thesis

Environmental Engineering:

Core / Compulsory Courses

CV-6501 Environmental Engineering Design
CV-6502 Water and Wastewater Engineering
CV-6504 Solid Waste Management
CV-7503 Air Pollution & Control Engineering
CV-7505 Environmental Impact Assessment

Elective Courses

CV-6506 Environmental Management Techniques
CV-6509 Marine and Estuarine Environment
CV-6510 Environmental Measurements
CV-6511 Water Quality Management
CV-6512 Disaster Management and Risk Analyses
CV-7507 Environmental Auditing
CV-7508 Industrial and Hazardous waste management
CV-7099 Thesis

MS in Telecommunication Engineering (From Batch 2021 Fall)

Core Courses

TE-6140: Advanced Communication Systems

TE-6141: Data Networks

TE-6142: Advanced Information Theory and Coding

TE-6143: Stochastic processes

Compulsory Core

TE-7111 Research Methodology

Elective Courses

TE-6144: Wireless and Mobile Networks

TE-6145: Advanced Wireless Communications Networks and Systems

TE-6146: Emerging Wireless Techniques

TE-6147: Optical Communications Systems

TE-6148: Satellite Communication

TE-6149: Multi-User Information Theory

TE-6150: Network Planning

TE-6151: Antennas and Wave Propagation

TE-6152: Security in Communications and Storage

TE-6153: Techno-Economic Analysis of Telecommunication Networks

TE-6154: Communication Network Reliability

TE-6155: Network Management

TE-7116: Cyber Security

TE-7117: Internet of Things (IoT)

TE-7118: System Design for the Internet of Things

TE-7119: Simulation of Mobile Communications

TE-7120: Artificial Intelligence

TE-7121: MIMO Systems

TE-7122: Nano-Systems

TE-7123: Navigation Using the Global Positioning System

TE-7124: Software Defined Networks

TE-7125: Machine Learning

TE-7126: Machine Learning for Wireless Communications

TE-7127: Advanced Electromagnetic Waves

TE-7128: System-on-Chip Technologies

TE-7129: Advanced Methods in Cryptography

TE-7130: Adaptive Signal Processing

PhD in Biomedical Engineering (From Batch 2021 Fall)

Core Courses

BM-7105 Research Methodology (if not taken in MS)

Elective Courses

BM-7101 Advanced Bio-Instrumentation Design
BM-7102 Advanced Biomedical Signals Processing
BM-7103 Advanced Biomedical Imaging
BM-7104 Advanced Biomaterial
BM-8105 Bio nanotechnology
BM-7106 Advanced Modeling and Simulation of
Physiological System
BM-7201 Tissue Engineering
BM-7202 Material Engineering
BM-8203 Polymers in Drugs Delivery Systems
BM-8204 Regenerative Medicine
BM-8205 Bio Implants Material

BM-7301 Radiological Imaging
BM-8302 Video Signal Processing
BM-8303 Advance Biomedical Optical Engineering and
Design

BM-7304 MR Radiology and Spectroscopy

BM-7305 Neural and Fuzzy Systems

BM-7401 Neural Sciences and Neural Implants Devices

BM-7402 Sensors in Bio Instrumentation

BM-7403 Rehabilitation Engineering and Assistive Devices

BM-8404 Applied Bioelectricity

BM-8405 Innovating Medical Technologies

Thesis

BM-8099 PhD Thesis

PhD in Computer Engineering (From Batch 2021 Fall)

Core Subject

CE-7104 Research Methodology (if not taken in MS)

Elective Courses

CE-7105 Wavelet Analysis and Applications

CE-7106 Wireless Sensor Network
CE-7107 Cryptography
CE-7108 Digital Processing of Random Signals
CE-7109 Internet of Things
CE-7110 Cloud Computing
CE-7111 Software Defined Networking
CE-7206 Decision Support and Expert Systems
CE-7205 Intelligent Systems
CE-7295 Case Studies and Projects
CE-8001 Computer Vision
CE-8002 Optimization Techniques
CE-8003 Intelligent Data Analysis and Probabilistic
Inference
CE-8004 Advanced Computer Systems Analysis
CE-8090 Advanced Topics in Computer Engineering I
CE-8091 Advanced Topics in Computer Engineering -II
Thesis
CE-8099 PhD Thesis

MS in Mathematics (From Batch 2021 Fall)

Core / Compulsory Courses

MS-6101 Real Analysis

MS-6105 Complex Analysis

MS-6201 Abstract Algebra

MS-6401 Ordinary Differential Equations

Compulsory Core

MS-7111: Research Methodology

Elective Courses:

MS-6110 Measure Theory – I

MS-6115 Functional Analysis – I

MS-6120 Summability Theory – I

MS-6215 Ring Theory - I

MS-6501 Introduction to Continuum Mechanics

MS-6205 Linear Algebra

MS-6301 General Topology

MS-6601 Mathematical Statistics

MS-6901 Special Topics – I

MS-7110 Measure Theory - II

MS-7115 Functional Analysis - II

MS-7120 Summability Theory – II

MS-7125 Fourier Analysis

MS-7215 Ring Theory - II

MS-7220 Theory of Semigroups

MS-7225 Theory of Semirings

MS-7230 Fuzzy Set Theory

MS-7301 Algebraic Topology
MS-7401 Partial Differential Equations
MS-7405 Mathematical Techniques for Scientists and Engineers
MS-7410 Calculus of Variation and Integral Equations
MS-7415 Optimization
MS-7420 Integral Equations
MS-7425 Numerical Solutions of Ordinary Differential Equations
MS-7430 Numerical Solutions of Partial Differential Equations
MS-7435- Bio-Mathematics
MS-7501 Fluid Mechanics
MS-7510 Basics of the Theory of Fluids
MS-7515 Theory of Stability
MS-7520 Computational Fluid Dynamics
MS-7525 Aerodynamics
MS-7530 Bio-Mechanics
MS-7601 Elementary Decision Theory
MS-7605 Operations Research
MS-7610 Approximation Theory
MS-7615 Stochastic Processes
MS-7620 Mathematical Modeling
MS-7701 Data Structure
MS-7705 Mathematical Coding Theory
MS-7710 Graph Theory
MS-7715 Theory of Computation
MS-7720 Numerical Analysis
MS-7801 Differential Geometry
MS-7901 Special Topics - II
MS-6099 Thesis

PhD in Electronic Engineering (From Batch 2021 Fall)

Core Courses

EE-7101 Research Methodology (If not taken in MS)

Elective Courses

EE-7102 Simulation, Modeling and Optimization

EE-7103 Mechatronics

EE-7104 Dynamics and Controls of Nonholonomic Systems

EE-7105 Embedded System Modeling

EE-7106 Advance Engineering Mathematics

EE-7107 Linear System Theory

EE-7108 Adaptive Systems

EE-7109 Advance Digital Signal Processing

EE-7112 Design of Industrial Control Systems

EE-7116 Digital Image Processing and its Applications

EE-7118 Artificial Intelligence and Advanced Neural Networks

EE-7119 Machine Learning

EE-8103 Computer Vision & Pattern Recognition

EE-8104 Advance Adaptive Control Systems

EE-8105 Non-Linear Control system

EE-8106 Advanced Topics in Electronic Engineering – I

EE-8107 Advanced Topics in Electronic Engineering – II

Thesis

EE-8199 PhD Thesis

MS in Software Engineering (From Batch 2021 Fall)

Core / Compulsory Courses

SE – 6101 Advanced Requirements Engineering
SE – 6102 Advanced Software System Architecture
SE – 6103 Advanced Software Quality Assurance

Compulsory Core

SE – 7124 Research Methodology

Domain Elective Courses:

Select courses equivalent to minimum 6 credit hours. (minimum 02 courses)

SE – 6111 Software Measurement and Metrics
SE – 6112 Software Risk Management
SE – 6113 Software Configuration Management
SE – 6114 Agile Software Development Methods
SE – 7111 Advanced Formal Methods
SE – 7112 Component Based Software Engineering
SE – 7113 Advanced Human-Computer Interaction
SE – 7114 Advanced Software Project Management
SE – 7190 Special Topics in Software Engineering

General Elective Courses:

Select courses equivalent to minimum 9 credit hours. (minimum 03 courses)

SE – 6121 Advanced Operating Systems
SE – 6122 Advanced Computer Networks
SE – 6123 Advanced Database Systems
SE – 6124 Intelligent Systems
SE – 7121 Advanced Big Data Analytics
SE – 7122 Advanced Information Security
SE – 7123 Cloud Computing
SE – 7125 Internet of Things
SE – 7180 Special Topics in Computing
SE – 6099 MS Thesis

MS in Electrical Engineering (From Batch 2021 Fall)

Core Courses

EL-6101 Advanced Power System Analysis

EL-6102 Renewable Energy and Embedded Generation

EL-6103 Advanced Power System Operation and Control

Compulsory Core

EL-7101 Research Methodology

Elective Courses:

EL-6104 Power System Stability

EL-6105 Advanced High Voltage Engineering

EL-6106 Advanced Digital Signal Processing

EL-6107 Power System Reliability

EL-6108 Computer methods in Power System Analysis

EL-6109 Electrical Power Distribution System

EL-6110 Advanced Power System Transmission

EL-6111 Power System Protection

EL-6112 Smart Grid System

EL-6113 Transients in Power System

EL-6114 Special Topics in Power Engineering

EL-6199 MS Thesis

MBA Scheme of Studies (From Batch 2021 Fall)

The fields of specialization offered are:

- **Marketing**
- **Human Resource Management**
- **Finance**
- **Supply Chain Management**
- **Media Management**
- **Urban Management and Development**

Compulsory Courses

The candidate has to complete the following Compulsory courses.

MKT-510 Marketing
ACC-501 Financial Accounting
MGT-510 Principles Of Management
ECO-520 Economics
QTM-503 Business Mathematics & Statistics

MGT-541 Human Resources Management
ACC-503 Cost & Managerial Accounting
BCM-512 Business Communication
FIN-502 Financial Management
ECO-601 Econometric

MGT-600 Strategic Management

FIN-603 Entrepreneurial Finance
MGT-601 Project Management
Specialization I
Specialization II

MGT-650 Advanced Qualitative & Quantitative Techniques
Specialization III
Specialization IV
RMT-700 Dissertation /Thesis

Specialization Electives:

From 6 specialization electives, Students need to select FOUR courses from their desired field.

• Marketing

MKT-620 Brand & Advertising Management
MKT 621 Integrated Marketing Communication
MKT 622 Public Relation & Event Management
MKT 623 Sales Management
MKT 624 New Product Development
MKT 625 International Marketing

• Human Resource Management

HRM 620 Training & Development
HRM 621 Performance Management
HRM 622 Compensation & Benefits Management
HRM 623 Recruitment & Selection
HRM 624 Industrial Management & Labor Laws
HRM 625 Job Analysis & Design

- **Finance**

- FIN 620 Banking & Finance
- FIN 621 Financial Reporting & Analysis
- FIN 622 Financial Portfolio Analysis
- FIN 623 Islamic Banking & Finance
- FIN 624 Corporate Finance
- FIN 625 Financial Risk Management

- **Supply Chain Management**

- SCM 620 Supply Chain Management
- SCM 621 Inventory Management
- SCM 622 Demand Management and Value Chains
- SCM 623 Transportation & Distribution System
- SCM 624 Strategic Operations Management
- SCM 625 Total Quality Management

- **Media Management**

- MAM 620 Communication & Communication Theories
- MAM 621 Writing for Media Print & Electronics
- MAM 622 Mass Media & Society
- MAM 623 Communication & Negotiations
- MAM 624 Communication & Public Opinion
- MAM 625 Advertising Management
- MAM 626 Media and Event Management

- **Urban Management and Development**

- URM 620 City Governance

- URM 621 3rd Tier of Government-Local govt & Financial Mgt

- URM 622 Introduction of Urban Planning & Modern Trends in Planning

- URM 623 Infrastructure Planning, Development and Management

- URM 624 Sustainable Development and Planning

- URM 625 Urban Conversation and Urban Renewal

- URM 626 Hazards and Disaster Mitigation

Updated curriculum for MSCS, MSCV,
MSEE, MSEL, MSMA, MSSE, MSTE, MBA
PhDEE, PhDCE and PhDBM

Biomedical Engineering Courses

BM-7105 Research Methodology

Introduction: Problem identification, Problem Statement, Objectives, Literature Review & Referencing, Conceptual Framework/ Hypotheses, Planning, Methods and Procedures, Presenting Professional Papers. Data Collection & Analysis: Introduction to data collection and analysis, Statistical measures, hypothesis testing, linear regression and analysis of variance in application-oriented manner. Data collection methods using various instruments, Analysis of experimental and quasi-experimental methods. Presentation of research findings.

BM-7101 Advanced Bio- Instrumentation and Design

This course will introduce the advance level of biomedical instrumentation system, Building blocks of the biomedical Instrumentation systems, future need of biomedical instrumentations the course deal with advance bio instruments used to record the bio, detail discussion on origin of the bio signals, signal originated from the heart like sound signals from the movement of the heart valves, devices used to record the signal and its advancements, details analysis of electrocardiogram signal it instrumentation and advancements in the recording, Electromyogram system design, EMG signal interpretation and advancements in the

current EMG devices its future Applications, electroencephalography signal interpretation , EEG system design advancement in the EEG device and its application in brain computer interfacing, Neural spikes amplifiers, electro muscles stimulator, the design and application and future advancements in the system, Future biomedical instrumentation trends, Advancements in the Xray, MRI and CT scan and PET Scan Systems. fMRI and its application in medical diagnosis, Advance instrument used for respiration System, implantable Biomedical Systems their application and limitations and future trends. Medical instruments and devices used in the home, future device for home and remote areas etc.

BM-7102 Advanced Biomedical Signals and Processing

This course will introduce the Nature of the biomedical signals, Noise removal and signal compensation of ECG and EMG signals, Biomedical examples of IIR digital filter design, Stochastic filter as filtered white noise, Random process, Digital Biomedical Signal Acquisition and processing, Time frequency signal representations of biomedical signals, Uncertainty management in medical applications, Nonlinear behavior of heart rate variability, Ventriculo-Arterial interaction after acute increase of the aortic input impedance , Nonlinear Estimation of respiratory induced heart movement and its Application in ECG signal processing, Nonlinear deterministic behavior on blood pressure control, Wavelet Analysis in biomedical signal processing, Future Directions of biomedical signal processing and multimedia communication.

BM-7103 Advanced Biomedical Imaging Processing

This course will deal with the biomedical image processing, need of image processing in medicine, principles of image used in biomedical devices, types of imaging, components of image processing, image analysis, image managements, Magnetic resonance imaging, Spin echo, One dimensional Fourier imaging, k space and gradient echoes, slice excitation, sampling and aliasing in image reconstruction , projection reconstruction of images, MR angiography, motion artifacts and flow compensation, MR Spectroscopy, X-ray and computerized tomography, color X ray imaging, ultrasound imaging, tissue, Scattering, Ultrasound tissue phantom, Ultrasound beam formation, Ultrasound image modalities, Electrical impedance tomography, Optical Coherence Tomography, Medical application of virtual reality technology.

BM-7104 Advanced Biomaterial

This course will cover the introduction to the biomaterial, Application of biomaterial in Medical engineering, Need and requirement of Biomaterial in regenerative medicine and tissue engineering, Classes of materials used in medicine, Metals Polymers, FRPs, Glasses, Ceramics, bioerodable material. Host reactions to biomaterials, Bio- compatibility, Implant associated infection, Testing of Biomaterials, In vitro assessment, in vivo assessments, Blood Materials interactions. Design on materials for biomedical application, Wound healing, Ophthalmologic applications, Sutures, dental implants, Cardio- vascular implants, neural implants,

Skin and Orthopedic application. Implantation techniques for soft tissues and hard tissues replacements, Problems and possible solutions in implant fixation. Failure analysis of medical device and implants.

BM-8105 Bio Nanotechnology

This course will cover the introduction to the bio-nanotechnology, Application of bio-nanotechnology, Protein Engineering, tools for genome analysis, Microchip, Bioelectronics chips, Gene Chips. Micro fabrication processes of silicon and glass chips, Self-assembled monolayers Applications in surface modification and micro-patterning, Fabrication of polymer Microfluidic devices, Noncontact microarraying techniques, electronic manipulation of cells on a microchip based devices, micro-filters based separation of cells, Technology options and applications in microchips, Micro-fabricated devices for integrated DNA Analysis, Biochip based portable laboratory, biological applications of paramagnetic particles in chips, and Nano scale size based bio-molecular separations technology.

BM-7106 Advanced Modeling and Simulation of Physiological System

This course deals with the definition of Modeling and simulation, in importance, Types of modeling and its Application in biomedical engineering with examples. Hybrid models and its application in bio- medical

engineering, example of simulators. Multi-scale modeling its application in biomedical engineering and its examples. Conceptual Modeling, why and when to use the conceptual model. Things necessary before building a model. Conceptual model of cardiorespiratory system Subdivision of Physiology models and combining of basic elements of Conceptual models. Mathematical Models. Mathematical model of Mechanical and electrical system. Mathematical model of electrical system. State space variable and derivation of its equations. Example of State space equation and transfer its relation with transfer function. Representation of fluid and biomedical system in electrical component diagram. Electrical and mechanical modeling of the blood flow through the artery. Introduction to the software implementation of model. Flow diagram of the software implementation. Electrical model of the Skin. Use of Skin model in Electrical Impedance Plethysmography. Electrical model of the electrode. Application of electrode electrolyte model by attaching the electrode. Bio Heat equation and its derivative. Application of bio-heat equation in simulation and modeling. Model of the brain and temperature effect on implanted Deep Brain stimulation electrodes. Modeling of the Human Eye. Electrical Modeling of the Neuron and Cable Theory. Block diagram of Middle Ear and its Electrical Modeling. Electrical Model of the Respiratory System. Three Block Model of the Renal System. Monte-Carlo Simulation of the Photon Movement in the Biological Tissue. Model design in COMSOL Multiphysics Software, designing of the electrode and identify the electrical field passing through the medium using COMSOL.

BM-7201 Tissue Engineering

This course will cover biological principles and physiological phenomena underlying cellular regulation during development, homeostasis, and cell proliferations and wound healing. The course also includes tissue engineering fundamentals, such as cell sources, transplantation immunology, processing of scaffolding materials, integration at cell-material interfaces, mechanisms of incorporation and release of biologics, engineered culture environments, and host-transplant integration. A Brief Introduction to Different Cell Types, Human Embryonic Stem Cells, Derivation and Culture of embryonic stem cell, Stem Cells Differentiation, Marrow Stem Cells, Cord Blood Stem Cells Potentials and Realities, Control of Adult Stem Cell Function in Bioengineered Artificial cell and functions, Stem Cell and tissue Immunology, Development of a Design of Experiment Methodology, Applications to the Design and Analysis of Experiments, Synthetic Biomaterials as Cell-Responsive Artificial Extracellular Matrices, Bioactive Composite Materials for Bone Tissue Engineering Scaffolds Aggregation of Cells Using Biomaterials, Nanotechnology for Tissue Engineering, Microscale Technologies for Tissue Engineering, Cell Expansion, Cell Encapsulation, 3D Cultures, Stem Cell Therapy (Past, Present, and Future, Tissue Engineered organs and implants, Tissue Engineering for Tooth and Bone Regeneration, Animal Model and material compatibility, In Vitro 3D Human Tissue Models for Osteochondral Diseases, Application of Tissue

Engineering according to the latest trends and Technology, importance of clinical trials and its outcomes.

BM-7202 Bio-Material Engineering

The course deals with the material the biological materials used in the field of biomedical. The fundamental of the course is the material and its types, biomaterial and artificial materials used as bio implants. The advance physical and chemical properties of the materials. design of the biomaterial, physical, chemical and behavior of the material in and outside the biological system. Synthetic Biomaterials as Cell-Responsive

Artificial Extracellular Matrices, Bioactive Composite Materials for Bone Tissue Engineering Scaffolds Aggregation of Cells Using Biomaterials. The development of new scaffolds for regenerative medicine, biomaterials characterization, stem cell therapy, cell-materials interface engineering, self-assembled bio-mimetic copolymers and nanomaterials for bio sensing applications. Biomaterials activities are particularly exciting is the tailoring of inorganic nan-particles such as gold and quantum dots with bioactive peptides so that they can act as reporters for the detection of enzyme activity. Ultrasensitive detection of enzymes related diseases such as cancer or infectious diseases. Natural and synthetic materials as well as the interactions between materials and biological tissues. It covers a wide range of research areas including advance materials science, biocompatibility, implant device development, surgical applications, and failure analysis and

has application throughout most physiologic systems. Application of material Engineering according to the latest trends and Technology, importance of clinical trials and its outcomes.

BM-8203 Polymers in Drugs Delivery Systems

It will focus on topics at the interface between engineering and medicine such as polymer chemistry, biomaterials, mass transport, and pharmacokinetics. The course will first cover the fundamentals of drug delivery, including physiology, pharmacokinetics/pharmacodynamics, drug diffusion and permeation, and biomaterials used in drug delivery course, Fundamentals and challenges of drug delivery, Barriers to Drug Delivery, In vitro models in drug discovery and delivery, Routes of Drug Delivery, Pharmacokinetics, Pharmacodynamics, Diffusion in Biological Systems, Drug Metabolism, Polymer Selection, Polymer Characterization, Hydrogel drug delivery systems, Polymer Microparticles/Nanoparticles/ Micelles/Vesicles, Polymer-Drug Conjugates, Implantable Drug Delivery Systems, Drug Delivery in Tissue Engineering, Controlled Release Drug Delivery, Mucoadhesive Drug Delivery Systems, Stimuli-Responsive Polymer Delivery Systems, Affinity Based Drug Delivery, Drug Targeting, Prodrugs/ Bio-conjugation.

BM-8204 Regenerative Medicine

Regenerative medicine course includes the following are topics Biomaterials: including novel biomaterials that are

designed to direct the organization, growth, and differentiation of cells in the process of forming functional tissue providing both physical and chemical cues. Cells: including enabling methodologies for the proliferation and differentiation of cells, acquiring the appropriate source of cells such as autologous cells, allogeneic cells, xenogeneic cells, stem cells, genetically engineered cells, and immunological manipulation. Biomolecules: including growth and other differentiating factors. Engineering design aspects: including 2D cell expansion, 3D tissue growth, bioreactors, vascularization, cell and tissue storage and shipping (biological packaging). Biomechanical aspects of design: including properties of native tissues, identification of minimum properties required for engineered tissues, mechanical signals regulating engineered tissues, and efficacy and safety of engineered tissues. In this course, we will introduce most of these elements through some examples that have already successfully reached the clinics and others that have still to be further improved to enter daily clinical practices.

BM-8205 Bio Implantable Material

The course will include (i) biomaterials used for the implants, (ii) surface modification and coatings (iii) biomechanics aspects of the implant (iv) corrosion and tri-bocorrosion aspects of the implants (v) Clinical concerns. Some other topics related with implants such as Introduction of Biomedical implants, Different types of

implants used in dentistry, orthopedics, and Cardiac implants, Implant materials, Implant design, Surface coatings and modifications, Mechanics of implant in action- Contact stresses and forces, Corrosion aspects, Tri-bocorrosion aspects, Major failure mechanisms, Lab experience from dental and hip implant simulator, Diagnostic techniques for the implant monitoring in orthopedics and dentistry, Material selection and economic impact, Clinical issues and concerns, Current status and future direction.

BM-7301 Radiological Imaging

The course will cover the advance techniques used for the radiological imaging and its types. The importance of the radiological imaging for diagnoses, treatment, and therapy of the disease. Advance physics applied for the generation, transmission, and acquisition of the radiological signals. Signal and body interface, effect on the biological tissue before, during for the Source of the Radiological images. Radiation biology and protection. Radiological Pathology, digital vascular imaging, computed tomography (CT), general ultrasound and magnetic resonance imaging (MRI). Head and soft tissue imaging, cardiovascular and pulmonary imaging, spinal stenosis imaging, stroke imaging. Techniques, trends, and technology of the imaging. Extraction of the information from the radiological images. Format and manipulation of the images. Diagnostic techniques for the radiological imaging in orthopedics and dentistry, cardiovascular and pulmonary system. safety procedure and precautions. economic impact, Clinical issues and concerns, Current status and future

BM- 8302 Video Signal Processing

The course will cover the advance techniques used for the video signal techniques. The course includes the elaboration of the Video Analysis and Video Processing. Video Analysis and Video Processing, Video Coding and Transmission, Compensated Multi-Dimensional Wavelet-Lifting, Compressed Domain Video Analysis, Image Reconstruction from Arbitrary Pixel Meshes, Objective quality evaluation of video, Reconstruction of HDR Videos using Multiple Camera Set- ups, Reconstruction of Non-Regularly Sampled Data, Resolution Enhancement Techniques for Compressed Video Sequences, Signal processing for digital camera systems, Video processing for multi camera systems. Coding and Processing of Non-Rectilinear Image and Video Data, Coding medical datasets, Compression of Display data, Energy Efficient Video Coding, Error Concealment of Image Data, High Quality Video Coding, Spatio-Temporal Prediction. Theory of Multidimensional Signals and Systems, implementation of the Signal transmission and its techniques. The display and reading of the video signals and its format. The use of Video signals in medical and medical devices. The comparison of the conventional and the latest used videos signal devices. The advancement in the trends and technology and its barriers.

BM- 8303 Advanced Biomedical Optical Engineering and Design

The course will cover the advance techniques used for the optical Engineering in the field of Biomedical. The course includes the detail knowledge of the Light Propagation in Microstructure Optical Fibers and Designing High Gain Fiber Amplifier. Details and application of the Fiber Optics and Devices. Nano-photonics, Bio-photonics and Bio-medical Optics, Diagnosing Heterogeneous Dynamics for CT Scan Images of Human Brain in Wavelet and MFDDFA Domain. Automated Detection of Optic Disc in Fundus Images. Three-Dimensional Optical-Resolution Photoacoustic Microscopy. Fluorescence Microscopy Imaging in Biomedical Sciences. Spectral Imaging: Methods, Design, and Applications. Optical Coherence Tomography: Technical Aspects. Introduction to Biomedical Optical Imaging. Optical Fibers in Biomedical Imaging. Microscope Optics. Fluorescence Imaging and Techniques. Polarization Imaging. Confocal Imaging. Endoscope Optics.

BM- 7304 MR Radiology and Spectroscopy

The course will cover the fundamentals of the Magnet resonance phenomena. The Advance technique for the MR Radiology and Spectroscopy. The application of the MR in the Radiology. MR imaging and acquiring of the Image data. Methods and formulation of the Technique for the data analysis. Signal, noise and data analysis and its difference. Advance filters and algorithm for the data process. Latest

trends and technology in MR radiology and spectroscopy. Introduction to the Spectroscopy in Vivo. Pulse sequence and protocol design. Normal regional variation, MR in neurology. MR in Cardiology, MR in traumatic injury. MR in cancer diagnoses and its importance.

BM- 7401 Neural Sciences and Neural Implants Devices

The course will include the Microelectronic Visual Prostheses, Visual Prosthesis for Optic Nerve Stimulation, Cochlear Implants, Auditory Prosthesis Using Deep Brain Stimulation: Development and Implementation, Spinal Cord Stimulation: Engineering Approaches to Clinical and Physiological Challenges, Microelectrode Technologies for Deep Brain Stimulation, Implantable Cardiac Electro-stimulation Devices, The Bion1 Microstimulator and its Clinical Applications, Brain Control and Sensing of Artificial Limbs, Magnetic Stimulation of Neural Tissue: Techniques and System Design, and Regulatory Approval of Implantable Medical Devices in the United States and Europe,

BM- 7402 Sensors in Bio Instrumentation

The course will include the Introduction to the bio sensors, Temperature Sensors, Humidity sensors, Tilt Sensors, Pulse sensors, Accelerometers and its application in biomedical Instrumentation, Pres- sure Sensor and its application in Biomedical instrumentation, capacitive sensors and its application in biomedical instrumentation, Optical sensors in

medical care, Bio sensors for monitoring glucose, Non-Invasive cardiovascular hemodynamic measurements, Sensors for Respirator system, Sensors for fetal and neonatal monitoring, Body Motion Analysis, Cardiac Pacemakers, Sensors for Catheter Applications, Home Health Care and Telecare. Normal regional variation, MR in neurology. MR in Cardiology, MR in traumatic injury. MR in cancer diagnoses and its importance.

BM- 7403 Rehabilitation Engineering and Assistive Devices

The course will include the Principles of Assistive Technology: Intro-Technologies That Aid Transportation, Technologies That Aid Manipulation and Control of the Environment, Sensory Aids for Persons with Visual Impairments, Sensory Aids for Persons with Auditory Impairment, Assistive Technologies for Cognitive Augmentation, and Augmentative and Alternative Communication Systems, Inducing the Human Activity Assistive Technology Model, Technologies that Assist People Who Have Disabilities, Activity, Human, and Context: The Human Doing an Activity in Context, Ethical Issues in Assistive Technology, Control Interfaces for Assistive Technologies, Accessing Mainstream Information and Communication Technologies: The Technology and the Web, Technologies that Enable Mobility,

BM-8404 Applied Bioelectricity

The course will include the Impedance and Current Distribution, Electrical Principles of Nerve and Muscle Function, Excitation Models, Electrical Properties of the Heart, Cardiac Sensitivity to Electrical Stimulation, Sensory Responses to Electrical Stimulation, Skeletal Muscle Response to Electrical Stimulation, Stimulation via Electric and Magnetic Fields, TENS for pain management, TENS equipment, techniques, and biophysical principles, Appropriate electrode sites and electrical characteristics for TENS, Mechanism of action of TENS, and The use of TENS for non-painful conditions, Functional electrical Stimulation, Bio signal control based electrical stimulation.

BM- 8405 Innovating Medical Technologies

The course will include the all the expects of device design which includes Identification: Strategic focus, needs exploration, Need statement development Screening: Disease state fundamentals, Existing solutions, Stakeholder analysis, Market analysis, Needs selection Concept Generation: Ideation, Initial concept selection Concept Screening: Intellectual property basics, Regulatory basics, Reimbursement basics, Business models, Concept exploration and testing, Final concept selection Strategy Development: IP strategy, R&D strategy, Clinical strategy, Regulatory strategy, Quality management, Reimbursement strategy, Marketing and stakeholder strategy, Sales and distribution strategy, Competitive advantage and business

strategy Business Planning: Operating plan and financial model, Strategy integration and communication, Funding approaches, Alternate pathways.

BM-7305 Neural and Fuzzy Systems

The objective of this course is to provide a thorough introduction to the field of soft computing techniques to modeling, optimization, and control. It highlights current topics and applications, and describes a wide range of intelligent systems techniques, in the field of neural networks and fuzzy logic. The course also demonstrates concepts The course aims at building skills that allow students to design and maintain intelligent control systems for complex plants where there are difficulties to obtain adequate description and modeling of plant dynamics by analytical means. The topics include: Introduction to Fuzzy logic, Classical vs Fuzzy sets, Membership function, Mamdani and Takagi – Sugeno fuzzy models, Introduction to Neural Networks, Perceptron and Backpropagation, Multilayered feedforward Networks Neural Networks as classifiers, Introduction to Deep Neural Networks Convolution Networks

BM-8099 PhD Thesis

Student has to take a topic for literature review and research under the supervision of his advisor. He/She has to submit the results of his findings in the form of a thesis/report and defend his findings in front of a panel of experts

Curriculum of MSCS

CS-6001 Advanced Operating Systems

Operating system structures, microkernel approach, Memory and I/O virtualization, Multimedia operating systems, Parallel and distributed systems, Protection mechanisms and authentication, Operating system design, case studies of various operating systems.

CS-6003 Advanced Algorithm Analysis

Fundamentals of formal techniques and the underlying mathematical theory, NP-completeness. Search Techniques, Randomized Algorithms. Heuristic and Approximation Algorithms. Asymptotic analysis of upper and average complexity bounds using big-O, little-O, and theta notation. Fundamental algorithmic strategies (brute-force, greedy,

divide and conquer, backtracking, branch-and-bound, pattern matching, and numerical approximations) are covered. Standard graph and tree algorithms. Complexity classes, time and space tradeoffs in algorithms, using recurrence relations to analyze recursive algorithms, non-computable functions, the halting problem, and the implications of non-computability. Algorithmic animation. Mathematical concepts used in describing the complexity of an algorithm. Algorithm selection strategies.

CS- 6004 Theory of Programming Languages

Introduction: Models of Computation, Syntax and Semantics, Pragmatics, Language Design Principles. Syntax and Semantics: Context-Free Grammars, Regular Expressions, Attribute Grammars and Static Semantics, Algebraic Semantics, Axiomatic Semantics, Denotational Semantics. BNF

grammars and Syntax, Operational Equivalence, Abstraction and Generalization, Expressions, Assignment Statement, and Control Structures, Functional Programming: The Lambda Calculus, Operational Semantics, Reduction Order, Recursive Functions, Logic Programming, Inference Engine, Concurrency.

CS-6005 Research Methodology

It covers categories, techniques and process of doing research in Computer Science like Qualitative and Quantitative. It also addresses the process of formulating appropriate research questions/problems, objectives and hypothesis, techniques for reviewing literature, approaches for testing relationship and patterns. It introduces the essential aspects of designing, supporting and conducting a research project. This course covers research proposal, select an appropriate methodology with which to conduct the research and defend the methodology of their selection and understand the various tasks required to carry out the research.

CS-6006 Advanced Theory of Computation

Automata theory, formal languages, Turing machines, computability theory and reducibility, computational complexity, determinism, non-determinism, time hierarchy, space hierarchy, NP completeness, selected advanced topics.

CS-6008 Advanced Computer Architecture

Quantitative principles of Computer Design, Memory technology and optimizations, Virtual memory and virtual machines, Instruction level parallelism and its optimization, data level and thread level parallelism, Domain specific architectures.

CS-6101 Advanced Database Management System

Role and functions of database administration, data planning and information architectures, data centered information systems development. Advanced database manipulation with high-level languages and natural languages. Next Generation of DBMS; Object-Oriented DBMS. Data Warehousing, architecture, multidimensional databases, STAR schema, extract and transformation (ETL) tools, OLAP tools. Use of CASE tools to support information systems design and development. Maintaining data base integrity, technical, administrative and legal mechanisms. Deploying and managing data in a distributed (shared, networked) environment, database (SQL) servers, middleware tools to access enterprise databases on host computers. Organizational strategies for database administration, encouraging the use of advanced DBMS and supporting systems development and operations.

CS-6102 Advanced Data Warehousing

Advanced concepts involved in developing data warehouses and data marts, planning, design, implementation, and evaluation; review of vendor data warehouse products; cases involving

contemporary implementations in business, government and industry; techniques for maximizing effectiveness through OLAP and data mining. Critical Factors to design data warehouse. Data management, Data quality, Performance usage, Business Intelligence, Analytics and Big Data, Data warehousing Architectures.

CS-6103 Object Oriented Data Bases

Refreshing, extension and formalization of basic concepts in object oriented programming and relational databases. Classes, objects, inheritance, polymorphism, encapsulation, static and dynamic binding, message sending, relational mathematics, normal forms. Handling of non-normalized structures. Extensions, generalizations of relational modeling and corresponding mathematics modeling. Object management systems. Concepts and problems. Persistent programming Methods and systems. Object database management systems. Modeling, meta programming, transaction, garbage collection, query handling. Prototypes and user interfaces. Problems related to temporal and spatial aspects. Existing systems. An overview of commercial and academic systems.

CS-6104 Web Based DBMS

Web based database processing environment. Design and implement a web based database using MySQL. Developing script using PHP. Design code and implementation of a fully integrated database driven web site in PHP/MySQL environment. Development of Scripts using ASP. Etc.

Relational database servers, build a client server architecture and prototype client/server application to access database,

CS-6105 Topics in Database Management Systems

Modern database and information systems as well as research issues in the field. Object oriented, workflow, active, deductive, spatial, temporal and multimedia databases. recent advances in database systems such as data mining, on-line analytical processing, data warehousing, declarative and visual query languages, multimedia database tools, web and unstructured data sources, and client-server and heterogeneous systems.

CS-6106 Database Security

Information Security Fundamentals and the Types of Attacks- Information Security Fundamentals, Attackers and their attacks; Information Security Framework, Operating System and user Administration- Operating System and User Administration, Profiles, Passwords, Privileges and Roles, Authorization, Database Applications Security ,Virtual-Private Database; How the virtual Private Database works, Auditing, Data Dictionary, Encryption with Oracle, SQL Injection. Security algorithms.

CS -6107 Data Mining

Concepts of Data mining, data pre-processing and pre-mining, ²⁹(noisy and missing data, data normalization and discretization),

outlier detection, Data mining learning methods, Data mining classes (association rule mining, clustering, classification), fundamental of other algorithms related to data mining (fuzzy logic, genetic algorithm and neural network), decision trees, rules, patterns and trends. Statistical modeling, linear models, clustering. Real machine learning schemes, comparing data mining methods, Predicting probabilities. Automatic data cleansing, Combining multiple models.

CS -6108 User Interface Analysis & Design

Introduction to HCL,HCL Paradigms, Design process; Know The User – Ethnography, Interviews, Questionnaires, etc., Requirements Gathering and Task Analysis, Understanding the Human –Cognitive Frameworks ,Mental Models ,Memory, Attention ,Big –Picture models of user: Characteristics, Gulf of Execution, Modeling the Human-Model Processor ,GOMS, Fits, User-Centered Design Principles, Design – Avoid Errors and Provide Help; Graphic Physiology ;Visual Structure; Icons ;Graphic color, Futuristic Videos, Prototyping-What, when ,why, how ,User Interface Software, Typography, Observational Techniques, Dialogue Styles-Command Language, WIMP, Direct Manipulation, Cognitive Walkthroughs, Dialogue Styles- Pen and PDA, Large Screen ,Speech ,Web Design, Design of cell phone Services and UIs.

CS -6109 Intelligent Systems

Introduction to Artificial Intelligence ,Logic Programming Using Prolog, Searching Techniques ,Knowledge Representation and Reasoning, Design & Development of Expert Systems, Basics of Natural Language Processing ,Design & Development of Neural Network Applications ,Fundamentals of unsupervised learning techniques, Overview of decision tree learning ,Introduction to genetic algorithms ,Introduction to fuzzy systems, Components and architecture of a robot ,Intelligent agents and agent frameworks.

CS-6201 Software Quality Assurance

Quality Assurance, Quality Engineering, Concepts, Issues, and Techniques, Test Activities, Management, and Automation, Coverage and Usage Testing Based on Checklists and Partitions, Input Domain Partitioning and Boundary Testing, Coverage and Usage Testing Based on Finite-State Machines and Markov Chains, Control Flow, Data Dependency, and Interaction Testing, Testing Techniques: Adaptation, Specialization, and Integration. Defect Prevention and Process Improvement, Software Inspection, Formal Verification, Fault Tolerance and Failure Containment, Comparing Quality Assurance Techniques and Activities. Feedback Loop and Activities for Quantifiable Quality Improvement, Quality Models and Measurements, Defect Classification and Analysis. Risk Identification for Quantifiable Quality Improvement, Software Reliability Engineering.

Role of requirements engineering in system development, Fundamental concepts and activities of requirements engineering, Information elicitation techniques, Fundamentals of goal-oriented requirements engineering, Modeling behavioral goals, Modeling quality goals, Goal modeling heuristics, Deriving operational requirements from goals, Requirements Specification, Requirements verification and validation, Management of inconsistency and conflict, requirements engineering risks, requirement change control board and process, the role of quality goals in the requirements selection process, Techniques for requirements evaluation, selection and prioritization, Requirements management, Requirements traceability and impact analysis.

CS-6203 Software System Architecture

The architecture business cycle, Understanding and achieving quality attributes, Attribute-driven design, Documenting software architecture, Evaluating software architecture, Architecture reuse Life-cycle view of architecture design and analysis methods, The QAW, a method for eliciting critical quality attributes, such as availability, performance, security, interoperability, and modifiability, Architecture Driven Design, Evaluating a software architecture (ATAM, CBAM, ARID), Principles of sound documentation, View types, styles and views, Advanced concepts such as refinement, context diagrams, variability, software interfaces, and how to document interfaces, Documenting the behavior of software elements and software systems, Choosing relevant views, Building a documentation package, Future of Software

Design, Architecture Description Languages , Introduction to AADL , AADL, Testing Architectures, Feature Modeling in SPLs, Testing a Family of Products.

CS-6204 Software Design

Software Processes, Software Design Basics, Software Architecture, Software Design Principles, Software Patterns, Design Patterns, Creational Design Patterns, Introduction to Architectural Patterns, Structural Design Patterns, Behavioral Patterns, Idioms, Anti-Patterns, Model Driven Architecture, Service Oriented Architecture (SOA)

CS-6205 Software Project Management

Software Crisis and Software Engineering, Classic Mistakes, Overview of Project Management, PMI Process Groups, Software project Phases, Project charter, Statement of Work (SOW), Development lifecycle models, matching lifecycles to projects, Project plans, Work Breakdown Structures (WBS), Estimation of effort and cost (Expert Judgment, FP and Use Case point methods), Project network diagram fundamentals, CPM, PERT, Gantt charts, Critical chain scheduling, Using MS Project -Assigning Resources, Resource leveling, Team models, Managing conflict and motivating, Status reporting, Project metrics, EVM, Communications Techniques, Risk management and Change control Project Recovery, Documentation, Cutover/Migration, Post Project Reviews, Closing.

CS-6206 Information Retrieval

Basic Concepts of IR, IR System Block, Diagram. Automatic Text Analysis, Indexing and Classification. Measures of Association. Clustering Algorithms. File Structures. IR Models. Search Strategies. Performance Evaluation. Online IR Systems & Interfaces Standards. Taxonomy and Ontology. Distributed and Parallel IR. Query Processing. Multimedia IR Models & Languages- Data Modeling Techniques to Represent Audio and Visual Document, Query Languages Indexing & Searching- Generic Multimedia Indexing Approach, Query Databases of Multimedia Documents, Display the Results of Multimedia Searches, One Dimensional Time Series, Two Dimensional Color Images, Automatic Feature Extraction. Searching the Web, Challenges, Characterizing the Web, Web Crawlers, Robot Exclusion, Web Data Mining, Metacrawler, Collaborative Filtering, Web Agents (Web Shopping, Bargain Finder...), Latest Development and Economics, Ethical, Legal and Political Issues related to Information Retrieval.

CS-6207 Software process Improvement

Process Modeling and Process Modeling Techniques (Introduction and ETVX), Process Modeling Techniques (IDEF0) Measuring and Analyzing the Current State of Process, CMM and Other process models, CMMI– I, PSP and TSP, Process Changes using PDCA and IDEAL models, Process Assessments, Base-lining, and Benchmarking, Project Management aspects related to process management ,Process Measurement, Process Metrics i.e. Maturity, Management, and Life Cycle Metrics, Fundamentals of

Measurement and Experimentation, GQM and its application to process management and improvement, Introduction to Quality Metrics, Software Engineering Measurements, Advance Topics in Software Process

CS-6208 Software Risk Management

Risk-Management Discovery, Risk-Management Process, Process steps, inputs, and outputs, Methods and tools, reusable process component. Risk-management Infrastructure, Training metrics, establishing a baseline for quantitative process improvement, infrastructure, Risk-Management implementation, standard process, Risk management activities, lifecycle planning, budgeting, scheduling and staffing, Crisis and Control, risk-management evolution stages, Effective and ineffective practices.

CS-6209 Software Measurements & Metrics

Foundations of measurement theory, models of software engineering measurement, software products metrics, software process metrics and measuring management. Measurement theory (overview of software metrics, basics of measurement theory, goal-based framework for software measurement, empirical investigation in software engineering). Software product and process measurements (measuring internal product attributes: size and structure, measuring external product attributes: quality, measuring cost and effort, measuring software reliability, software test metrics, object-oriented metrics) Measurement management.

CS-6210 Software Configuration Management

Source Code Management, Build Engineering, Environment Configuration, Change Control, Release Management, Deployment, Architecting Your Application for CM, Hardware Configuration Management, Rightsizing Your Processes, Overcoming Resistance to Change, Learning From Mistakes, Establishing IT Controls and Compliance, Industry Standards and Framework.

CS-6211 Component Based Software Engineering

Introduction to CBSE, Reuse, Basic Concepts in CBSE, Modeling components with UML, Open-COM component model, Fractal component model, Component Models and Technology, Component contracts component specification techniques, Component integration and Predictable composition, Service Oriented Computing - Key Concepts and Principles, SOA.

CS-6301 Semantic Web

Knowledge Representation and the Semantic Web, Web Ontology Language OWL, Description logics and classifiers, Description Logics Syntax, Semantics, and reasoning problems, Methods for developing and evaluating ontologies. Common problems and patterns in ontology development, Application development using the OWL API.

CS-6302 Web Services

Web Services, Service-Oriented Architecture, SOA development lifecycle, Enterprise Service Bus, SOA analysis and design methods, HTTP and XML, Simple Object Access Protocol (SOAP), Web Service Description Language (WSDL), Universal Description, Discovery and Integration (UDDI), WS-I Basic and Related Profiles, REST, Web Services as Component-Based Software, Web service development API.

CS-6303 Cyber Crime and Security

Security weaknesses and vulnerabilities in network protocols and equipment, Web Traffic – CGI, Penetration testing, Foot printing and Intelligence gathering, Packet Sniffing, Intruders and Malicious code, Denial of Service attacks, VPNs, Intrusion Detection Systems, Packet-filters, Application-Level, DMZ, Encryption techniques, Public Key Infrastructure, Trusted Third Parties, Certificates and C.A's, Digital Signatures and message digests, MD5, SHA, HMAC, SSL, IPsec, PGP, S/MIME, WEP/WAA, Rainbow tables, Hashing, Birthday Paradox, Legal issues and Computer Misuse Act.

CS-6304 Mobile Commerce Technology

Characteristics and functions M-commerce technology, M-commerce applications, M-commerce trust, security, and payment, M-commerce business model, Current and emerging M-commerce services such as mobile financial services, mobile entertainment services, and location-based M-commerce

services, Group-oriented mobile commerce services and transactions management, wireless user interface design, Design and develop mobile applications using a prominent mobile technology.

CS-6305 Advanced Web Systems & Technologies

Web Effort Estimation, Web Productivity Measurement and Benchmarking, Web Quality, Web Usability, Web System Reliability and Performance, Web Application Testing, Conceptual Modeling of Web Applications, Model-Based Web Application Development, Modeling Notation for Complex Web Applications, Statistics Analysis, W3C Web Content Accessibility Guidelines, Internationalization, Mobile Web Applications, Mobile Web for Social Development, Accessible Rich Internet Applications (WAI-ARIA), Declarative Web Applications, Web Components, Web 2.0 & Associated Technologies, Web Real Time Communication and Web Authoring.

CS-6306 Internet Banking

e-Banking, Informational websites, Transactional websites, Internet Banking components, Internet Banking Trends & Directions, Retail payment trends, The global payments landscape, Emerging products & technologies, Operating Strategies & Management Models, Product Development Life Cycle, Internet Banking products including the contactless card, mobile payments, biometrics, stored value cards and bit coins, Managing risk in Internet Banking

activities, Internet Banking controls, Risk in new and emerging Internet Banking payments and Critical issues in Internet Banking Development.

CS-6307 E-Commerce Strategies and Technology

Electronic Commerce, E-Marketplaces, E-Tailing Products and Services, Online Marketing and Online Consumer Behavior, Business- to-Business E-Commerce, E-Government and E-Learning, Web 2.0, Social Networks and Search Engine Optimization, E-Commerce Security, Payment Solutions and Order Fulfillment, E-Commerce Strategy and Global Issues, Legal, Ethical and Tax Issues, E-Commerce Business Analysis and Development.

CS-6308 Social Marketing and Social Networking Applications

Social Marketing, The role of content marketing in a multi-channel marketing world, Business Objectives and User-centered content, Brand Storytelling and Branded Content, Content Marketing for Multiple Online and Traditional Channels, Devices and Context, Content Marketing Strategy, Challenges and Considerations in Content Marketing, online social networking applications and their design/development, Develop dynamic web sites and applications on social networking platforms using server-side programming technology to meet strategic marketing goals.

CS-6309 Multimedia Databases

Multimedia Data, The Human Sensory System and Multimedia, Database Approach for the Management of Multimedia Information, Multimedia Databases, Object-Oriented Multimedia DBMS, SQL and Multimedia, Multimedia Query Specification Language, Querying Multimedia Data, Modeling Multimedia Databases, Using Multimedia Metadata, Multimedia Database Architecture and Performance, Multimedia and the Internet, Quality-of-service Issues, Dealing with Text Databases, Content-dependent Metadata, Dealing with Image Databases, Dealing with Video Databases, Model for Interactive Retrieval of Videos and Still Images.

CS-6310 Web Mining

Web usage, content, and structure mining, Use of Machine Learning and Computational Intelligence Techniques for web mining and information networks, mining information sites and streams, Web crawling, indexing, ranking and filtering algorithms using content and link analysis summarizing and analyzing web information, mining opinion and reviews, identifying and mining social networks and social media, Applications for searching, classification, recommendation, and Web intelligence.

CS-6311 Rich Internet Applications

Key Characteristics of Rich Internet Applications, RIA Platforms, RIA Architectures, RIA Architecture Details, RIA Benefits, RIA Drawbacks, RIA Patterns, RIA Best Practices,

Direct Web Remoting, Mashups, RIA Using different frameworks, RIA using various Toolkits, Latest trends and technologies in RIA.

CS-6312 Social Network Analysis

Nodes, edges, adjacency matrix, one and two-mode networks, node degree, connected components, giant component, average shortest path, diameter, breadth-first search, preferential attachment, Betweenness, closeness, eigenvector centrality, network centralization, community clustering, community structure, modularity, overlapping communities, Small world network models, optimization, strategic network formation and search, Contagion, opinion formation, coordination and cooperation, Unusual applications of SNA, SNA and online social networks.

CS-6110 Advanced Machine Learning

Introduction to machine learning and statistical pattern recognition. Supervised learning: Part I (Graphical models (full Bayes, Naïve Bayes), Decision trees for classification & regression for both categorical & numerical data, Ensemble methods, Random forests, Boosting (Adaboost and Xgboost), Stacking; Part II (Four Components of Machine Learning Algorithm (Hypothesis, Loss Functions, Derivatives and Optimization Algorithms), Gradient Descent, Stochastic Gradient Descent, Linear Regression, Nonlinear Regression, Perceptron, Support vector machines, Kernel Methods, Logistic Regression, Softmax, Neural networks); Unsupervised learning: K-means, Density Based Clustering Methods (DBSCAN, etc.),

Gaussian mixture models, EM algorithm, etc.; Reinforcement learning; Tuning model complexity; Bias-Variance Tradeoff; Grid Search, Random Search; Evaluation Metrics; Reporting predictive performance

CS-6111 Big Data Analytics

Introduction to Big Data Analytics, Big Data Platforms, Data Store & Processing using Hadoop, Big Data Storage and Analytics, Big Data Analytics ML Algorithms, Recommendation, Clustering, and Classification, Linked Big Data: Graph Computing and Graph Analytics, Graphical Models and Bayesian Networks, Big Data Visualization, Cognitive Mobile Analytics.

CS-6112 Deep Learning

Introduction to Deep learning, Review of Linear classification (Multi-class Support Vector Machines, Soft max) and Regularization, Gradient Descent & Stochastic Gradient Descent (SGD), Back propagation (Intuitions, back propagation, as flow graph), Introduction to Neural Networks (model of a biological neuron, activation functions, neural net architecture, representational power, etc.), Building Neural Networks (data preprocessing, loss functions, weight initialization, regularization, dropout, batch normalization), Learning Neural Networks (Learning and Evaluation gradient checks, sanity checks), Variants of SGD (momentum, Adagrad/RMSprop, ADAM), Introduction to Convolutional

Neural Networks (CNN) and its components (Convolution and Pooling Layers), Convolutional Neural Network case studies (AlexNet/ZFNet/VGGNet), Understanding and Visualizing Convolutional Neural Networks, Convolutional networks for other visual Recognition Tasks (Localization, Detection, Segmentation, etc.), Transfer Learning and Fine-tuning Convolutional Neural Networks, Introduction to Natural Language Processing (NLP), Learning word and sentences embedding (wordvec, glove, sentvec), Introduction to recurrent networks (RNNs, LSTMS, etc.), Applications of Recurrent neural networks to different NLP tasks (e.g. sentiment analysis, parsing, NER tagging, etc.), Introduction to Reinforcement Learning and QLearning, Deep Q-Networks (DQN) and Game playing using DQN, Introduction to Policy gradients and their applications.,

CS-6113 Tools and Techniques in Data science:

Introduction to Data Science, Data Science Life cycle & Process (Asking Right Questions, Obtaining Data, Understanding Data, Building Predictive Models, Generating Visualizations) For Building Data Products, Introduction to Data (Types of Data and Datasets), Data Quality (Measurement and Data Collection Issues), Data pre-processing Stages (Aggregation, Sampling, Dimensionality Reduction, Feature subset selection, Feature creation etc.), Algebraic & Probabilistic View of Data, Introduction to Python Data Science Stack (Python, Numpy, Pandas, Matplotlib), Relational Algebra & SQL, Scraping & Data Wrangling (assessing, structuring, cleaning & munging of data), Basic Descriptive &

Exploratory Data Analysis, Introduction to Text Analysis (Stemming, Lemmatization, Bag of Words, TF-IDF), Introduction to Prediction and Inference (Supervised & Unsupervised) Algorithms, Introduction to Scikit Learn, Bias-Variance Tradeoff, Model Evaluation & Performance Metrics (Accuracy, Contingency Matrix, Precision-Recall, F-1 Score, Lift, etc.), Introduction to Map-Reduce paradigm

CS- 6099 Thesis

The aim of the thesis is to work on research question and its objectives through tools, logic and reasoning. The research must be specific, measurable, realistic, time constrained and target oriented. For accomplishment of thesis goals, department associates supervisor to student for guidance and supervision. Student will be responsible to show case the results, conclusion, future work and to ensure his original contribution. Student will undergo the thesis defense process.

PhD Computer Engineering Courses

CE-7104 Research Methodology

Research design, qualitative and quantitative research, sources of data. Data collection procedures, measurement strategies, questionnaire design, interviewing techniques, content analysis. Literature surveys; information data bases. Research Ethics, Probability testing, inferential statistics, deductive methods and proofs. The use of computers. Evaluating and writing research reports. Development of a research project.

CE-7105 Wavelet Analysis and Applications

One-and two-dimensional Haar, Daubechies, Mallat wavelets etc., Wavelet Transforms and Fast Wavelet Transforms; Applications (Data compression, Image compression, Edge detection, Network traffics, Nuclear engineering medicine etc.); Multiresolution analysis and wavelets, computation and design of wavelets.

CE-7106 Wireless Sensor Network

Introduction and Overview, Sensor Node Architecture, Sensor-Level Energy Management, Wireless Transmission, Medium Access Arbitration, MAC Protocols for Sensor Networks, Network Bootstrapping and Clustering, Data Routing, Node Positioning/Relocation, Sensor Network Security

CE-7107 Cryptography

An Introduction to Cryptography: Simple Substitution ciphers, Divisibility and Greatest Common Divisors, Modular arithmetic, Prime numbers unique factorization, and finite fields, Powers and Primitive roots in finite fields, Cryptography before the Computer age, Symmetric and asymmetric ciphers, Discrete Logarithms and Diffie–Hellman, The Chinese remainder theorem, The Pohlig–Hellman algorithm, Rings, quotients, polynomials, and finite fields. Integer Factorization and RSA, Combinatorics, Probability, and Information Theory: Basic principles of counting, The Vigenere cipher, Probability theory, Collision

algorithms and meet-in-the-middle attacks, Pollard's ρ method, Information theory, Complexity Theory and P versus NP. Digital Signature: What is a digital Signature? RSA digital signatures, Hash functions, Random numbers and pseudorandom number generators, Zero-knowledge proofs, Secret sharing schemes, Identification schemes, Padding schemes and the random oracle model, Building protocols from cryptographic primitives, Hyper-Elliptic curve cryptography, Quantum computing, Modern symmetric cryptosystems: DES and AES.

CE-7108 Digital Processing of Random Signals

The Structure Of Stationary Processor, Parameter Estimation, Nonparametric Spectrum, Parameter Estimation Theory For Gaussian Processes, Autoregressive Parameter, Moving Average And Arma Parameter Estimation, Adaptive Ar And Aram, High-order Statistical Analysis, Time-frequency Signal Analysis: Linear Transforms, The Short-time Fourier Transform, The Gabber Representation: Elementary Discussion, Thegabor Representation: Advanced Discussion, The Wavelet Transform, Orthonormal Wavelet Bases, Implementation Of Linear Transforms For Discrete-time Signals Time-frequency Signal Analysis: Nonlinear Transforms, The Wigner-ville Distribution, The Ambiguity Function, The Choen Class Of Distributions, High-order Ambiguity Function, Estimation Using The High-order Ambiguity Functions.

CE-7109 Internet of Things

Introduction of the Internet of Things (IoT), main assumptions and perspectives, IoT device architectures, Operating systems

for resource-constrained devices, Wired and wireless communication technologies for IoT, Ad hoc and Sensor networks, Dynamic routing protocols for ad hoc networks, Communication protocols for IoT, Data processing for IoT, Various applications and Industrial case studies of IoT. Data and Knowledge Management and use of Devices in IoT Technology. Big Data and the Internet of Things.

CE-7110 Cloud Computing

Datacenter Architectures, Cloud Stack, Technology Trends, Consistency, Availability, Partitions, Cluster File Systems, Data-flow Com Putation Frameworks, Key-Value Store and Interactive Query Systems, Big Data in the Clouds, Geographic distributed Storage, Programming Languages for the Cloud, Data Bases in the Cloud, InMemory Frameworks, Google file system, Hadoop file system, MapReduce, Cloud networking topologies, Traffic Management, Transport Protocol Improvements, Security, Scheduling and Resource Management in clouds, Software Level Agreements. Cloud Computing Trends & Issues.

CE-7111 Software Defined

Networking Course Outline: fundamentals of software defined networking (SDN) technology and the perspective from different industrial enterprises. API between control plane and data plane of SDN. SDN controller design. SDN abstraction, protocol independent forwarding, composition and trace tree, network update. Various SDN applications

e.g. in traffic engineering and wireless networks, SDN virtualization. SDN fault tolerance and security.

CE-7190 Special Topics in Computer Networks-I

Topics will be chosen based on industry trends and requirements.

CE-7191 Special Topics in Computer Networks-II

Topics will be chosen based on industry trends and requirements.

CE-7205 Intelligent Systems

Topics include elements of AI, searching techniques, language paradigms, knowledge representation, reference techniques, object-oriented techniques, engineering application of intelligent systems using production rules, fuzzy logic networks. Project work required. CE-7206 Decision Support and Expert Systems To study the application of artificial intelligence in building decision support and expert systems for management and other applications. Topics include: fundamentals of artificial intelligence, knowledge representation and knowledge processing, tools for building expert systems and decision support system design.

CE-7295 Case Studies and Projects

Application of the methodologies, tools, and theory of software engineering to produce a specific validated software product. Projects can be faculty generated, self-generated, and/or work related. All projects must be undertaken with one

or more students under the supervision of the instructor. Prior to enrollment, a project proposal must be prepared and approved by the instructor and department chair. Standard software engineering documents must be prepared and approved at each phase of the project, and an oral presentation of the project is required. Course includes lectures and case studies.

CE-8001 Computer Vision

The human eye-brain system as a model for computer vision - Image formation: sampling theorem, Fourier transform and Fourier analysis - Image models - Basic image processing: Sampling and quantization, Brightness and color - Histogram operations, Filters and convolution, Frequency domain processing - Edge detection - Boundary and line extraction - Building machines that see: constraints, robustness, invariance and repeatability - Fundamentals of machine-learning: classification and clustering - Understanding covariance, Eigende composition and PCA - Feature extraction - Interest point detection - Segmentation - 2-D Shape representation - Local features - Image matching - Large-scale image search and feature indexing - Understanding image data and performing classification and recognition - 3D vision systems - Recovering depth from multiple views - Practical examples, including: biometric systems (recognizing people), industrial computer vision, etc.

CE-8002 Optimization Techniques

Introduction to optimisation and optimal decisions. Convexity. Unconstrained optimisation. Constrained optimisation. Management decision formulations. Optimality conditions for constrained problems. Need for unconstrained methods in solving constrained problems, Necessary conditions of unconstrained optimization, Structure methods, Quadratic models, Methods of line search, Steepest descent method, Quasi-Newton methods: DFP, BFGS, Conjugate-direction methods:, Methods for sums of squares and nonlinear equations. Linear Programming: Simplex Methods, Duality ii LPP, Transportation problem. Nonlinear programming: Lagrange Multiplier, KKT conditions, Convex programming.

CE-8003 Intelligent Data Analysis and Probabilistic Inference

Probabilistic methods for modelling data and making inferences from it. Bayes' Theorem and Bayesian inference and networks. Bayesian Decision Trees. Evidence and message passing. Probabilitypropagation and inference in singly connected networks, generating networks from data, and calculating the network accuracy considering highly dependent data and special techniques for exact and approximate inference in these cases. Exact Inference. Data modelling using probability theory and distributions. Gaussian processes for solving regression problems. Probability propagation in Join Trees. Approximate inference techniques including various sampling techniques and variational inference.

CE-8004 Advanced Computer Systems Analysis

This course covers techniques for analysis and comparison of computer systems using measurement, simulation, and queueing models. Common mistakes and how to avoid them, selection of techniques and metrics, art of data presentation, summarizing measured data, comparing systems using sample data. Experimental designs and fractional factorial designs. Simulation, common mistakes in simulations, analysis of simulation results, random number generation, random variate generation, commonly used distributions. Queueing theory, single queues, and queueing networks. Students do a project involving application of these techniques to a problem of their interest.

CE-8090 Advanced Topics in Computer Engineering-I

Selected research topics in computer engineering. Emphasis is on new results or technical publication and emerging areas.

CE-8091 Advanced Topics in Computer Engineering -II

Selected research topics in computer engineering. Emphasis is on new results or technical publication and emerging areas. CE-8099 PhD Thesis The PhD thesis is a report of theoretical or laboratory/practical work, suitable for publication, preferably presented also in HEC approved journals/international conferences of repute out of which at least one research paper must be published in an ISI indexed journal (with impact factor) in relevant area as specified by post graduate committee. The University will appoint a PhD Thesis Supervisor (and co-supervisor wherever deemed

necessary) for research purpose. The student will choose a suitable topic with the approval of the Supervisor who will guide, supervise and monitor the student's progress and suggest reading material.

Electronic Engineering Courses

EE-6102 Industrial Control Systems

Review of Control system, Architecture of Industrial Automation / Control Systems, PLC (Programmable Logic Controllers): architecture, real-time control I/O layout, I/O types, inter-processor communications, programming. Industrial applications, interlocking, safety, risks, justification. Loop tuning, communications applications, Operator Interfaces, simple operators, terminals, Measurement Systems Characteristics, Data Acquisition Systems, Introduction to Automatic Control, P-I-D Controller and its tuning, feed forward Control Ratio Control, Time Delay Systems and Inverse Response Systems, Special Control Structures, HMI (Human Machine Interfaces) package software, business system connectivity (SQL), data structures.

EE-6103 Advanced Digital Electronics and Interfacing Techniques

Advanced Digital Concepts, Logic Families and their Applications. Internal Structure of Logic Families, Complex Digital Circuits, Synchronous Logic, A/D and D/A Conversion, timing diagrams, computer bus systems, programmable logic devices (PLD), and complex circuit debugging using a Logic Analyzer. Standard logic interfacing, Circuit Design Fundamentals for Microprocessors and Microcontroller based Systems, Different Man-machine Interfacing

Techniques. High-level digital design methodology using VHDL/Verilog, Design, Implementation, and Verification. Transformation for high speed using pipelining, retiming, and parallel processing. Fully Parallel Architecture, Time shared Architecture, State Machine Design, FPGA-based design and logic synthesis. Introduction to High Speed Digital Design and Signal Integrity.

EE-6104 Electronic Design Automation

Introduction Digital design flow. Verilog: introduction and use in synthesis, modeling combinational and sequential logic, writing test benches. Logic synthesis: multilevel gate level optimization tools, basic concepts of high-level synthesis – partitioning, scheduling, allocation and binding. Testability issues: fault modeling and simulation, test generation, design for testability, built-in self-test. Testing SoC's. Basic Concepts of verification. Physical design automation. Review of MOS/CMOS. Fabrication technology. VLSI design styles: fullcustom. Standard-cell, gate-array and FPGA. Physical design automation algorithms: floor-planning, placement, routing, compaction, clock and power routing, etc.

EE-6105 Measurement and Calibration of Electronic Systems

Introduction to Instrumentation for Test and Measurement: Systems approach. Standardization and Traceability. Characteristics of Dynamic Measurements: Types of Dynamic data, Periodic, transient and non-periodic (random). Accuracy, Calibration and Error Assessment. Measurement Systems and

Instrumentation Electronics: Amplifies and signal conditioners, Avoiding unwanted signals, System Considerations; amplifier to transducer matching, Integrating, differentiating and filters. Digital signal Processing: Generating and processing digital data, Digital analytical techniques, and Recording and readout devices. Data Acquisition and Measurement Environment.

EE-6106 Intelligent Measurements and Instrumentation

Analog and digital instrumentation principles, analog instrumentation blocks, microprocessor concepts, digital instrumentation blocks, bus communications, telemetry systems, instrument systems setups, interference reduction, configuration, selection, installation and application.

EE-6107 Advanced Power Electronics

Introduction. Power Semi-conductor devices and commutation circuits. Thyristor, Power MOSFET, Power IGBT and their characteristics and other Thyristors. Snubber circuit, Line Commutation and Forced Commutation circuits. Single Phase controlled Three phase converters, power factor improvement techniques used in converters, Harmonic reduction techniques used in inverters, Buck and Boost dc to dc converters, three-phase ac regulator, Cyclo-converters and Multi-level inverters and their applications. Space Vector Switching of inverters. Chopper circuits and its applications. AC and DC Drives. Grid interface of renewable energy resources Power converters and control for

interfacing solar and wind energy. Soft switching and Concept of ZVS and ZCS Zero voltage transition converters. Resonant converters and applications.

EE-6108 Sensors and Systems

Review of system .(Discrete and continuous time systems, memory and memory less systems, analysis of linear time invariant and time variant systems)Introduction to different types sensors and systems. The methods of sensing systems, physical principles of sensors operations, practical design of sensors in various systems and interfaces, (It covers design and selection of best suited sensors for a specified problem, regarding sensor range, sensitivity, accuracy, repeatability). Sensors characteristics, analysis of performance and the required signal processing for corresponding system.

EE-6109 Robotics and its Application of Industrial Electronics

Evolution of Robots and Introductory aspects of Robotics, Homogeneous Transforms, Robot arm kinematics, Robot configurations, Inverse Kinematics, Robot Dynamics, Robot Autonomy, Mobility, Manipulation, Sensing, Control and Navigation, Work-space considerations and planning, obstacle Avoidance, Robot Algorithms and Program Design, Advanced Robotics Example and case studies.

EE-6110 Selected Topics in Industrial Electronics

Topics to be selected from emerging technologies and trends in the field of Electronic Engineering. Contents vary from year-to-year according to student and instructor in-charge interest.

EE-6113 Fuzzy Logic and Intelligent Electronic Control Systems

Introduction to Fuzzy logic, Fuzzy logic sets and systems, Fuzzy modeling, control and decision making, Supervised learning and neural networks, back propagation, radial-base functions, associativememory and pattern recognition, self-organization systems, neurofuzzy logic controllers, neuro-fuzzy logic, hybrid controllers, applications, implementation.

EE-6114 Solid State Drives

Variable speed drive systems, Separately excited and series DC motor single phase drives, power factor improvement. Three phase drives, Semi Converter, Full Converter, Series connected and dual converter drives. Reversible drives. DC Chopper drives. Dynamic and regenerative braking. Closed loop control, Phase locked Loop control and Microprocessor control. Review of three phase induction motor speed control, Speed control by Slip-Energy Recovery schemes, Induction motor with voltage source inverters, Induction motor with current source inverters, Synchronous motor drives. Stepper motor drives. Cyclo-converter controlled AC drives. Brushless synchronous machines.

EE-6115 FPGA Based Systems

This course introduces fundamentals and circuit architectures of field programmable gate arrays (FPGAs), design tools supporting FPGA-based system designs, and their applications in reconfigurable computing. Students will gain hands-on experience of designing system with FPGAs, and learn the basics of design tools targeted for FPGA based designs. The applications of FPGAs in various custom computing environments will also be examined.

EE-7116 Digital Image Processing and its applications

Image sampling and quantization, point operations, segmentation, morphological image processing, linear image filtering and correlation, image transforms, Eigen images, multi-resolution image processing, noise reduction and restoration, feature extraction and recognition tasks, image registration. Image processing in frequency domain, color image processing, image compression and its different techniques, discrete cosine transform and wavelet transform for image processing. Algorithms implementation and investigation in MATLAB.

EE-7118 Artificial Intelligence & Advanced Neural Networks

Overview of Artificial and biological neural networks, Artificial intelligence and neural networks, Introduction of learning system, supervised and unsupervised learning. Neuron Model and Network Architectures, Perceptron Learning Rule, Single and multilayer perceptron, radial-basis function networks, Backpropagation, Interpolation, Regularization, Learning strategies, Classification model. Recurrent Neural networks

KNN, Decision Tree and K-mean clustering , Support Vector Machine, Concept of Convolutional Neural network(CNN), Deep Learning and applications related to control system and Image Processing.

EE-7119 Machine Learning

Introduction, Classification, learning and training. Concept learning as search through a hypothesis space. Learning conjunctive concepts, Entropy and information gain. Overfitting, noisy data, and pruning. Ensemble Learning: Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing rules. Learning recursive rules. Hidden Markov models (HMM's). Viterbi algorithm for determining most-probable state sequences Bayesian Learning. Generative vs. discriminative training. Bayes nets and Markov nets for representing dependencies. K- Nearest-neighbor algorithm. Clustering and Unsupervised learning. . K-means partitional clustering. Semi-supervised learning with EM using labeled and unlabeled data. Artificial Neural Networks, Linear threshold units. Gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Support Vector Machines, Maximum margin linear separators. Kernels for learning non-linear functions.

EE-7101 Research Methodology

Research Methodology is a hands-on course designed to impart education in the foundational methods and techniques of academic research in Electronic Engineering. Research scholars would examine and be practically exposed to the main components of a research framework i.e., problem definition, research design, data collection, ethical issues in research, report writing, and presentation. Once equipped with this knowledge, participants would be well-placed to conduct disciplined research under supervision in an area of their choosing. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments.

EE-7112 Design of Industrial Control Systems

Analog and digital control system design. Analog controller design methods: lead and lag compensators, pole placement, model matching, two-parameter configuration, plant input/output feedback configuration. Introduction to state-space control system. State estimator and state feedback. Introduction to digital control system. Ztransform. Difference equations. Stability in the Z-domain. Digital implementation of analog controllers. Equivalent digital plant method. Alias signals. Selection of sampling time. PID controller. Project on specific topic or applications.

EE-7103 Mechatronics

Introduction to mechatronics; basic elements of mechatronic systems. Measurement systems: including principles of

measurement systems; sensors and transducers; signal conditioning processes and circuits; filters and data acquisition. Actuation systems: mechanical actuation systems and electrical actuation systems. Controllers: control modes; PID controller; performance measures; introduction to digital controllers and robust control. Modeling and analysis of mechatronic systems; performance measures; frequency response; transient response analysis; stability analysis.

EE-7104 Dynamics and Controls of Nonholonomic Systems

Kinematics of nonholonomic systems; dynamics of nonholonomic systems. Euler-Lagrange equations; equations of motion of nonholonomic systems with Lagrangian multipliers; the reaction of ideal nonholonomic constraints; nonholonomic Caplygin systems; Bifurcation and stability analysis of the nonholonomic systems. Analysis and design of nonlinear control of nonholonomic systems, including kinematic control and dynamic control as well as force control. Controller designs with uncertain nonholonomic systems. Application examples including control of wheeled mobile robots and walking robots. A project.

EE-7105 Embedded System Modeling

Fundamental issues and state-of-the-art methods, tools and techniques for system-level design of heterogeneous multi-core embedded systems. Modeling at different levels, from abstract specification down to implementation across hardware-software boundaries. Embedded system

specification using system-level design languages, SystemC and SpecC. Application modelling and analysis. Embedded multi-core platforms. Transaction-level platform modelling. Processor and RTOS modeling. Communication architecture modelling.

EE-7106 Advance Engineering Mathematics

A Brief Review, Numerical Solutions of Equations and Interpolation, Ordinary differential equations, The Laplace transformation, Fourier Methods, Linear Algebra, Systems of Ordinary Differential Equations, Partial Differentiation, Partial differential equations, Numerical Solutions of Partial Differential Equations, Integral Functions.

EE-7107 Linear System Theory

Theory Review of linear algebra, state space representations. State transition matrix, linear time varying systems. Controllability, observability, stability, stabilizable, minimal realizations. Synthesis of linear controllers, pole placement, state feedback, observer design.

EE-7108 Adaptive Systems

Introduction: scope and objectives of the course, overview of issues in adaptive filtering, survey of a few applications. Random processes and signal modelling: discrete-time random processes, correlation and power spectrum, models: linear processes, harmonic processes, AR, MA, ARMA processes. Wiener filters and linear prediction: optimal linear filtering,

forward and backward prediction, Levinson-Durbin algorithm. LMS adaptive filtering: method of steepest descent, LMS algorithm, stability and performance analysis. Method of least squares: least-squares solution, properties, singular value decomposition and pseudo-inverse, recursive least-squares method.

EE-7109 Advance Digital Signal Processing

Digital processing of continuous-time signals, Sampling and sampling theorem, Quantization, A/D and D/A conversion, DFT and FFT, Windowing, FFT structure, Digital filters, FIR-filters: Structures, linear phase filters, least-squares frequency domain design, IIR-filters: Structures, classical analog lowpass filter, approximations, conversion to digital transfer functions, Multirate digital signal processing

EE-7110 Stochastic Processes

Probability and random variables, characteristic functions, transformation of random variables, sequences of random variables, linear mean squared estimation, stationary estimation, stationary random process, correlation functions power spectrum output of linear systems with stochastic input, Gaussian process. Markov chains, state classification, kolmogorov equations, applications to Probabilistic finite state machines, Birth death process, applications to queuing theory, buffer problems and the design of communication nets.

EE-7102 Simulation, Modelling and Optimization

In this course the students will study the constituents of the simulation and modelling methods of the physical systems using mathematical formulations. During the course, mathematical modeling will be described as a research and development tool. Recent engineering and development software uses a number of modelling techniques. Once the models are developed, the validation of the developed design is highly needed. With the techniques, student can use them to predict the behavior of the real world engineering system designs. The course will cover Modeling & simulation development process, Numerical and mathematical modelling, Introduction to MATLAB simulation tools, Managing Simulation Development, Classical Optimization Theory, Design of Experiments – Analysis of Variance (ANOVA), Response Surface Methods (RSM) and Verification and validation in systems engineering

EE-8103 Computer Vision & Pattern Recognition

Classification theory in terms of Bayesian costs, decision functions and the geometry of decision regions for continuous and discrete random variables, classification error probabilities and bounds, Maximum-Likelihood and Bayesian parameter estimation, Non parametric recognition, Parzen window operation, K-nearest neighbor classifier, decision trees, Algorithm independent machine learning, re sampling for estimating statistics and accuracy, mixture densities and identifiability, K-means clustering, unsupervised Bayesian learning, decision-directed approximation, hierarchical

clustering, minimum spanning trees, Applications to computer vision problems of estimation and recognition.

EE-8104 Advanced Adaptive Control Systems

Overview of Adaptive Control Systems, advanced tools for stability of non-autonomous nonlinear systems, Stability of prototypical adaptive control systems, Adaptive observers for linear systems, Model reference control, Model reference adaptive control, Adaptive controllers for nonlinear systems, Robust redesign of adaptive control systems, Robustness of adaptive systems, Dead-zone and projection-based techniques, system identification of adaptive control systems, Model Free Adaptive Control.

EE-8105 Non-Linear Control Systems

Linear, non-Linear system theory, classification of control systems, linear system and its properties, LTI systems, modeling of systems, norms, inner-product, norm of linear operator, linear operators, rank, null-space, orthogonal complement, Eigen vector, controllability & observability of system, controllable canonical form, observable canonical form, Jordan canonical form, Jacobian linearization and gain scheduling, introduction to feedback linearization and extensions of optimal control techniques, state feedback estimator, techniques for the stability analysis of nonlinear and time-varying systems, internal stability of feedback systems, Lyapunov and MIT stability theorems.

EE-8106 Special Topics in Electronic Engineering – I

Topics will be chosen based on latest electronic engineering topics for research.

EE-8107 Special Topics in Electronic Engineering – II

Topics will be chosen based on latest electronic engineering topics for research.

Telecommunication Engineering Courses

TE-6140: Advanced Communication Systems

Principles of signal time discretization, amplitude quantization. Communication system as a signal vector space, Gram-Schmidt orthogonalization. Matched filter receiver, principles of digital signal detection and probability of bit/symbol error. Inter-symbol interference (ISI), Nyquist criteria for ISI free transmission. Equalization, linear equalizer, decision feedback equalizer. Adaptive equalization, LMS algorithm, RLS adaptive algorithm. Modulation schemes BPSK, FSK, QPSK, MSK. Probability of bit error and spectral properties of mentioned modulations. CDMA and spread spectrum principle.

TE-6141: Data Networks

Medium Access Control and Resource Management for broadband wireless and wireline networks and its performance analysis: requirements of emerging 5G communication networks, Medium Access Control (MAC), (wireless) contention, Aloha, slotted aloha, CSMA (WLAN, Ethernet), resource partitioning, polling, cellular network resource management: from TDMA to OFDMA, scheduling, cellular principle, architecture, protocols (HSPA, LTE, LTE-A), packet switching, label switching (MPLS), Software Defined Networking (SDN) and OpenFlow, Dependability.

TE-6142: Advanced Information Theory and Coding:

Introduction to how to Measure, represent, and communicate information effectively. Digitization universal currency for information exchange, influence of information theory on the design and operation of modern-day systems such as smartphones and the Internet, the role of entropy and mutual information in data compression, communication, and inference, compressors and error correcting codes, source coding, error-detecting and error-correcting channel coding and decoding. The information theory relation and applications to probability, statistics, machine learning, and artificial neural networks, quantum information, and blockchains.

TE-6143: Stochastic processes

Introduce to probability, random variables and random signals (or stochastic processes), notions of conditional probabilities and expectations, random phenomena, the modeling of signals and noise namely the notions of

independence, normality etc. Central Limit Theorem, Laws of Large Numbers and convergence concepts. signal models especially the so-called theory of wide sense stationary processes. introduction to Markov chains.

TE-6144: Wireless and Mobile Networks

Introduction to architecture and protocols of typical communications networks, flow control, congestion control, error control, routing algorithms, delay modelling, multiple-access principles, basic queueing theory, introduction to cellular wireless communications systems, techniques and basic principles of wireless LANs, wireless ad-hoc networks, wireless sensor networks, etc., communication security and communication security techniques

TE-6145: Advanced Wireless Communications Networks and Systems

Fundamentals of mobile wireless channels, limitations of mobile channels imposed on communication systems, architectures of mobile communications and recent standard mobile systems such as the fifth generation (5G) system, working of future generation of wireless systems, advanced modulation and transmission techniques, and practical channel coding schemes, analyzation of practical wireless systems, and current as well as future wireless network protocols

TE-6146: Emerging Wireless Techniques

Introduction to Multiple-input multiple-output (MIMO) and the related techniques for its implementation, principles of MIMO and its potential through the capacity analysis of MIMO systems, Multiuser MIMO and massive MIMO, relay communications and the typical relay techniques, characteristics of milli-meter wave (MmWave) channels, MIMO transceiver optimization, principles and technical challenges of full-duplex, and employ the capability to exploit the potentials of full-duplex for system design, non-orthogonal multiple-access (NOMA) scheme for ultra-densely deployed wireless systems, multicell cooperation and cooperative MIMO, ultrawideband (UWB) communications, design of UWB systems, optional techniques for MmWave transceiver design.

TE-6147: Optical Communications Systems

Optical fiber and photonic components, Optical fibers – basic characteristics and mode of operation, types (single-mode, multimode, multicore), signal degradation (attenuation, dispersion), Passive optical components, Semiconductor optical sources – LEDs, laser diodes, Optical amplifiers – erbium-doped fiber amplifiers, Photodiodes – PIN and avalanche photodiodes, noise mechanisms, Optical communication systems, Design of simple point-to-point links – link power budget and rise-time budget, Detection of analogue/digital signals in the presence of noise; relationship between SNR and BER, SNR of PIN and avalanche photodetectors, Quantum-limited photo-detection, Coherent optical communications, Wavelength division multiplexing, Passive Optical Networks (PON): Definition, Architecture of

PON, Data Transmission, Types of PON (GPON, EPON, APON & BPON)

TE-6148: Satellite Communication

Introduction to satellite communication, historical perspective, orbital mechanics, constellations, choice of orbital parameters, propagation considerations, link budgets, interference issues and other obstacles, existing and proposed mobile satellite systems. business aspects such as the cost of deploying and maintaining systems. Radio based determination of position, time and velocity Satellite Orbits and Constellations Navigation Services and Signals (Modulation and Codes) Receivers: Signal Acquisition and Tracking Propagation: Multipath, Ionosphere and Troposphere Measures of Accuracy GNSS Systems: Time – Relativistic Corrections; and Terrestrial Reference System

TE-6149: Multi-User Information Theory

Source Coding; Rate-Distortion and Multiple Descriptions; Capacity-Cost; The Slepian-Wolf Problem, or Distributed Source Coding; The Wineries Problem, or Rate-Distortion with Side Information; The Gelfand-Pinsker Problem, or Coding for Channels with State; The Broadcast Channel; The Multiaccess Channel; The Relay Channel; The Multiple Relay Channel; The Multiaccess Channel with Generalized Feedback; Interference Channels; Network Flows; Network Coding; Multicast for Networks with Broadcast and Erasures

TE-6150: Network Planning

Introduction: Motivation, Range of Tasks, Application Areas, Classification, Planning Process, Traffic Engineering Related Optimization Fundamentals:

Mathematical Formulation, Categories, Solution Methods (principles of exact and heuristic methods), Traffic and Demand Modeling: Traffic Types, Modeling, Forecasting Network Topology Design: Initial Planning, Extension Planning, Site Selection Network Dimensioning: Approaches for Circuit and Packet Switched Networks, Optimization Problems, Representative Heuristics Resilience Planning: Redundancy Concepts, Disjointness, Resource Sharing Generalizations: Multilayer Planning, Multiperiod Planning Access Networks

Planning: Overview, Selected Problems Mobile Networks Planning: Overview (delineation with Resource Management in Wireless Networks course Post- Planning Analysis: Network Simulation, Availability Analysis In Practice: Network

Planning Tools, Economics Aspects

TE-6151: Antennas and Wave Propagation

Antenna basics: Far-field and circuit properties; Wave propagation: deterministic and empirical methods based on far-field considerations, ray-tracing including reflections and diffractions; Electromagnetic concepts: Maxwell equations, Radiation from sources, Huygens' and reciprocity principles; Utilization of electromagnetic concepts and numerical methods for analysis and design of antennas; Hertzian and Fitzgerald dipoles, wire antennas, aperture antennas, printed antennas, ultra-wideband antennas, antenna arrays, leaky-wave antennas; Antenna applications;

TE-6152: Security in Communications and Storage

Motivation and practical need for secure systems, Short overview of classical cryptography: symmetric and public, key cryptography, Short introduction to linear error, correcting codes: generator and parity, check matrix, dual code, minimum distance, MDS codes, Post-quantum cryptography: threat of a quantum computer, code-based cryptography (McEliece & Niederreiter schemes, attacks), latticebased cryptography, Authentication, Distributed data storage: choice of parameters, regenerating codes, locally repairable codes, bounds, Basics of information theory: entropy, mutual information, Secure distributed data storage, Private information retrieval: basic idea (security vs anonymity vs privacy as concepts), toy schemes for 1-3 servers; computational vs. information-theoretic PIR; review of communication complexity results, Private information retrieval over coded databases: PIR rate and capacity results

TE-6153: Techno-Economic Analysis of Telecommunication Networks

Value analysis studies are an integral part of every strategic marketing and business plan related with new products and services in the ICT industry. They are commonly used to compare important parameters such as capital and operational expenditures (CapEX, OpEx), life cycle costs, revenue streams, discounted cash flows, and techno economic evaluation⁵¹ measures such as the net present value (NPV) and the internal

rate of return (IRR). Such studies offer a measurable output and can be used to support the decision-making process related with the business or the market that a company should be in, the potential of certain technology solutions, or, the future of internal R&D projects, etc. A good modelling of the network operational process is necessary to identify the key costs factors and find ways to reduce cost and increase benefits. A process modeling tool will be presented in detailed and will be used by the students to perform studies.

TE-6154: Communication Network Reliability

Introduction to network reliability and main concepts and parameters. Mathematical models (including failure and repair models). Basic span- and pathrestoration techniques. Logical network design. Operational aspects of real-time restoration and self-organizing pre-planning against failures. Restoration in IP networks. Techniques for mesh-restorable networks. p-Cycles. Dual-failure restorability and availability in mesh networks.

TE-6155: Network Management

This course complements courses in Switching Systems, and Computer Networks and gives students an understanding of the concepts of network and content management. It introduces concepts that are used in the management modern communication networks by examining SNMP in detail. Then it introduces the concepts that are used for management of mobility in these networks. Finally, it examines the concepts of content management by examining the

fundamental concepts of caching, and the emerging technologies associated with content distribution networks.

TE-7116: Cyber Security

Cyber security Fundamentals, Types of Malware, Cyber Security Breaches, Types of Cyber Attacks, Prevention Tips, Mobile Protection, Social Network Security, Prevention Software, Critical Cyber Threats, Defense Against Hackers.

TE-7117: Internet of Things (IoT)

What is IoT is and how it works, contributing factors to the emergence of IoT, design and program IoT of devices, IoT protocols for communication, Security in IoT devices, IoT device and Cloud Computing infrastructure, transfer IoT data to the cloud and in between cloud providers, infrastructure for supporting IoT deployments

TE-7118: System Design for the Internet of Things

Introduction to embedded and cyber-physical systems and the IoT; application scenarios for IoT; wireless sensor networks and IoT; design and modeling of embedded platforms; sensors, actuators and computation/control; processing of large data sets; energy supply and constraints; architectures of distributed systems; Internet principles; communication frameworks and protocols; consumer-producer and publisher-subscriber communication patterns; safety, information security and privacy concepts; software design patterns for dependable systems; system simulation and validation; application examples, among others, from the smart energy, smart⁵²manufacturing and automotive

domains.

TE-7119: Simulation of Mobile Communications

Simulation and modeling basics, Wireless Communication block diagram, Analogue and digital modulation, Constellation diagram, Eye diagram, Spectral analysis, Baseband simulation, Bit Error Ratio computation, Monte Carlo simulation, Equalization, Carrier simulation

TE-7120: Artificial Intelligence

Major principles and techniques of artificial intelligence, in-depth studies of core issues such as knowledge representation and problem identification, formulation, and solving; models of logic, predicate calculus, production-rules, semantic networks, symbolic and sub-symbolic representations), problem solving (search theorem-proving, reasoning), and knowledge-based systems (expert systems, natural language processing, vision, planning).

TE-7121: MIMO Systems

Linear and non-linear algorithms for baseband signal processing in multiple input multiple output (MIMO) communication systems (point-to-point, multiple access, and broadcast setup). For point-to-point communication: - capacity for error-free knowledge about the channel state at the transmitter- waterfilling- diagonalization of the MIMO channel- capacity for statistical channel knowledge of the transmitter rate bounds for erroneous channel state knowledge at the receiver For multiple access channels: - capacity region via successive interference cancellation iterative waterfilling-

maximum likelihood detection (MLD, sphere decoder)- decision feedback equalization (DFE, optimization of detection order, V-BLAST), linear equalization For broadcast channels: - sum rate capacity via dirty paper coding- capacity region, vector precoding (VP)- Tomlinson-Harashima precoding (THP, optimization of precoding order)- linear precoding.

TE-7122: Nano-Systems

Semiconducting nanodevices. Nanofabrication. Spray coating techniques. Film functionalization. CMOS-based nano-systems. Hybrid systems. Autonomous systems. Sensors (gas, temperature, gas, bio). Energy harvesting. Through the projects, the students will work on a special nano-project. Design, fabrication and characterization of autonomous sensors network based on carbon nanotubes and graphene films.

TE-7123: Navigation Using the Global Positioning System

Theoretical and practical foundation of the Global Positioning System (GPS), navigational information such as user position and velocity, satellite orbits, control, space, and user segments, signal structure, measurements, least-squares solution position and clock errors, error sources, dilution of precision availability, differential GPS, modernization, and Global Navigation Satellite Systems.

TE-7124: Software Defined Networks

Introduction to SDN, Centralized and distributed control planes, Splitting control and data planes, Traditional mechanisms for control and configuration of network nodes, Need for network programming, Introduction to OpenFlow, Architecture of OpenFlow Protocol, Applications and scenarios for the use of

OpenFlow, Architecture of OpenFlow Controllers, Overview of different OpenFlow Controllers and frameworks, Testing of Virtual Infrastructures, Related programming interfaces and utilities, Network Hypervisors, Other SDN protocols, Relevant Standardization efforts. IETF. ONF.

TE-7125: Machine Learning

Introduction to machine learning, Modelling: Probabilistic models, Graphical models, Neural networks, Bayesian Inference: Probabilistic programming, learning algorithms, learning algorithms for sources, compression, learning algorithms for channels and transmission formats, Assessment: figures of merit compression ratio, reliability, throughput, energy consumption, evaluation of model and learning algorithm using information-theoretic criteria, introduction to Deep Learning.

TE-7126: Machine Learning for Wireless Communications

Fundamentals of Machine learning, application of machine learning in the design of physical layer techniques for wireless communications, application of machine learning in network design, mathematical principles of probability, linear algebra and optimizations, fundamental principles for regression and classification, design and optimization of intelligent mobile networks by applying the principles of machine learning.

TE-7127: Advanced Electromagnetic Waves

Review of plane wave propagation in unbound media, reflection and transmission of waves at planar interfaces, Maxwell's equations to the homogeneous vector wave

equation, wave equation in rectangular, cylindrical and spherical coordinates, boundary value problems such as rectangular and circular waveguides and cavities, the spherical cavity, and scattering by cylinders and spheres. construction of Green's functions for boundary value problems involving the inhomogeneous scalar wave equation.

TE-7128: System-on-Chip Technologies

Microprocessors, memories and interconnects, the microarchitectural structure and building blocks of processors elements (RISC cores), on-/off-chip memory technology (SRAM, DRAM, Flash), bus and point-to-point interconnect standards (Processor Local Bus, Advanced Microcontroller Bus Architecture, FIFO) as well as the design of communications specific arithmetic blocks (adder, multipliers, shift and comparators) will be introduced and analyzed. implementation methods for SoCs, such as FPGA, standard cell and full custom design, and methods for low power design, for the development of SoCs in embedded systems.

TE-7129: Advanced Methods in Cryptography

Introduction of modern cryptography, analytical methods and concepts in modern cryptography, influence of modern cryptography in the design and implementation of cryptosystems, Cryptanalytical algorithms, security models, cryptanalysis, implementations attack and advanced functionalities such as computing on encrypted data, cryptocurrencies and post-quantum cryptography.

TE-7130: Adaptive Signal Processing

Introduction to Learning, Review and background, Probability and Random Processes, Linear Algebra, The Linear Model and Hoeffdings Inequality; Error and Noise; Training versus Testing; The Theory of Generalization; the VC Dimension and the Bias-Variance Tradeoff, Optimum Filtering, the normal equations and the Wiener filter, Linear prediction, the discrete Kalman filter, Particle Filters, Gradient-based adaptive filters, Steepest descent, the LMS algorithm, Recursive Least Squares (RLS), Adaptive IIR filters, Neural networks, the perceptron, multilayer perceptron, Backpropagation algorithm, Overfitting Regularization, and Validation, Support Vector Machines and Kernel Methods, Radial Basis Functions

Software Engineering Courses

SE – 6099 MS Thesis

The thesis is a report of theoretical or laboratory/practical work, suitable for publication. The Department will appoint an MS Thesis Supervisor for this purpose. The student will choose a suitable topic with the approval of his Supervisor who will guide and monitor his/her progress, and suggest reading material.

SE – 6101 Advanced Requirements Engineering

Software Requirement Fundamentals: Product and process requirements, Functional and non-functional requirements, Emergent properties, Quantifiable requirements, System and software requirements.

Requirements Process: Process models, Process actors, Process support and management. Requirements Analysis: Requirements sources, Elicitation techniques. Requirements Analysis: Requirements classification, Conceptual modeling, Requirements negotiation, Formal analysis. Requirements Specification: System definition document, System requirements document, Software requirements specification. Requirements Validation: Requirements reviews, Prototyping, Model validation, Acceptance tests. Practical Considerations: Iterative nature of the requirements process, Change management, Requirements attributes, Requirements tracing, Measuring requirements. Software Requirements Tools. Current research topics in requirement engineering.

SE – 6102 Advanced Software System Architecture

The fundamentals of software architecture. Principles and guidelines for software architecture design, architectural styles, patterns and frameworks. Quality attributes along with qualitative and quantitative assessment of architectures. Architectural modeling through Architecture Description Languages. System modeling and its relation to software architecting. Architecting for evolution and variability. Partitioned and layered architectures. System-of-Systems and Ultra-Large Scale Systems. Software Product Lines and Configurable Software. Self-Adaptive Software. Architectural Description Languages. Feature Modeling. Future challenges and emerging trends in software architecture discipline.

SE – 6103 Advanced Software Quality Assurance

Foundation of Software Quality Assurance, Total Quality Management, Software Quality Lessons, Standardization of Software Quality Assurance, Costing of Quality Assurance, Up-Front Quality Technique, Software Configuration Management, Software Capability and Maturity Model, CASE Tools, Software Quality Assurance Metrics, Practical Applications of SQA, Software Reliability Management. Testing techniques. Black Box testing, White Box and Grey Box testing techniques. Quality Assurance planning and execution. Automated testing topics include constructing a framework, scripting techniques, generating a test data, generating test architecture, pre/post-processing, test

maintenance, and job specific metrics. Current issues in Software Quality Assurance.

SE – 6111 Software Measurement and Metrics

Foundation of quality control and planning needs, Measurement Concepts, Measurement as a support process, Review Metrics Models and Standards. Measurement goals, formulating problem and goal statement, prioritize information needs and objectives, Formalize measurement goals. Specify Measures, identify questions and indicators, Identify data elements, Operational definitions for measures. Specify Data Collection and Storage Procedures. Sources of data and identify the measures to collect and store the measurement data. Specify Analysis Procedures. Potential data analyses. Methods and tools for measuring software. Develop software measurement reporting.

SE – 6112 Software Risk Management

Overview of risk and risk management. Need for risk management. Risk Management paradigm. Identifying and recording software risk. Risk Taxonomy. Tools and methods for identifying and recording risks. Analyzing and classifying risks. Complex project management theory. Software Risk Identification. Software Risk Analysis. Software Risk Planning. Software Risk Monitoring. Software Qualitative Risk Analysis. Quantitative Risk Analysis. Risk management and the SDLC. Risk management in CMM. Other useful tools for successful risk management. Current research topics in Software Risk Management.

SE – 6113 Software Configuration Management

Management of the Software Configuration Management (SCM) Process. Organizational Context for SCM. Constraints and Guidance for the SCM Process. Planning for SCM. Software Configuration Identification. Identifying Items to Be Controlled. Software Configuration Control. Requesting,

Evaluating, and Approving Software Changes. Implementing Software Changes. Deviations and Waivers. Software Configuration Status Accounting, Software Configuration Status Information and Reporting. Software Configuration Audit. Software Release Management and Delivery. Software Configuration Management Tools.

SE – 6114 Agile Software Development Methods

Agile values and principles, Agile development approaches and practices, Agile Software Development Life Cycles, Iterative Development, Incremental Delivery, Agile Architecture, Agile Product Definition, Agile Analysis and Design, Agile Programming, Applying and integrating different agile methods, Agile Software Development Management.

SE – 6121 Advanced Operating Systems

Foundation of operating systems in term of HW/SW classification, architecture of non-conventional operating systems, goals and problems. Introduction to distributed operating systems: goals and problems. Communication in distributed systems: client-server model, remote procedure call, group communication. Synchronization in distributed systems: synchronization of logical and physical clocks, identification of the global state, distributed mutual exclusion, atomic transaction, deadlock management, election algorithms. Process management: process allocation and migration, scheduling algorithms. Distributed shared memory: definition and implementation, memory consistency. Distributed File system: access model, sharing semantics, implementation, data migration and replication, consistency mechanisms. Real-time operating systems: definition, objective and problems. Scheduling in real time operating systems: scheduling of periodic, aperiodic and mixed tasks.

SE – 6122 Advanced Computer Networks

Fundamentals of computer networks and the Internet. Protocol layers and their service models. Application layer services and protocols, Transport layer services and protocols, Quality of Service, reliability, congestion control, Network layer services and protocols, Link layer services and protocols, Wireless

networking, Internet of Things, Software Defined Networking, Modern networking technologies.

SE – 6123 Advanced Database Systems

Foundation of Database Systems and its progression to new database technology with emphasis on object orientation. The focus is mainly on the data modelling aspect. Other aspects handled are, e.g., transaction management, active mechanisms, and heterogeneous database management systems. The course provides a picture of existing database systems and concrete perspectives and is intended for the potential user of new database systems. The course provides students with theoretical knowledge and practical skills in advanced topics in database systems, big data and modern data-intensive systems. The specific topics include indexing methods, query processing and optimization strategies for relational database systems, Object Relational Mapping and Object Database design, distributed database systems, data mining on large databases.

SE – 6124 Intelligent Systems

Foundation of Artificial Intelligence (AI) search, searching techniques, language paradigms, knowledge representation, reference techniques, object-oriented techniques, engineering application of intelligent systems using production rules, fuzzy logic networks, intelligent agents (reinforcement learning, information-theoretic foundations), and bio-inspired computing (neural networks, and evolutionary algorithms). This major provides a solid covering of the whole field of AI.

SE – 7111 Advanced Formal Methods

The course covers the different formal mechanisms for specifying, validating and verifying software systems. Topics include: program verification through Hoare's method and Dijkstra's weakest precondition, formal specification via algebraic specifications and abstract model specifications, including initial specification and refinement towards implementation, integration of formal methods with existing programming languages, and the application for formal methods for requirement analysis, testing, safety analysis and object

oriented approaches. Temporal Specification: reactive systems, syntax and semantics of temporal logic, temporal specification of reactive systems (safety, aliveness, fairness). Model Checking: Generating finite models, Analysis of a simple model checking algorithm. Symbolic model checking. Overview of reduction methods. Spin and Promela. Case study and practical verification of properties. Current research topics based on Formal Methods.

SE – 7112 Component Based Software Engineering

Introduction to Software Component (Component. Definition and Essentials, What is CBSE? Why CBSE? The Anatomy of Components: internals, application interfaces, platform interfaces, middleware, Component Characteristics: Properties of Software Component in CBSE). Basic Concepts in CBSE. Component-Based Software Development (CBSD) Approach. Component Patterns & Abstraction. Challenges of CBSE. Technical Issues and Objectives of Component Based Software Engineering. Reuse Dimensions. Software Components Types: open, closed, COTS, in house. Challenges in Software Reuse. Software Component Specification. Specification Techniques. Specifying the Semantics of Components. Specifying Extra-Functional Properties. Architecting component based systems (Software Architecture Parts, The Roles of Software Architecture, Designing Software Architectures, Architectural Styles, Architecture-Driven Component Development, Components and Component Models, Component Model Implementation, Component Frameworks, Black-Box and White-Box Frameworks, Component Interface Specification). Component Engineering Process: Domain Engineering, Domain Engineering pattern based design. Domain Engineering: Component Repositories, Overview of Existing Component Techniques, Component testing in CBSE. Current research topics in Component Based Software Engineering.

SE – 7113 Advanced Human-Computer Interaction

Foundation of HCI and its progression towards in the Software Industry along its importance of usable and useful software products. Modern theories and techniques used in HCI and to evaluate/develop and deploy software products. How to conduct their own research about aspects of usability and user experience. Advanced concepts of Human Computer Interaction. The

psychology of usable things, Usability Engineering, Prototypes and Usability inspection methods. Usability testing methods. Usability in practice. User Experience (UX). Web Usability. Mobile Usability. Mobile User Experience. Site objectives and user needs. Information architecture. Information and navigation design. Implementation and optimization. Experiments and HCI guidelines. Current research topics in Human-Computer Interaction.

SE – 7114 Advanced Software Project Management

Overview of software project management, Life cycle view of organizing and managing software projects, including project selection, planning, and execution. Methods for managing and controlling project costs, schedules, and scope. Resource Management. Project tracking and Control. Quality Management. Project Communications Management. Current trends in Software Project Management.

SE – 7121 Advanced Big Data Analytics

To learn the basics of big data tools and techniques and apply that knowledge in the practical environment. Big Data Computing discusses the technical and practical issues related to Big Data in intelligent information management. A wide variety of novel approaches and tools have emerged to tackle the challenges of Big Data, creating both more opportunities and more challenges for professionals in the field of data computation and analysis. Introduces a broad range of Big Data concepts, tools, and techniques to emphasizing the adoption and diffusion of Big Data tools and technologies along with business and economic perspectives across industries.

SE – 7122 Advanced Information Security

This course is an advance level course in Information security that deals with advance topics in Information Security to include theory and practice of cryptographic techniques used in communication security. The topics such as encryption (secret-key and public-key), message integrity, digital signatures, user authentication, key management, cryptographic hashing, Network security protocols (SSL, IPsec), public-key infrastructure, etc will be covered

to students who want to adopt Information Security as a specialization in their career.

SE – 7123 Cloud Computing

Datacentre Architectures, Cloud Stack, Technology Trends, Consistency, Availability, Partitions, Cluster File Systems, Data-flow Computation Frameworks, Key-Value Store and Interactive Query Systems, Big Data in the Clouds, Geographic distributed Storage, Programming Languages for the Cloud, Data Bases in the Cloud, In-Memory Frameworks, Google file system, Hadoop file system, MapReduce, Cloud networking topologies, Traffic Management, Transport Protocol Improvements, Security, Scheduling and Resource Management in clouds, Software Level Agreements. Cloud Computing Trends & Issues.

SE – 7124 Research Methodology

Introduction to Research. Objectives of Research. Importance of Research Methodology in Research Study. Types of Research. Steps in Conducting Research. Literature Review, Types of Literature Review. Problem Statement and Problem formulation. Criteria for selecting a problem. Research Ethics, Probability testing, inferential statistics, deductive methods and proofs. Evaluating and writing research reports. Development of a research project.

CE-7125 Internet of Things

Introduction of the Internet of Things (IoT), main assumptions and perspectives, IoT device architectures, Operating systems for resource-constrained devices, Wired and wireless communication technologies for IoT, Ad hoc and Sensor networks, Dynamic routing protocols for ad hoc networks, Communication protocols for IoT, Data processing for IoT, Various applications and Industrial case studies of IoT. Data and Knowledge Management and use of Devices in IoT Technology.

SE – 7180 Special Topics in Computing

Topics will be chosen based on current trends and requirements.

SE – 7190 Special Topics in Software Engineering

Topics will be chosen based on current trends and requirements.

Electrical Engineering Courses

EL-6101 Advanced Power System Analysis

Load Flow studies, system formulation and modeling techniques of solutions, voltage profile and control, system optimization i.e. generation and voltage control, load frequency control valve model, turbine model, block diagram and the control model, single and two area load frequency control. Symmetrical components, unsymmetrical shunt and faults, sequence impedance of transmission lines, matching machines and transformers, change of symmetry, simultaneous faults, two components method for fault analysis

EL-6102: Renewable Energy and Embedded Power Generation

Power conditioning aspects of major renewable energy technologies including wind, photovoltaic and small hydro. Reasons, extent issues and technical impacts of embedded or dispersed generation. Economic impacts of embedded generation on transmission, distribution and

central generation systems. Embedded generation plants, combined heat and power plants, renewable energy generation small scale hydro-generation, wind power plants, off-shore wind energy, solar photovoltaic generation. Power flow studies of an embedded generation scheme, balanced and unbalanced fault studies as applied to an embedded scheme.

EL-6103: Advance Power System Operation and Control

Economic dispatch of thermal units and methods of solution; transmission losses; unit commitment. Transmission line transients. Control of generation. Active power-frequency and reactive power-voltage control. Automatic generation control. Optimal power flow. Power system protection and reliability of protection system. Power system stability and protection for stability enhancement. Interchange of power and energy. Power system security. Power quality; harmonic generation, monitoring and elimination.

EL-6104: Power System Stability

Steady state and transient stability problems of multi machines interconnected systems, swing equations, point-by-point solution of swing equation. Equal area criterion, one machine and two machine systems, critical fault clearing time. Effect of fault on stability, stability study of typical system

EL-6105: Advance high voltage Engineering)

The course provides advanced knowledge associated with high voltage engineering methods, techniques and equipment. Fundamentals of the failure mechanisms of solid, liquid and gaseous insulation at high voltages. Design principles for high-voltage equipment; of the generation of high direct, alternating and impulse voltages for testing high-voltage equipment; and of methods for monitoring and assessing the condition

of high-voltage equipment such as dissolved gas analysis for oil-filled transformers and partial discharge in cables. Overhead transmission lines, transformer, bushings and switchgear.

EL-6106 Advanced Digital Signal Processing

Review of the discrete signals and systems in temporal and spectral domains, data acquisition, discrete transforms (DFT, DCT and z-transforms), digital filters – IIR and FIR, spectral estimation, adaptive filters, multi rate signal processing, Wavelets and joint time-frequency analysis and real time signal processing.

EL-6107 Power System Reliability

Network and state space methods for reliability evaluation. Component reliability, generating capacity, reserve evaluation and operating reserve evaluation, interconnected systems, bulk power reliability. Area supply reliability, distribution systems reliability, reliability modelling

EL-6108 Computer Methods in Power System Analysis

Network matrix Algorithms for the formulation of network matrices, short circuit studies, solution of simultaneous algebraic equations, load flow studies, numerical solution of differential equation, transient stability study, power system reliability.

EL-6109 Electrical Power Distribution System

Distribution system planning and automation, load characteristics, application of distribution transformation, design of sub transmission lines and distribution substations, voltage drop and power loss calculations. Application of capacitors to distribution system,

Distribution systems voltage regulation, distribution system protection, distribution system reliability.

EL-6110 Electrical Power Transmission System

Intense and rigorous treatment of the constants of HV and EHV lines and cables, mathematical modeling, insulation co-ordination and their effect on insulation during short circuits, travelling waves, optimum loading of facilities, effect of line transients and insulation. HVDC transmission, types of DC links, technical and economic advantages of DC transmission, incorporations of HVDC in to AC systems, converter station equipment, skin effects.

EL-6111 Power System Protection

Protective relaying philosophy and fundamental considerations, transmission lines, rotating machines and transformer protections, relay input sources and their performance, static relays. Basic components of static relays, comparator, basic static relays used in the protective schemes.

Static relays, comparators, components, circuits and power supply circuit for static relays, time relays, voltage relays, directional, over current, differential and distance relays, pilot wire and carrier current schemes.

EL-6112: Smart Grid System (3+0):

Distribution Systems and Smart Grid Applications: A course focusing on distribution system engineering and the smart grid technology applications at the distribution level: advanced communication, metering, demand side management.

EL-6113: Transients in Power Systems (3+0)

Introducing Electrical Transients in power systems Cover the concepts of traveling waves and propagation, Modeling of transmission lines as distributed parameter systems. Discuss issues related to insulation coordination, grounding and limiting of surge effects. Develop techniques related to reflections at transition points in lines and cables. Multi conductor transients and distributed parameter modeling for components and shielding issues.

has to submit the results of his findings in the form of a thesis/report and defend his findings in front of a panel of experts.

EL-6114 Special Topics in Power Engineering

Topics will be chosen based on industry trends and requirements. The topic could also be selected based upon area of specialization of the teaching faculty.

EL-7101 Research Methodology

Research Methodology is a hands-on course designed to impart education in the foundational methods and techniques of academic research in Electrical Engineering. The student would be practically exposed to the main components of a research framework i.e. problem definition, research design, data collection, ethical issues in research, report writing, and presentation.

.EL-6199 MS Thesis

The thesis is a report of theoretical or laboratory/practical work, suitable for publication. The Department will appoint an MS Thesis Supervisor for this purpose. The student will choose a suitable topic with the approval of the Supervisor who will guide, supervise and monitor the student's progress and suggest reading material. He/ She

Mathematics Curriculum

MS-6001 Mathematical Methods

Set theory, Relations on set, Functions, Samples & Selections, Mathematical Induction, Countability of sets, Discrete Sets, Continuum, Elementary Algorithms, Elementary Recursion, Theory of Monoids & Groups, Complex numbers and their representation. Graphs as data structures, graphs and their special instances as trees. Finite State Machine, Infinite Machines, Turing machines & Non-deterministic Machines (NFA). Real analysis and, Elementary Measure Theory, limit points, some examples of sets that have discrete nature and have special distance / difference concepts.

MS-6101 REAL ANALYSIS

Review of real number system: Sequences, subsequences and series. Cauchy sequences. Completeness, convergence of series. Absolute and conditional convergence of series. Uniform convergence, difference between pointwise and uniform convergence of sequences and series of functions, continuity, differentiability, properties of continuous functions, types of discontinuities. Functions of several variables: Limit, continuity, differentiability of functions of severable variables. Taylor's theorem of functions of several variables, maxima and minima of functions of two and three variables. Method of Lagrange multipliers. Implicit functions, Jacobians, functional dependence. The Riemann-Stieltjes (R-S) integral: Properties of R-S integrable functions of bounded variation. Mean value theorems. Convergence of improper integrals, Weierstrass M-test, theorem of improper integrals. Multiple integrals. Line and surface integrals. Theorems of Gauss, Stokes and Green. Differentiation under the integral sign.

MS-6105 COMPLEX ANALYSIS

Definitions, properties of complex numbers, polar form, De-Moivre's theorem and its applications, exponentials, limit, continuity, differentiability, analytical functions Cauchy-Riemann equations, Cauchy's theorem and integral formulae, power series, Taylor's series, Laurent's series, zeros and poles, classification of singularities, residues and Cauchy's residue theorem and its applications, argument principle, theorems of Rouché and Gauss-Lucas, contour integration, analytic continuation, Möbius transformation, Schwarz-Christoffel transformation, iterated functions system, fractals, algorithms to generate Sierpinski Gasket.

MS-6201 ABSTRACT ALGEBRA

Groups and subgroups. Generators and relations. Cyclic groups. Cosets and Lagrange's theorem. Normalizers and centralizers. Centre of a group. Subgroups. Conjugacy classes of groups. Normal subgroups and simple groups. Factor groups. Commutators. Permutation groups and Cayley's theorem. Isomorphism theorems and automorphisms. Introduction to rings. Types of rings. Integral domains. Fields and their characteristics.

MS-6205 LINEAR ALGEBRA

Review of elementary concepts of vector spaces. Linear dependence and independence of vectors. Vector spaces and subspaces. Quotient spaces. Direct sum of spaces. Linear transformations. Rank and

nullity of linear transformations. Algebra of linear transformations and representation of linear transformations as matrices. Change of bases. Linear functionals. Dual spaces and annihilators. Eigenvectors, eigenvalues and Cayley-Hamilton theorem. Diagonalization of matrices. Inner product spaces. Bilinear, quadratic and Hermitian forms

MS-6301 GENERAL TOPOLOGY

Metric spaces, open sets, closed sets, convergence and continuity in metric spaces, topological spaces, bases and subbases, product topology, subspace topology, closed sets and limit points, closure, interior and boundary, Hausdorff spaces, continuous functions, homeomorphisms, metric topology. Connectedness, path connectedness, component and local connectedness, compact spaces, compact sub-spaces of the real line, limit point compactness, local compactness, first countable and second countable spaces, regular and normal spaces.

MS-6401 ORDINARY DIFFERENTIAL EQUATIONS

Review of ordinary differential equations with constant and variable coefficients, ordinary points, regular and irregular singular points and series solutions of differential equations. Frobenius method: The Bessel, Legendre, Hermite, Chebychev, hypergeometric equations and their solutions, orthogonal polynomials Sturm-Liouville systems. Adjoint differential equations. Linear systems of differential equations, Cauchy's problems for linear second order equations in independent variables. Cauchy-Kowalewski theorem. Characteristic surfaces. Adjoint operations, bicharacteristics. Spherical and cylindrical waves. Heat equation, wave equation, Laplace equation, maximum-minimum principle. Integral transforms.

MS-6099 MS THESIS

The thesis is a report of theoretical or laboratory/practical work, suitable for publication. For the MS degree a Thesis is required. The Department will appoint an MS Thesis Supervisor for this purpose. The student will choose a suitable topic with the approval of his Supervisor who will guide, and monitor his/her progress and suggest reading material. A student will only graduate after the final acceptance of his/her thesis report.

MS-6110 MEASURE THEORY - I

Algebra of sets: The axiom of choice and infinite direct products, countable sets, relations and equivalences, partial ordering and the maximal principle, well-ordering and countable ordinals. The real number system : Axioms of real numbers, the natural and rational numbers as subsets of \mathbb{R} , the extended real numbers, sequences of real numbers, open and closed sets of real numbers, continuous functions, Borel sets. Lebesgue measure: Introduction, outer measure, measurable sets and Lebesgue measure, A non measurable set, measurable functions, Little wood's three principles .Lebesgue integrals: The Riemann integral, the Lebesgue integral of a bounded function over a set of finite measure, the integral of a nonnegative function, the general Lebesgue integral, convergence in measure. Differentiation and Integration: Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity, convex functions. The Classical Banach Spaces: The L_p spaces, Minkowski and Holder inequalities, convergence and completeness, approximation in L_p , bounded linear functional on L_p spaces.

MS-6115 FUNCTIONAL ANALYSIS – I

Banach spaces: Definition and examples of normed spaces, Banach spaces, characterization of Banach spaces, quotient spaces. Bounded linear transformations, functionals and their examples, various characterizations of bounded (continuous) linear operators, the space of all bounded linear operators. The open mapping and closed graph theorems. The dual (conjugate) spaces, reflexive spaces, Hahn-Banach theorem. Some important consequences of the Hahn-Banach theorem. Inner product spaces and their examples. The Cauchy-Schwarz inequality. Hilbert spaces. Adjoint, self-adjoint, normal and unitary operators (simple properties).

MS-6120 SUMMABILITY THEORY - I

General theory, regular transformations. Toeplitz theorems. Special methods of summability, Borel and Abel type methods of summability. Norlund means, Cesaro and Holder means. Summability of products of series, summability factors, summability of integrals, Hausdorff methods.

MS-6215 RING THEORY-I

Rings, subrings, characteristics of a ring, Boolean ring, direct products and direct sums of rings, ideals and homomorphisms, factor rings, sums and direct sums of ideals, maximal and prime ideals, nilpotent and nil ideals, modules and vector spaces, R-homomorphisms and quotient modules, simple and completely reducible modules.

MS-6501 INTRODUCTION TO CONTINUUM MECHANICS

Introduction to tensors. Stress tensor. Equilibrium equations. Mohr's circle for plane stress. Deformation, Strain tensor. Rate of deformation tensor. Equations of motion. Dynamic similarity. Exact solutions. Laminar boundary layer over a flat plate.

Vorticity circulation & irrational flow. Torsion of cylindrical bars. Plane elastic waves.

MS-6601 MATHEMATICAL STATISTICS

Introduction to probability, basic classical theorems, modes of probabilistic convergence, random variable and its distribution, moment generating functions, characteristic functions, probability distribution of functions of random samples, theory of point and interval estimation, hypothesis testing, elementary decision theory.

MS-7110 MEASURE THEORY- II

Measure and integration: Measure spaces, measurable functions, integration, general convergence theorems, signed measures, the Radon-Nikodym theorem, the L^p spaces. Measure and outer measure and measurability, the extension theorem, the Lebesgue-Stieltjes integral, product measure, extension by sets of measure zero, Caratheodory outer measure. Hausdorff measure. Measure and Topology: Baire sets and Borel sets, the regularity of Baire and Borel measures, the construction of Borel measures, positive linear functionals and Borel measures, bounded linear functionals on $C(X)$. The Daniell integral.

MS-7115 FUNCTIONAL ANALYSIS – II

Hahn-Banach theorem, Principle of uniform boundedness, open mapping theorem, closed graph theorem. Weak topologies and Ba-

nach-Alaoglu theorem, extreme points and the Klein-Milman theorem. The dual and bidual spaces, reflexive spaces, compact operators, spectrum of an operator, eigenvalues and eigenvectors, elementary spectral theory.

MS-7120 SUMMABILITY THEORY - II

Euler & Borel Methods: Generalization of some methods of summability, strong and absolute summability, Tauberian theorems. Wiener theory, special topics.

MS-7125 FOURIER ANALYSIS

Fourier series: Norm and pointwise convergence, approximate identities, Plancherel theorem, conjugation, maximal functions. Classical Hardy spaces, F. and M. Riesz theorems, interpolation of linear operators. Fourier & Fourier Stieltjes transforms, tempered distributions, Paley-Wiener theorems. Wiener-Tauberian theorems & applications

MS-7215 RING THEORY-II

Free modules, Noetherian and Artinian rings and modules, composition series, projective modules, split exact sequences, the group of homomorphism, important homological properties, injective modules, characterization of injective modules, divisible abelian groups and their relationship with injective modules.

MS-7220 THEORY OF SEMIGROUPS

Introductory ideas, basic definitions, cyclic semi groups, ordered sets, semilattices and lattices, binary relations, equivalences, congruences, free semigroups, Green's equivalences, L, R, H, I and D, regular semigroups, 0-simple semigroups, simple and 0-simple

semi- groups, Rees's theorem, primitive independents, completely 0-simple semigroups, finite congruence-free semigroups, union of groups, bands, free bands, varieties of bands, inverse semigroups.

MS-7225 THEORY OF SEMIRINGS

Hemirings and semirings, definitions and examples, building new semirings from old. Complemented elements in semirings. Ideals in semirings. Prime and semiprime ideals in semirings. Factor semirings. Morphisms of semirings. Regular semirings. Semimodules, factor semimodules. Free, projective and injective semimodules.

MS-7230 FUZZY SET THEORY

Introduction, classical logic, classical set theory. Fuzzy sets: Basic concepts and properties, further properties, classical relations, fuzzy relations, fuzzy arithmetics, fuzzy logic, applications.

MS-7301 ALGEBRAIC TOPOLOGY

Homotopy of paths, the fundamental group. Covering spaces. Simplicial complexes and simplicial maps, homology groups, barycentric subdivision, the simplicial approximation theorem. Singular homology groups, The exact homology sequences, the Eilenberg-Steenrod axioms, Mayer-Vietoris sequence.

MS-7401 PARTIAL DIFFERENTIAL EQUATIONS

Cauchy's problems for linear second order equations in independent variables. Cauchy-Kowalewski theorem. Characteristic surfaces. Adjoint operations, bicharacteristics. Spherical and cylindrical

waves. Heat equation, Wave equation, Laplace equation, maximum-minimum principle, integral transforms.

MS-7405 MATHEMATICAL TECHNIQUES FOR SCIENTISTS AND ENGI- NEERS

Green's function, method with applications to wave-propagation. Perturbation method, regular and singular perturbation techniques with applications. Variational methods. A survey of transform techniques, Wiener-Hopf technique with applications to diffraction problems

MS-7410 CALCULUS OF VARIATION AND INTEGRAL EQUATIONS

Euler's equation and its generalization: Variational problems with moving boundaries, Rayleigh-Ritz method. Classification of integral equations, Neumann's iterative method for Fredholm's equation of the second kind, Volterra type integral equations, integral equations of the first kind.

MS-7415 OPTIMIZATION

Optimization Problem: various examples, characterization of optimality and constrained optimal problems. Convex sets and convex functions and their properties, non-linear programming theory. Kuhn-Tucker conditions, Lagrange's theory, duality theory, search techniques-one variable and several variables, Pontryagin's maximum principle and its applications, dynamic programming and its applications.

MS-7420 INTEGRAL EQUATIONS

Volterra and Fredholm integral equations, resolvent kernels. Operator equations, Fredholm theory, Hilbert-Schmidt theory, nonlinear integral equations, singular integral equations

MS-7425 NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS

Introduction. Runge-Kutta, methods, derivation, error bounds and error estimates. Weak stability theory for Runge-Kutta methods. Order and convergence of the general explicit one-step methods. Linear multi-step methods -derivation, order consistency, zero-stability and convergence. Weak stability theory for general linear multi-step methods. Predictor-corrector methods. Stiff systems.

MS-7430 NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Basic linear algebra, vector and matrix norms and related theorems. Parabolic equations in one and two space dimensions - explicit and implicit formulae. Consistency, stability and convergence. Iterative methods for linear systems, split operator methods. Multilevel difference schemes. Nonlinear equations. Elliptic Equations: Dirichlet, Neumann and mixed problems. Direct factorization methods and successive over relaxation (S.O.R.). ADI and conjugate gradient methods. Hyperbolic equations. First order hyperbolic systems in one and two space dimensions-stability and convergence. Second order equations in one and two space dimensions. The Galerkin method and applications.

MS-7435 BIO-MATHEMATICS

Bio fluid dynamics; Blood flow & arterial diseases; Transport in intestines & lungs; Diffusion processes in human system; Mathematical study of nonlinear Volterra equations, Stochastic & deterministic models in population dynamics and epidemics.

MS-7501 FLUID MECHANICS

Introduction to fluid dynamics. Steady and turbulent flow. Conservation of mass in fluid flow, viscosity. Laminar and turbulent flow of ideal and viscous liquid. Euler's and Bernoulli's equation. Calculation of pressure variation in accelerating fluid surface resistance in laminar and turbulent flow. Evaluating head loss in pipes and conduits & solving engineering problem fluid flow. Calculating lift and drag on moving liquid, Poiseuille formula. Calculating hydraulic pipe flow problem using Moody's diagram. Computational fluid dynamics Introduction to computational fluid dynamics. Fluid dynamics governing equation, Numerical Methods, Principle of CFD.

MS-7510 BASICS OF THE THEORY OF FLUIDS

Euler's equation of motion, viscosity, Navier-Stokes equation and exact solutions, dynamical similarity and Reynold's number, turbulent flow, boundary layer concept and governing equations, Reynold's equations of turbulent motion. Magneto hydrodynamics, MHD equation, fluid drifts, stability and equilibrium problems

MS-7515 THEORY OF STABILITY

Stability of fluid flows, Bénard convection, Poiseuille flow. Rotatory Couette flow. Rayleigh-Taylor and Kelvin-Helmholtz problems. Nonlinear stability limits. Supercritical and subcritical regimes.

MS-7520 COMPUTATIONAL FLUID DYNAMICS

Conservation laws, weak solutions & shocks, monotone difference schemes. Total variation diminishing schemes, Godunov-type schemes, essentially non oscillatory methods. Flux limiters

MS-7525 AERODYNAMICS

Introduction to aerodynamics, review of the fluid kinematics and conservation laws of vorticity theorem. Two dimensional potential flow. Aerofoil theory, finite wing oblique shocks, subsonic, transonic and supersonic airfoil theory, laminar and turbulent boundary layers, lift reduction, down force generation and drag reduction. Wind tunnel testing technique. Computational aerodynamics. Solving problems by the use of commercial packages in aerodynamics.

MS-7530 BIO-MECHANICS

Introduction to bio-mechanics, Circulatory system, pressure & flow in arterial system, elastic & non-Newtonian effects on blood flow. Arterial diseases, dialysis, artificial kidneys. Human joints & their mechanism, human joint lubrication; mucus transport in lungs.

MS-7601 ELEMENTARY DECISION THEORY

Utility and loss functions, the prior information, basic principles of making decisions under uncertainty, Bayes and minimax decision rules, prior and posterior analysis, applications to classical statistical inference procedures.

MS-7605 OPERATIONS RESEARCH

Different techniques used in operations research and their applications, formulation and solution of linear programming problems, queuing systems, rehabilitation analysis, probabilistic risk analysis.

MS-7610 APPROXIMATION THEORY

Best approximation in normed spaces. Tchebycheff systems. Tchebycheff- Weierstrass - Jackson - Bernstein - Zygmund-Nikolaev etc. theorems. Fourier series, splines, convolutions, linear positive, variation diminishing. Simultaneous etc. approximations. Direct-inverse-saturation theorems, applications.

MS-7615 STOCHASTIC PROCESSES

Definition and classification of general stochastic processes. Markov chains with discrete state space, Poisson process, birth and death processes. Renewal Process: renewal equation, mean renewal time, stopping time. Markov process with continuous state space: Introduction to Brownian motion.

MS-7620 MATHEMATICAL MODELING

Elementary mathematical models. Role of mathematics in problem solving. Concepts of mathematical modeling. System approach formulation. Analysis of models. Sensitivity analysis & parameter estimation. Design of experiment, validation. Simulation approach. Pitfalls in modeling. Illustrations.

MS-7701 DATA STRUCTURE

Introduction to data structures, Mathematical background, how to create and analyze programs. Arrays, Records and Pointers: Introduction, linear arrays, multidimensional arrays, records, pointers, representation of arrays, Sparse matrices. Stacks and Queues: Introduction, representation of stacks, evaluation of expression, recursion, representation of queues, circular queues. Linked Lists: Singly linked lists, linked stacks and queues, circular linked lists, application of linked lists, polynomial addition, sparse matrices, Generalized lists. Trees, basic terminology, binary tree representation, binary tree traversal. Application of trees. Hash Tables: Direct address tables, Hash tables. Hash functions. Overflow handling. Red-Black Trees: Properties of Red- Black tree, rotations, insertion, deletion. Advanced data Structures: B-Trees, heaps, data structure for disjoint sets. Design and Analysis Techniques: Dynamic programming, Greedy algorithms, examples. Graphs: Representation of graphs, Traversals: Depth first search, breadth first search, minimum spanning tree, shortest paths.

MS-7705 MATHEMATICAL CODING THEORY

Polynomial rings over fields. Extension of fields, computation in $GF(q)$, root fields of polynomial. Vector space over finite fields, binary group codes, hamming codes, polynomial codes, linear block codes, the structure of cyclic codes. Quadratic residue codes, Reed-Mueller codes, simplex codes.

MS-7710 GRAPH THEORY

Basic definitions. Blocks, Ramsey numbers. Degree sequences. Connectivity. Eulerian and Hamiltonian graphs. Planar graphs and 5-colour theorem. Chromatic numbers. Enumeration, Max-Flow Min-Cut theorem. Groups and graphs. Matrices and graphs. Matchings and Hall's Marriage theorem. Eigenvalues of graphs.

MS-7715 THEORY OF COMPUTATION

Some fundamental proof techniques. Finite Automata: Finite automata and regular languages, languages that are and are not regular, algorithm aspects of finite automata. Context-free grammars: Push-down automata, languages that are and are not context-free, algorithms for context-free grammars. Basic turing machine model and turing computability: Variants of turing machines.

MS-7720 NUMERICAL ANALYSIS

Differentiation and integration in multi-dimensions , ordinary differential equations : predictor methods, modified Euler's method, truncation error and stability, Taylor series method , Runge-Kutta methods, differential equations of higher order, systems of differential equations, shooting methods, boundary value problems. Partial differential equations: Elliptic, hyperbolic and parabolic equations, explicit and implicit finite difference methods, stability, convergence and consistency analysis, the method of characteristic.

MS-7801 DIFFERENTIAL GEOMETRY

Theory of Space Curves: The Serret-Frenet formulas. Gauss theory of surfaces, first and second fundamental forms. Examples, Weingarten

map. Principal curvatures, Gaussian curvature, examples. Computation of the curvature in standard spaces, sphere, torus, surfaces of revolution etc. Levi-Civita connection, uniqueness, Gauss theorem, Egregium, Hubert's theorem on the positivity of curvature at a point on a compact surface in R^3 , geodesics, equations of geodesics, examples, Jacobi fields, conjugate points etc., Riemannian area element on a surface, Gauss-Bonnet theorem. Differential manifolds, differentiable structure, sub-manifolds, immersions, embeddings. Metric tensor, Riemannian connections and curvature.

MS-7901 SPECIAL TOPICS -II

Topics will be chosen based on industry trends and requirements

Civil Engineering Courses

CV-6101 Advanced Reinforced and Pre-stressed Concrete Introduction, Behaviour and design of beams-Review, Behaviour and design of Short Columns- Review, Behaviour and design for Slender Columns, Two Way Slab Systems, Strip Method, Direct design method, Equivalent frame method, Shear in walls, Structural Walls, Prestressed Concrete- elastic analysis, prestress losses, deflections, flexural and shear strength, bond and anchorage.

CV-6104 Structural Dynamics

Single degree of freedom systems: Formulation of the equation of motion and its methods of formulation, Free vibration response; undamped free vibration and damped free vibration; Response to different types of dynamic loadings and different methods of analysis of nonlinear structural response. Development of software in C++ language.

CV-6001 Advanced Engineering Mathematics

Numerical solutions of linear algebraic equations; Solutions of non-linear using first and second order iterative methods; Numerical differentiation and integration; Partial differential equations and finite difference methods; Eigen value problems such as plates. Laplace equations; Applications of Legendre, Chebyshev, Hankel and Bessel Functions to Structural Problems. Application of Taylor Series, Runge Kutta Method. Calculus of Variation, Euler Lagrange equations, Raleigh-Ritz & Galerkin techniques. Development of software for all numerical techniques in C++ language CV-6106 Structural Mechanics Introduction, Energy Principles- principle of virtual work, potential energy, complementary energy, Stability Theory- Euler method, nonconservative systems, Review of Classical Beam Theories- Euler- Bernoulli and Timoshenko, beam theories, energy methods, large deflections (beam-columns), stability (planer and lateral buckling), Classical Plate Theories- Kirchhoff and Reissner-Mindlin plate theories, solution methods, energy methods.

CV-6108 Earth Quake Resistant

Design Introduction- Basis of earthquake philosophies, role of uncertainty and the management of risk, an 'ideal' approach and some practical

simplifications, limit state approaches, approaches adopted in current and emerging building code provisions, Sources of Earthquake ground motions, measures of earthquake intensity and damage potential, effects of local soil conditions on ground shaking, engineering estimation of ground motion characteristics based on deterministic and probabilistic approaches, Assessment of the effect of structural system and ground motions on the response of simple one and multiple degrees of freedom systems, Development of Design Earthquakes for Linear and Non-Linear Structural Response, Analytical Procedures for Preliminary/ Conceptual Design and Proportioning of Structural Systems, Code Related Issues, Applications.

CV-6109 Sustainable Construction

Patterns of Development-current global patterns, sustainable development, Global Environment Issues, Life Cycle Assessment (LCA), Sustainable Design- Introduction, principles and strategies, Design for Environment, Sustainable Consumption.

CV-6111 Design of High Rise Structures

Design Criteria- design philosophy, architectural requirements, loading, strength and stability, stiffness and drift limitations, human comfort criteria, creep, shrinkage and temperature effects, Gravity Load Resisting Systems- composite steel floor systems, precast concrete floor systems, post-tensioned concrete floor systems, Lateral Load Resisting Systems- moment resisting frames, brace frames, shear wall systems, core and outrigger systems, tubular systems, hybrid systems, Modelling for Analysis- Assumptions, computer modelling for accurate analysis, dynamic analysis, Fire Safety Engineering- fire protection systems, fire-resistance-rated construction, Foundation Systems and Construction Techniques- foundation systems, shallow foundations, pile foundations, raft foundation design and analysis, settlement aspect of foundation for tall buildings, basement excavation design and construction, Project Management for Tall Buildings- planning and scheduling, design management and constructability reviews, value engineering, site control.

CV-6112 Bridge Engineering

Introduction to bridge engineering, Historical perspective, Structural members- Materials, structural types, Selection of site, Bridge loads - dead

load, live load, Live load moments and shears, influence lines, dynamic load (impact), Longitudinal loads. Load combinations, Bridge substructure - pier, abutment, pile, Design of concrete slab, Design of non-composite steel girders, Design of non-composite steel girders, Design of composite steel girders, Design of composite steel girders, Design of prestressed concrete girders, Composite action - shear connectors, Bridge tests and NDT procedures, Evaluation of existing bridges, Corrosion - types, mechanisms, evaluation of corroded bridges, Fatigue - steel bridges, concrete bridges, Rehabilitation of bridges.

CV-7102 Mechanics of Solids

Introduction to Cartesian tensors; stress tensor and tensorial transformation of stress; Mohr's circle for 3-D stress transformation; dyadic and indicial symbols; finite and infinitesimal strain tensors; Mohr's circle for 3-D strain; constitutive equations for anisotropic material; composite laminates; two dimensional theories of yield; Airy's stress function in plane elasticity; generalized Fourier series solution to bi-harmonic equation; elasticity in polar coordinates; thermoelectricity; numerical methods in elasticity.

CV-7103 Advanced Structural Analysis

Matrix algebra, solution of equations, review of energy principles, virtual work; degree of redundancy, choice of redundant, flexibility method, kinematics indeterminacy, development of element stiffness matrices, stiffness method of analysis of structures, computer applications and software development, axial force effects and Eigen value analysis, introduction to finite element method, introduction to structural stability. Development of software in C++ language.

CV-7105 Finite Element Methods

Basic concepts of structural modelling, Review of the Stiffness method of Structural Analysis, Modelling stiffness, loads and displacement boundary conditions, Mathematical interpretation of finite elements, variational formulation, Formulation of Finite Elements- development of continuum elements, shape functions consistent loads, numerical integration, convergence requirements, Computer Implementation of the Finite Element

Method- Pre-processing: model definition, element level calculations, equation assembly, equation solver.

CV-7107 Advanced Steel Design

Introduction of Steel Structures- material behaviour, member and structural behaviour, loads, connections, design of steel structures, Basic Stability Theory- potential energy and strain energy, buckling of one degree of freedom, Stability of Steel Beams- Elastic buckling under axial loading, elastic torsional buckling, elastic lateral buckling, design against buckling, Stability of Steel Plates and Shells- theory of plate bending, elastic buckling of plates and shells, Fatigue Design of Steel Structures- S-N curves, fatigue crack propagation, fatigue category, fatigue life estimate.

CV-7110 Plates and Shells

Pure bending of plates (Kirchhoff theory), Rectangular, circular and annular plates under lateral loads, Various edge conditions, Effect of transverse shear deformation (Mindlin theory), Large deflection of Plates, Theory of thin curved shells, Deformation and stresses of cylindrical and conical shells.

CV-7113 Advanced Concrete Technology

Characteristics and properties of constituents of concrete; Cement, Aggregates, Admixtures, etc. and their influence on properties and behavior of fresh and hardened concrete ; testing of properties of concrete and its constituents, performance and durability of concrete; strength development, deterioration vis-à-vis environment; assessment of causes and mechanism of deterioration of concrete with emphasis on some well-known causes, non-destructive testing (NDT), Design of concrete mixes; high performance concrete, light weight concrete, Self-compacting Concrete, Ready mixed concrete .

CV-6201 Applied Soil Mechanics

Mechanical Analysis, Index Properties and Soil Classifications: Principle of sedimentation; sieve and sub-sieve analysis, Pre-treatment of soils, Index Properties, Casagrande's Plasticity Chart, unified soil classification, Relative density of sand. Effective Stress Principle and Permeability: Terzaghi's effective stress principle, Flow through soils and Darcy's Law, Constant and falling head permeability, In-situ permeability, theory, wells. Stress-History

and Compressibility of Soils: Normally consolidated and over-consolidated soils, pre-consolidation pressure, Terzaghi's theory of consolidation, Pore pressure coefficients, Skempton & Bjerrum Modification, Secondary consolidation. Stress Distribution in Soils: Evaluation of geo-static stresses, Mohr's circle of stresses, Elastic theories for evaluation of stress increments. Stress-Strain Behaviour and Shear Strength: Stress and strain conditions in plane shear and axi-symmetric conditions, Direct shear and triaxial tests, Stress-strain behaviour of cohesive and non-cohesive soils, Shear strength of cohesive and non-cohesive soils, Stress path methods and stress-strain theories. CV-6203 Foundation Engineering & Design Principles of Foundation Engineering: Design of foundations, Design criteria: allowable settlement, total factor of safety, partial factors. Stability Analysis based on plastic theorem: Total and effective stress analyses, Limit analysis: upper bound and lower bound calculation, Slip line method, Limit equilibrium method. Earth Pressure Problems Related to Foundation Engineering: Earth pressure and earth pressure coefficient, Earth pressure at rest, active and passive pressure, Earth pressure acting on flexible walls, Case histories. Shallow Foundations: Types of shallow foundation, bearing capacity Calculation: bearing capacity factors: Factors affecting bearing capacity: 2D and 3D, depth, load inclination and eccentricity, foundation flexibility, soil compressibility, Stress in elastic media due to surface loading, Settlement calculation: immediate settlement, consolidation settlement, Settlement predictions using in-situ tests and empirical methods, Case histories. Deep Foundation: Classification of deep foundations, types of pile foundation, Load transfer mechanism: friction resistance, pile tip bearing load, Vertical bearing capacity and settlement of piles, Time effects, group action of piles, negative skin friction, Lateral loads on piles, pile testing, Case histories.

CV-6205 Geology for Civil Engineers

Geological and Mechanical Principles: Geological time, Rock forming minerals, Rock types, Soil Types, Mechanical fundamentals for Engineering Geology, Soil and rock properties.

Geological Structure Analysis: Geological structures (faults, folds), Discontinuities, Hemispherical projection (basics and borehole analysis). Processes in Engineering Geology: Weathering, Erosion, transportation and sedimentation, Groundwater. Applied Engineering Geology: Landslides

classification for slopes in rock and soil, Mass movement in rock, Mass movement in soil, Excavation Principles in Rock and Soil. Engineering Geology in Practice: Site characterization and investigation techniques, Case histories and examples, reporting.

CV -6207 Soil Dynamics & Earthquake

Engineering Fundamentals of Vibration: Fundamental definitions, System with a single degree of freedom, System with two degrees of freedom. Waves in Elastic Medium: Elastic stress waves in a bar, Stress waves in an infinite elastic medium, Stress waves in elastic half-space. Properties of Dynamically Loaded Soils: Laboratory tests and results, Field test measurements, Correlations for shear modulus and damping ratio. Foundation Vibration: Vertical, rocking, and sliding vibrations of foundations, Vibration of embedded foundations, Vibration screening. Dynamic Bearing Capacity of Shallow Foundations: Ultimate dynamic bearing capacity, behaviour under transient load. Earthquake and Ground Vibration: Earthquake magnitude, Vibration of soil layers due to earthquake, Characteristics of rock motion during earthquake. Lateral Earth Pressure on Retaining Walls: Mononobe-Okabe active earth pressure, Laboratory model test results for active earth pressure coefficient, Design of gravity retaining walls based on limited displacement, Passive force on retaining wall. Compressibility of Soils under Dynamic Loads: Compaction of granular soils, Settlement of foundation on granular soil under vibration. Liquefaction of Soil: Fundamental concept of liquefaction, Laboratory studies to simulate field conditions for soil liquefaction, Procedures for determination of field liquefaction. Seismic Stability of Earth Embankments: Free vibration of earth embankment, Forced vibration of earth embankment, Pseudo-static analysis, Estimation of Earthquake-induced deformation.

CV-6208 Pavement Design

Introduction to pavement design process, concepts, history and design factors, stress-strain analysis for flexible pavements, stresses and deflections in rigid concrete pavements, analysis of traffic loads, material consideration in design, factors effecting design, serviceability concept and failure criteria of rigid and flexible pavement, AASHTO design method for rigid and flexible pavements, pavement evaluation, rehabilitation and overlay design.

CV-6209 Geotechnical & Geo Environmental Engineering Introduction: Waste characteristic, Landfill system. Clay Mineralogy: Basic structural unit, Two-layer sheet and three-layer sheet, Classification of clay minerals and their characteristics, Double layer theory. Leachate: Definition of leachate, Leachate characteristic. Soil-Leachate Compatibility: Soil-solution interaction, Soil-hydrocarbon interaction, Role of surfactant. Method for Assessing Hydraulic Conductivity: Laboratory tests for determination of hydraulic conductivity i.e. fixed wall test and flexible wall test, Field tests for determination of hydraulic conductivity i.e. variable head test, constant head test and pumping test. Flow through Porous Media: 1-D flow, 2-D flow. Conduction of Chemical Species through Porous Media: Steady state diffusion, Transient state diffusion, Column test, Batch equilibrium test. Cover System of Landfill: Type of cover system, Components of cover system, Design of cover system. Settlement of Landfill: Creep models, Prediction and quantification, Case studies. Gas from Landfill: Landfill gas characteristic, Landfill gas movements, Landfill gas control. Water Balance in Landfill: Design of drainage systems. Landfill Monitoring and Control: Drilling method, Soil sampling method, Groundwater sampling method, Landfill monitoring scheme. Site Remediation Technology: In-situ site remediation technique, Ex-situ site remediation technique.

CV-6210 Underground Excavating & Tunneling

Introduction: History, type, stability and influencing factors, related problems. Underground Excavations in Rocks: Stresses and displacements around underground excavations, In situ stresses, Thick-walled cylinder solution, stresses and displacements around a circular opening, uniform stress field & non-uniform stress field (elastic, elastoplastic), ground reaction curves (characteristic lines), Displacements around advancing tunnel face, Elastic stresses and displacements around non-circular openings and caverns; around multiple excavations, Design considerations for underground rock excavation on the basis of stress criteria; pressure tunnels, Tunnel responses and relation to ground properties and geology, Stand-up time and free span, Type of tunnel grounds: rock and soft ground, Major ground responses: rock burst, loosening, squeezing. Methods of excavation and support, Conventional method (drill-and-blast with steel support), Mechanized tunnelling & tunnel boring machines (TBM's), Supports (initial &

final supports): steel ribs, rockbolts, and shotcrete. Methods of excavation, ground treatments and supports for heavy grounds, Geotechnical investigations for design and construction, Determination of rock loads on tunnel support requirements, Empirical methods (Classifications: Terzaghi's, Deere's, Barton's, Bieniawski's, NATM, etc.). Analytical methods - confinement-convergence method. Numerical methods - stress and displacement analysis. Observational methods - control criteria/back analysis. Instrumentations, purposes, types of measurements and interpretation, New Austrian tunnelling method (NATM). Soft Ground Tunnelling: Types of ground responses and influencing factors, Face stability in clay and granular soils, Shield tunnelling, Ground movement prediction (empirical & numerical analyses), Response of structures to ground movement from tunnelling, shallow foundation, piled foundation, damage criteria, risk assessment, Control of stability and ground movements: compressed air; ground treatment (grouting, dewatering, freezing, etc.), Lining design: lining load, ground-lining interaction, segmented lining, analysis methods. Instrumentation and Monitoring.

CV-6212 Pressure & Retaining Systems

Pressure on Retaining walls. Basic concepts and earth pressure theories. Design criteria and pressure analysis of rigid walls with and without surcharge loads. Effect of seepage and drainage on walls. Pile – supported retaining wall. Behaviour of flexible earth retaining structures. Design criteria and pressure analysis of anchored bulk heads, braced out and tie back bracing system, design criteria for cellular cofferdams. Behaviour of retaining walls during earthquakes

CV-7202 Advanced Methods in Geotechnical Engineering Introduction to slope stability studies, Slope stability analysis, Design and construction of soil reinforcement. Bearing capacity of reinforced earth. Reinforced earth walls and slopes. Characterizing cohesion sands – Review factors, affecting strength, sampling and testing, In situ tests, static and seismic loading behaviour, characterizing saturated clays- Review factors affecting strength, sampling and testing, In situ tests, static and seismic loading behaviour, representation of strength in slope Stability Analysis, Slope in other Materials-stiff fissured clay, sensitive clay, partially saturated clay, loess,

residual soils, rock slopes landfill liners. Site investigation methods ground water flow: methods, control and design of dewatering systems. Ground support techniques during temporary works. Analysis of soil improvement techniques including grouting, vertical drains, and dynamic compaction.

CV-7204 Advanced Analytical Geotechnical Engineering

Field Testing Equipment and Data Interpretation: Sampling, Standard Penetration Test, Field Vane, Cone Penetration & Dissipation Tests, Pressuremeter, Dilatometer. Field Monitoring Equipment: Piezometer, Inclinometer, Settlement Measurements. Advanced Laboratory Equipment: Consolidation, Constant rate of strain/displacement, Rowe Cell & Radial flow, Ko consolidated Triaxial, Measurement of Ko-value, Strength testing, Ko-consolidated Triaxial (Compression & Extension), Direct Shear and Simple Shear, True Triaxial & Plane Strain, Torsional Shear Hollow Cylinder, Directional Shear Cell

CV-7206 Ground Improvement Techniques & Geo Synthetics Densification and Consolidation: Shallow and Deep Foundations, Dynamic consolidation and vibroflotation. Preloading and Drainage: Vertical drain with surcharge and vacuum preloading, Electro-osmotic consolidation with vertical drains. Soil Reinforcement: Reinforced earth and geotextiles applications, Granular piles/sand compaction piles. Soil Stabilization by Admixtures: Soil + cement (deep mixing method), Soil + lime (lime columns) and other additives. Designing with Geosynthetics: Composition, Properties and Functions of Geosynthetics, Designing for Separation, Filtration, Drainage and Roadway Applications, Designing for Landfill Liners and Barrier Applications.

CV-7211 Rock Mechanics

Rock Engineering in Geotechnical Practice: Overview of rock mechanics and rock engineering, Application to civil and mining engineering. Properties of Intact Rock, Rock Mass and Geologic Discontinuities: Index properties and classifications for rocks, Geologic discontinuities and description, In situ stresses and measurement, Stress-strain relationship, brittle fracturing and failure theories, Strength criteria of rock and rock mass, Properties of weak rock - creep, swelling, slaking. Deformability of Rock Mass: Types of problems - buildings, dams, pressure tunnels, Influencing factors and

theoretical assessment, Determination of modulus of rock mass (laboratory tests, in situ tests, empirical methods), Elastic solutions for stresses and displacements beneath foundations and around tunnels (close-formed and numerical analysis). Groundwater Flow in Rock Mass and Assessment: Flow characteristics, Permeability measurements and flow analysis and monitoring. Foundations on Rocks: Modes of bearing capacity failure, Socketted pile foundations, Foundation on weathered rock, Foundation on karstic terrain. Rock Slope Engineering: Types of slope movement and influencing factors, Classification of slope movement and landslides, Failures of rock slopes, Failures of weathered rock/residual soil slopes, Shear strength along geologic discontinuities, Influence of irregularity, displacement, joint filling and confining pressure, Strength criteria (Patton's, Barton's, etc), Rock Slope stability analysis, Plane failure, Wedge failure, Rotational failure, Rock falls, Application of software for rock slope analysis, Stabilization and instrumentation.

CV-6301 Development of Transport Infra-Structure Transportation & access needs of the society, various modes of transportation systems (e.g. road and rail), passenger and freight movements, basic considerations of transport infrastructure developments, current development programmes, Integration of transportation systems, interface between systems, National & Global Transportation Networks. Appraisal & Evaluation of Transportation Projects; Appraisal & evaluation guidelines, Requirements, Methodology, Other considerations and practical examples, Highway Planning, Design & Construction; General planning considerations, Components & Classification of highways, Design elements and standards, Loading on pavements, Design principles for flexible and rigid pavements, Construction & Maintenance of modern highways. Railway Systems; Important components of the railway system, Railway development, Railway capacity, Railway alignment, Rail joints, ballast and other infrastructure components, Airports and Sea ports; Airport activity systems & components, Airport planning procedure Runway orientation, Runway length and pavement design, Design of port terminals & connections, Seaport activity systems & components, Seaport planning procedure, Port and Airport Development Study (PADS).

CV-6302 Urban Transportation Planning and Development Coordination of City Planning and Transportation Planning. Trip generation, trip distribution, modal split, trip assignment models; Preparing land-use cum transport plans; Economic evaluation; Urban travel Characteristics and trends in travel demand. Basic urban transportation studies i/c origin destination surveys, Inventory use studies, Parking studies and transit surveys. Pedestrian facilities; Light rail and Mass Rapid Transit.

CV-6002 Probability and Statistics Probability

Concepts of Probability and their relevance to statistical analysis, Probability distributions relevant to transportation data analysis. Data Collection: Survey planning and design, traffic survey practice, inventory surveys, transport usage surveys, travel time and congestion surveys, matrix surveys, questionnaires and interviews, sources and use of secondary data, Statistics: Summary measures. Statistical distributions, confidence intervals, hypothesis testing, contingency table, correlation and linear regression analysis, ANOVA and multivariate analysis.

CV-6305 Geometric Design of Highway

Design philosophy and present trends, Design controls and criteria, Design speed, Safe sight distance, Road gradients, Super elevation, Capacity as design control, Horizontal and Vertical alignment, Cross sectionsection, Speed, Change lanes, Medians, Design of At-grade and grade separated intersections, Road-rail crossings, Highway drainage, Design automation concepts, and Highway design software.

CV-6307 Transport and Logistics Management

The Transport System; The function of transport; the elements of transport system; systems concept as applied to transport and distribution. The Structure and Management of Transport Organisations; The pattern of ownership and scale of operation; organisation structures; management function and practices; policy formulation and planning of strategies. Road Transport Management; Highway Classification; Area Traffic Control; Parking Control; Junction Control; Traffic Surveillance And Regulations; Transport Routing Management. Pavement Management System; Maintenance Assessment Rating and Costing for Highways; pavement maintenance and rehabilitation strategy; pavement performance prediction; economic analysis

and network optimization. Logistics Management; Concept of a logistics system, Logistics need evaluation, Design & management of logistic & distribution networks, Optimal vehicle fleet utilization techniques, Industrial logistics, Stores, spares & supplies management, Warehousing, Logistic operations for emergencies & relief operations, Training & Scheduling.

CV-6509 Highway Materials

Properties and usage of soil, sand and rock as highway materials, Modification and evaluation of their properties, Criteria for use and acceptance, Testing, variability and quality control, use of non-structural material, material resources, in-service conditions, and their effect on material, performance, properties and use of bitumen, asphalt & tars and concrete as pavement materials. Rheology of bitumen, bituminous coating of aggregates, optimization of bituminous mixtures, Asphalt Concrete mix design. Quality control and performance of bituminous & concrete pavement materials.

CV-6310 Transport Economics

Introduction to transport economics, Demand for transport, Transport supply, Transport pricing Subsidy and investment, Competition and ownership, Cost benefit analysis in developed countries, Cost benefit analysis in developing countries, Road user charging, Transport and the economy.

CV-6311 Public Transport Operations and Management

Overall Framework; Public transport operations and planning process; Problem decomposition. Tradeoffs between services; Standard versus mini-vehicle; Vehicle size models. Public transport planning studies. Data Collection Methods; Manual and automated data collection techniques; Automatic vehicle monitoring; Sampling considerations; Operations surveys: passenger load counts, boarding and alighting checks, transit speed and delay studies. Frequency and Headway Determination; Analyzing passenger load and running time data, Four methods for frequency and headway determination. Examples of the four methods and cost-effectiveness criteria. Timetable Development; Current practice, Alternative timetables, Timetables with evenly spaced headways, Timetables with even loads. Automated timetables with examples, Experiences with computer programs. Vehicle

Scheduling; An experience with an optimization scheduling method, Graphical and optimal method for an interactive system, Fixed and variable schedules, Minimum fleet size, Deadheading considerations. Service Reliability; Variability of concern to passengers and operator, The bunching phenomenon, Improving reliability, Passenger waiting time, Vehicle Running time; AVL (automatic vehicle location) systems-features and benefits. Systems Analysis; Recent developments, Production functions and marginal analysis; Sensitivity analysis; Resource allocation and transportation problems. Transit Network (Routes) Design; Current practices, Establishing objective functions, Creating routes and transfers, Demand assignment and initial frequency determination, Optimal criteria and best solutions with flexibility for decision makers. Design & Evaluation of Public Transport Priority Measures; Important elements in providing preference to public transport, Priority schemes, Design and Evaluation. Applications of information technologies in public transport. Field/Laboratory Work; Public transport network building and demand assignment, boarding and alighting counts, on-board surveys, and on-site case studies.

CV-7104 Research Methodology

Understanding and applying the elements of good research design for Civil Engineers is the primary focus of this course. These elements include the critical synthesis of literature and prior knowledge, formulation of research questions, the composition of research hypotheses, proper design of field data collection and experiments, collection and analysis of data (observational and experimental), modelling of stochastic data, and interpretation and dissemination of research results. In addition, technical writing skills and the organisation of a large document is introduced in detail. Work is then done on a self-study basis with the supervision of an academic member of staff.

CV-7303 Advanced Traffic Engineering and Management

Road inventory, Traffic measurements, flow, speed, road structures, driver, vehicle & pedestrian characteristic; Controlled & uncontrolled intersections; Signals, Street lights, road markings, traffic signs. One way and Tidal Flow System, Parking Controls, Traffic calming; Capacity Analysis of signalized and un-signalized intersections; Accident study and road safety; Intelligent Transport System, Travel Demand Management.

CV-7304 Pavement Analysis and Design

Pavement type, stress distribution in pavements; theoretical and actual sub-grade conditions & traffic loading, design principles, methods & criteria for flexible pavements, rigid & semi-rigid pavements. Design of special duty & temporary pavements; Environmental influences & effects, pavement overlays, Mechanistic Design of Pavements, Pavement sub-drainage.

CV-6306 Sustainable Transportation Systems

Introduction & emerging need for sustainable transportation systems, Sustainable transport Indicators, Sustainability Analysis of transportation systems with special focus on developing countries like Pakistan, Policy issues and main principles of design, Application of advanced transport technology and intelligent transport systems.

CV-7308 Intelligent Transportation Systems

Introduction to intelligent transportation systems, Basic types and application areas, Design & Performance Characteristics, World wide applications, and ongoing research, Accident prevention, Environmental pollution control and other main advantages.

CV-7312 Supply Chain Management

Concepts in supply chain management; Information technology for the supply chain; Decision support system for supply chain management; Logistics network design and planning; Inventory management in the supply chain; Risk pooling concept; Bullwhip effect in supply chain; Computerized beer game; Supply chain integration; Strategic alliance and partnering; Product and process design for logistics; International issues in supply chain management.

CV-7401 Project Management

Introduction to Project Management - Goals, Roles and Responsibilities Project life Cycle, Role of Project Manager, Project Selection Models, Project Acquisition and Risk Analysis, Project Scope Management, Time Cost and Quality Management, Project management Software, Project Communications, project Team Building, Project teams and Teamwork Issues, Project Termination Issues. CV-7402 Total Quality Management Introduction to quality (definitions, history and importance, dimensions), Principles of Total Quality Management, TQM as a new culture, Quality

management philosophies (Deming, Juran, Crosby, Ishikawa, Taguchi, Feigenbaum), Customer satisfaction and customer relationship management, Quality awards (Deming, EFQM, Malcolm Baldrige), Benchmarking, Tools for TQM (quality improvement, SPC, QFD, Taguchi, techniques, etc), Quality standards and quality assurance systems, Cost of quality.

CV-7404 Construction and Industrial Law

Introduction, Role of Engineers and managers, Ethics and Professional Status, Business Issues- Business Organizations, Law of Contract, Intellectual Property Law, Employment, Liability Issues- Law of Tort, Risk and Loss Management, Bonds and Insurance, Societal Responsibilities- Environmental Law and Considerations, Health and Safety Act, Sustainable Development, Employment Equity and Human Rights, Career Issues – Leadership and Management, The Engineering Design Process- Design for Safety, Quality Assurance. CV-7406 Statistics and Probability Introduction to Basic Elements of Probability Theory, Important Probability Distributions in Engineering- Gaussian, log-normal, binomial, exponential, Poisson, exact and asymptotic distributions of extremes, Emphasis on applications to various engineering problems, Component and System Reliability/Failure Analysis-time to failure, failure rate, hazard rate, hazard function, reliability of series system configuration, reliability of parallel system configuration, reliability of r-out-of-n system configuration, Elements of Decision Analysis Under Uncertainty-simple and more general risk decision problems, decision tree, decision criteria, maximum expected monetary value criterion, optimal alternative.

CV-7407 Infrastructure Management in Public Sector

Definition of public infrastructure, Infrastructure management process-monitoring and evaluation, planning and programming, design, construction, operations and maintenance, Infrastructure Organizations and Systems- role of Local, regional, state, and federal agencies, their organization and relationships. Managing infrastructure within and between large public agencies, role of civic organizations and the private sector, planning, design, and construction management consultants. Infrastructure systems: Streets, highways, and sidewalks; public transportation; street lighting and traffic control systems; potable water supply; wastewater and drainage, parks, recreation facilities, and public open spaces; communications systems; public

buildings; solid waste handling and disposal, Infrastructure Monitoring and Evaluation, Infrastructure Planning-Principles and practices of infrastructure planning, Infrastructure Programming and Budgeting, Project Development – infrastructure design, identification of barriers to project development, realistic project schedule and budget. Role of value engineering, Environmental Impact Assessment, Construction- bidding and contract award process, Construction inspection with and without a construction management consultant. Quality Assurance in the construction product.

CV-7408 Human Resource Management in Construction Projects Importance of HRM, external factors influencing HRM; planning and forecasting human resource requirements; recruitment and selection; performance management; reward systems; careers and mentoring; HRM outcomes and current issues in HM. Effects of sociological, legal, economic, ethical, political, strategic and environmental changes, issues and developments on human resource management processes, practices, programs and policies. Responsibilities of HR managers- strategic implementation, managing change, international employment relations, corporate restructuring initiatives, and employee information management, Legal constraints in HR planning

CV-7403 Construction Operations and Productivity

Lean construction principles; materials management including procurement and control; process simulation and flow improvement; constructability, subcontractor and supplier management; quality and productivity improvement; just-in-time, just-in-case, and justright delivery practices; bar coding for material identification; and construction facilities and site development.

CV-7405 Management of Design Process

Design Team Organization, Problem Definition Understanding, Design Process Overview, Schematic Design, Concept Design Development, Final Design, Ready to Advertise Construction Documents , Disruption Management/Phasing, Schedule Monitoring, Project Management Meetings, Construction Team Organization/Plan, Inspection & Testing/Surveillance, Computer applications/tools, Parking, Security, Outages, Interim Moves,

Relations between Contractor and Others, Mock-ups, Relationship to space plan and building design/construction, Budgets, Re-use criteria/analysis and refurbishment, Managing the moving target of technology, Process/phases, User review/approval, Computer Applications/Tools, A/E Relationship

CV-7409 Sustainability and the Built Environment

Fundamental concepts of sustainability and sustainable development, natural systems, interaction of the built environment (infrastructure) with natural systems, Role of technical and non-technical (economic, social, ecological, ethical, philosophical, political, psychological, cultural) issues in shaping engineering decisions, System science and system thinking, Methods to identify and select sustainable solutions to design problems, Methods of improving existing solutions; and methods of reasoning, Natural building technologies and Alternative building systems. Eco-materials, sustainable water and waste water systems, renewable energy, waste and waste products, green building construction, straw bale construction, natural plastersand building with earth and straw.

CV-7410 Information Technology

Applications Introduction and overview of technology applications for civil and environmental engineering, choice of tools and software, simulation and modelling, Intelligent transportation systems overview including environmental and energy savings concepts, Introduction to Remote sensing and cartography, photogrammetry, Introduction to GIS- data base system, GPS, Spatial data visualization, Computer aided design, computer graphics.

CV-6501 Environmental Engineering Design

Design Principles for water, wastewater and solid waste processing, Water treatment Plant design, Municipal wastewater treatment Plant design, Sludge and biosolids, Industrial wastewater, Municipal Solid waste management and disposal, Air Quality Criteria / Management.

CV-6502 Water and Wastewater Engineering

Water quality and standards, Sources of contamination; Treatment of water, Clarification, Design of Clarifier / Sedimentation tank, Sedimentation of flocculent suspensions, Hindered settling, Scouring; Coagulation processes, Flocculation processes, Chemical feeding methods, Sedimentation basin

design, Selection of mechanical equipment. Filtration of water, Slow and Rapid sand filters, Operating difficulties, other filtration processes. Disinfection. Advanced water treatment techniques; Aeration, Water softening, Stabilisation, Ion Exchange, Reverse Osmosis, Treatment of brackish / saline waters, and Water treatment wastes. Types of wastewaters, Sewage and its characteristics, Microbiology of sewage, Sewage treatment Preliminary treatment; Screening, Comminution, Grit and Grease removal, Pre-aeration, Equalization, Primary treatment; Primary sedimentation, Chemical coagulation, Fine screening. Secondary treatment; Attached growth processes; Design of Trickling Filters, Design of Rotating Biological Contactors, Design of Fluidized Bed Systems, Design of clarifier, Suspended growth processes; Activated Sludge, Lagoons and Oxidation ponds, Aeration and mixing techniques, Design of clarifier for suspended growth process. Sludge management, its amount and characteristics. Sludge conditioning, Digestion, Processing and Disposal, Composting. Advanced wastewater treatment; Purpose, Suspended Solids removal, Removal of Nitrogen, Phosphorus, Refractory organics and Dissolved Solids. Disinfection, Odour control.

CV-6504 Solid Waste Management

Evolution of Solid Waste Management; Sources, Composition and Properties of Solid Waste, Municipal Solid Waste, Physical, Chemical and Biological properties of MSW; Types of Hazardous wastes found in MSW. Solid waste generation and collection rates, Waste handling and separation, storage and processing, Collection, Transfer and Transport, Recovery, Reuse and Recycling, Disposal of Solid wastes and residual matter. Sanitary Landfills, Incineration and other methods of safe disposal.

CV-6506 Environmental Management Techniques Environmental Organization, Legislation, Standards, Monitoring and Compliance assurance, Environmental Economics, Regional Development Planning, Environmental Decision Making for industries, NEQs, ISO- 14000 and Occupational Safety and Hazard Regulations, Risk Analysis.

CV-6509 Marine and Estuarine

Environment Marine Ecology, Effects of Pollution Discharges, Oil Spills, Coast Development, Beach Erosion, Channel Dredging and Changing SeaLevel on Marine Environment and Control Measures, Modeling for Pollution Dispersion, Study of Marine Biology (Organism, Fisheries and Mangroves), Coastal Geology and Estuarine Ecology. Marine Resources Management

CV-6510 Environmental Measurements

Principle of Analysis Related to Important Areas in Environmental Chemistry. Analytical Techniques include Colorimetry, Gravimetric and Electrochemical Methods, Atomic Absorption Spectrophotometer, and Gas Chromatography for Determination of Physical/Chemical Characteristics of Water, Wastewater, Solid and Air. Analysis of Treatment Parameters Used in Monitoring of Biological Processes, Microbiological Examinations of Water and Wastewater. Toxicity Tests for Aquatic Organisms.

CV-6511 Water Quality Management

Introduction to Water Quality Management, Eco-toxicology, Biomonitoring and Environmental water quality, Aquatic Toxicology. Water Laws and Regulation and Strategies for Wastewater and Water Quality Management. Direct Estimation of Ecological Effect Potential. Water resources Hydrology and Geo-hydrology, Basic Water Microbiology and Chemistry, Biological, chemical and physical water quality parameters. Point and diffuse sources of pollution. CV-6512 Disaster Management and Risk Analysis Disaster Risk Context, Terms and concepts used in disaster management, Evolution of disaster risk management, Disaster management models and approaches, Disaster risk management process; Hazards, Vulnerability factors, Coping capacities, Outputs from risk assessment. Prevention / Mitigation; Framework for prevention and mitigation, Structural mitigation, Role of public awareness, Preparation of prevention and mitigation strategies. Preparedness Planning, Key preparedness considerations; Coordination and the emergency coordination center, Early warning systems, Damage assessment and needs analysis, working with the media. Emergency Response Management System; Damage assessment and needs analysis, Information management, Resource management. Recovery and Reconstruction.

CV-7503 Air Pollution and Control

Introduction to Air Pollution Control, Air Pollution Effects, Air Pollution Measurements, Emission Estimates, Meteorology, Air Pollutant Concentration Models, General ideas in Air Pollution Control, Nature of Particulate Pollutants, Control of Primary Particulates, Control VOCs, Sulphur dioxide, Nitrogen oxides. Control of Industrial emissions. Motor vehicle problems. Air Pollutants and Global Climate, Indoor Pollution.

CV-7505 Environmental Impact Assessment

Introduction to Environmental Impact Assessment, Overall EIA process; Preliminary Assessment, Scoping, Identification of Impacts, Quantification of Impacts, Mitigation Measure, Presentation of EIA, Decision making, EIA Guidelines for various developmental projects in different sectors. Case Studies.

CV-7507 Environmental Auditing

Introduction to Environmental Audit, Eco-design, Supply Chain Management, Quantifying and reporting environmental performance, Relationship and difference between ISO 14001, ISO 9000, EMAS & TQM, Life cycle analysis (L.C.A.). Audit skills and process, Overview of auditing, Types of audit, Basic audit process. Environmental Legislation and Auditing Skills, Evaluating audit results, Audit reporting, Post-audit activities.

CV-7508 Industrial and Hazardous Waste Management Evaluation of Industrial Waste Problems, Legislation, Characteristics, of wastes produced from industries, Application of Engineering Principles and Processes for Pollution Prevention, Waste Treatment, Recovery and Disposal, Integrated Municipal Solid Waste Management Practices combined with Hazardous Waste Management, Site Remediation Technologies-Bioremediation, Air Stripping and Vapor Extraction

MBA Courses

ACC 501 FINANCIAL ACCOUNTING

This course will orient the students to accounting as a management information system. The course provides basics concept & knowledge of accounting. It explores the accounting principles and conventions related to financial statements' preparation. It ensures that students understand the activities related to current and long-term Assets, Liabilities, equity that leads to preparation of financial statements.

FIN 502 FINANCIAL MANAGEMENT

The module aims at building competence in corporate finance further by extending the coverage in Business Finance module to include three more of the finance functions – financial planning and control, working capital management and financing sources. It continues to emphasize on strategic decision-making techniques that best serve the interests of shareholders, which is to maximize the value of the company.

ACC 503 COST AND MANAGERIAL ACCOUNTING

This course examines the importance of cost and managerial accounting in today's business environment, the student will learn how to use the information from both accounting in different business scenarios by means of effective decision making. Topics include, Product costing approaches Job order, Process costing, Absorption and Variable costing, CVP analysis, budgeting, standard costing and relevant costing.

QTM 503 BUSINESS MATHEMATICS & STATISTICS

The scope of the course is to see the horizon of Mathematics & Statistics application in business and financial affairs. The course stresses business applications using arithmetic, algebra, and ratio-proportion and graphing. Applications include payroll, cost-volume-profit analysis and merchandising mathematics. The course also includes Statistical Representation of Data, Correlation, Time Series and Exponential Smoothing, Elementary Probability and Probability Distributions. This course stresses logical reasoning and problem-solving skills.

MKT 510 MARKETING

This course is designed to introduce foundations of marketing as they relate to the whole business enterprise. This course will focus on developing an understanding of key marketing concepts. The objective of this course, specifically, is to enhance the conceptual knowledge of marketing as applicable to decision making process with a focus on tactical marketing mix decisions. Further it will provide the student with a comprehensive framework to evaluate marketing decisions and to create successful marketing initiatives. The course, will therefore, provide an understanding of the principles of marketing in relation to the product and services including the planning process, organizing the marketing functions, implementing the marketing decisions keeping in mind the ethical, legal and societal consideration.

MGT 510 PRINCIPLES OF MANAGEMENT

This is an introductory course about the management of organizations. It provides instructions on principles of

management that have general applicability to all types of enterprises; basic management philosophy and decision making; principles involved in planning, organizing, leading, and controlling; and recent concepts in management. The principles learned in this course will allow the student to effectively work with and through others in an organization. The course will also encourage the students to explore and inquire the applicability of western management principles and theories in local settings. Besides, the course will discuss the Islamic perspective of managing businesses and organizations.

BCM 512 BUSINESS COMMUNICATION

Business Communication is a broad based, introductory course in organizational communication designed to improve the student's skills as a communicator in a variety of situations. This course will help students develop effective communication skills, with emphasis on business writing, by understanding the components of strategic communication and by practicing different aspects of communication that are important for managers in organizations.

ECO 520 ECONOMICS

This course aims at imparting knowledge of basic economic principles to the business students. It covers micro-and macroeconomic issues that are essential for managers and professionals. The course starts with basic microeconomic concepts such as demand, supply, elasticity's, production and cost. Having established the solid ground of the basics of microeconomics, parts of macroeconomics including national income accounts, aggregate demand, aggregate supply, concepts of inflation and

unemployment, major macroeconomic policy operations will be dealt with. The students shall be able to apply principles of economics to solve economic problems being faced by both public and private sectors of Pakistan.

MGT 541 HUMAN RESOURCE MANAGEMENT

This course will provide an overview of human resource management, with particular emphasis in human resource planning and strategy, personnel selection, equal employment opportunity, training, performance appraisal, compensation, employee health and safety, and career management.

MGT 600 STRATEGIC MANAGEMENT

This course aims to provide students a broad foundation of key concepts, tools and principles of strategy formulation, competitive analysis, strategy evaluation and strategy implementation. The course shall discuss about forces shaping business strategy, developments and potential pitfalls of strategic thinking and outlines practical insights and techniques for handling options/choices for effective strategic decision making. The students shall also be provided real-life illustrations and examples to dig deeper into the tensions and complexity of strategy and equip them with the specific strategies & tactics to make effective strategies ensuring competitive advantage in the current and future environment of the organization.

MGT 600 STRATEGIC MARKETING

Marketing provides the interface between the customer and the firm in which the customer has become pivotal to the success of business activities. The marketer's role is to develop an

understanding of the customer and then use a variety of tools to design, promote and deliver attractive value packages. New media is influencing, determining and reflecting structural changes in the way a business conducts its marketing activities. Customized one-to-one marketing has displaced mass standardization and relationship building has become a major commitment for many organizations.

MGT 601 PROJECT MANAGEMENT

Participants will learn the fundamental concepts of project management, project processes of initiating, planning, executing, controlling and closing the project and application of knowledge and skills to manage the project scope, project time and workflow, project cost and budgets, project resources, project quality, project human resource requirements, project communication (reports, meetings, correspondence, etc.) project changes and project risk management. All these fundamentals are derived from PMBOK of PMI.

ECO 601 ECONOMETRICS

The objective of this course is to provide the basic knowledge of econometrics that is essential equipment for any serious economist or social scientist, to a level where the participant would be competent to continue with the study of the subject. This course looks at the broad range of estimation problems that often arise in economic applications and provides a comprehensive detail of the philosophical and ideological trends along with the assessment and application of economic principles and methodologies to key management decisions within organizations. This will encourage the students to focus

on the application of economic tools rather than allowing them to settle for a purely theoretical understanding.

FIN 603 ENTREPRENEURIAL FINANCE

The objective of this course is to make the students understand the issues and challenges that face decision makers at a strategic level in a corporation. The issues and challenges in Entrepreneurial Finance entail a variety of aspects and this course is offered to develop a thorough understanding of these aspects. These issues pertain to capital budgeting, capital structure, corporate investment, sources of corporate funding, corporate contingent claims, dividend policy, financial risk management, working capital management, etc. Understanding of these issues and their inter-relationship can help the students to apply these fundamentals of finance for the achievement of long-term goals and objectives of the corporation and also to excel in this field as a professional par excellence.

MGT 650 ADVANCE QUALITATIVE AND QUANTITATIVE TECHNIQUES

The course deals with the research methods related to Qualitative and Quantitative Research. It describes the process of research, strategies used in research, types of research, kinds of research, collection of data, reliability and validity of data, data analysis and writing reports including the citation and bibliography.

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MKT 620 BRANDING AND ADVERTISING MANAGEMENT

Management of brands including developing brand managing them. Measuring brand performance. Impact of digital media on brands. Advertisement management through brand value and expense. The course will enhance knowledge of advertisement activities for business development.

MKT 621 INTEGRATED MARKETING COMMUNICATION

Introduction to integrated fundamental Marketing Communications (IMS). IMS process, Role of integration. Creative strategy and use of traditional and digital media. Understanding of promotional tools of business, including advertising, publicity, personal selling and sales promotion.

MKT 622 PUBLIC RELATIONS AND EVENT MANAGEMENT

Operation management marketing. Mathematics and statistical analysis. Accounting, economics, performance in the workplace. Employee relations and entrepreneurial. Skills, event planning and event coordination. The course will benefit students to enable them with bread based practical skills for effective and productive manager job.

MKT 623 SALES MANAGEMENT

Management of sales forces. Sales analysis. Forecasting techniques. Account and territory management. Negotiation. Use of technology in the sales function. Use of computer in the decision processes. Integration of promotional strategies. Application of information-based technologies and tools of analysis. Allocation of promotional resources.

HRM 620 TRAINING AND DEVELOPMENT

Introduction to training and development. Training and assessment. Development of training objectives. Planning of instruction. Learning principles and implementation. Procedure and evaluation of training. Revising, existing

training programs. Establishing new programs. Issues in managing training for better performance of organization.

HRM 621 PERFORMANCE MANAGEMENT

Importance of Performance Management. Performance planning. Organizational mission. Strategy and goal. Creation of performance management culture in an organization. Steps in performance management. Reward for performance. Designing jobs to enhance performance. Performance assessment. Planning, identifying root causes & issues of performance. Team management.

HRM 622 COMPENSATION AND BENEFIT

Financial award system of organizations, identification, definitions, relationship and notification of job evaluation and pay equity. Employment law and procedure of compensation and benefit system. Various pay and compensation systems. Various employment policies and practice and their relation to the utility of compensation strategy.

HRM 623 RECRUITMENT AND SELECTION

Process and principles of organizational staffing. Conceptual and operational aspects of human resources. Staff functions such as job analysis, recruitment assessment, selection, and performance evaluation.

FIN 620 BANKING AND FINANCE

Principles of banking. Lending fundamentals. Banking and business law. Finance, and mortgage lending. studies on marketing, management, accounting and economics.

FIN 621 FINANCIAL REPORTING & ANALYSIS

Financial statements. Historical prospective of financial reporting. Competency of reading and understanding financial statements. Analysis of financial statements. Understanding and analysing quality of financial statements.

FIN 622 FINANCIAL PORTFOLIO MANAGEMENT

Theory and empirical evidence for financial portfolio management. How funds are allocated in a hypothetical portfolio. Studies on capital market parameters. Trade-off between risk and return. Optimal portfolio selection. Delegated portfolio management. Equity markets and financial markets.

FIN 623 ISLAMIC BANKING AND FINANCE

Deep understanding of Islamic banking operating system. Concepts of Islamic Finance provides economics, banking and shariah, Islamic financial institutions. Development of Islamic banking system and emerging banking and financial issues.

FIN 624 CORPORATE FINANCE

Issues confronting entrepreneurial firms at all stages of their existence. Frameworks and builds new skills needed to identify important business ideas, structure, financing, and ultimately

harvest the project. The course covers key aspects of successful entrepreneurship and/or small business management including development of a business plan, organizing and financing a new venture, measuring and evaluating financial performance, short term and long-term financial planning, creating and recognizing venture. Value, structuring financing for the growing venture, and exit and turnaround strategies.

SCM 620 SUPPLY CHAIN MANAGEMENT

Basic concept and strategies of Supply Chain Management (SCM). Understanding of strategic, tactical and operational issues of SCM. Supply chain strategy, e—procurement. Supply chain risk management. Supply chain coordination and integration. Value of information sharing. Global SCM. Customer value and SCM. Dynamics, pricing, coordinated product design chain. Supply chain, and supply chain performance measure.

SCM 621 INVENTORY MANAGEMENT

Role of inventory in supply chains. Economics of scale and buffering of uncertainty in demand and supply lead times. How inventory placement strategies are design. Identification of important functions and costs associated with inventory, explain benefit of risk pooling in supply chain design and inventory management.

SCM 622 DEMAND MANAGEMENT AND VALUE CHAINS

Role of forecasting in the supply chain process. Categories of forecasting methods and their strengths and weakness.

Strategies available of influence demands. Value of forecasting within the supply chain process.

SCM 623 TRANSPORTATION AND DISTRIBUTION SYSTEM

Understanding of strategic and tactical, principles, practices, and tools required to address the cost, service, capacity, and carbon emissions trade-offs in domestic and International transportation.

SCM 624 STRATEGIC OPERATIONS MANAGEMENT

Foundations of the operations function in both, Manufacturing and Services Strategic. Operation perspective. Operations as a competitive weapon in business activities.

MGT 620 SCIENCE AND TECHNOLOGY

Climate change, danger focused by environmental hazards. Debate on diseases. Decision involving nuclear weapons are policy issues that involve science and technology. How risk and uncertainty are accounted for (or not) in decision making. Whether policy decisions involving science and technology should be democratized, and how the public impacts science policy decisions.

MGT 621 MANAGEMENT LEADERSHIP

Introduction to Management Leadership. Theory concept, personal skills, self-assessment process. Leadership ethics. Networking. Coaching, Organization culture. Diversity. Strategies leadership and Crisis leadership.

MGT 623 SEMINARS ON 21ST CENTURY MANAGEMENT

To be arranged by the concerned SSUET faculty

MAM 620 COMMUNICATION AND COMMUNICATION THEORY

Principles and concepts of various types of human communication, including interpersonal, organizational, public and mass communication. Development of mass media with emphasis on print and electronic media in the areas of policy making, programming, regulations, economics and technology. Social, cultural and political impacts of the mass media on contemporary society. Concepts, models and perspectives in development of theories of communication with attention to reciprocal relationship between theory building and theory testing in the study of human communication process. Theory development, theories of meaning. Information processing, and influence with applications to selected communication contexts.

MAM 621 WRITING FOR MEDIA (PRINT & ELECTRONIC)

Introduction of journalism emphasizing journalistic conventions and gathering and writing of new for print and broadcast media. Various types of mass media writing — print and broadcast journalism, public relations, advertising and online media. Skills in information gathering, interviewing, organizing, writing and revising our own media writing, and in judging the quality of current media writing. Editorial essay, column and other interpretive matters.

Write press release, page make up, short video displays, and TV news writing techniques.

MAM 622 MASS MEDIA AND SOCIETY

Relationship between media, culture and society with special emphasis on the corporate sector. Social, cultural and political consequences of the dominance of privately SSUET corporate media on a democratic society, and the role media plays in the production, reception and representation of race, class, gender and sexuality. Roles and the responsibilities of mass media in society, issues of media policy, control and analysis of the relationship between the media and the government, as well as other kinds of institutions. Media's rights, role and responsibilities for the society.

MAM 623 COMMUNICATION AND NEGOTIATIONS

Framework for achieving their goals in global management settings. Time-tested strategies for achieving communication competence with persons from different cultures. Negotiating in the global context. Theories of culture and communications. Valuable skills for overcoming obstacles in global management environments. Negotiation exercises, and simulations, the global manager with tools to solve problems and take advantage of opportunities in a multicultural world.

MAM 624 COMMUNICATION AND PUBLIC OPINION

Contemporary concepts of public opinion, Theories about public opinion formation, and ways of measuring public opinion, with special reference to political topics and issues. Role of knowledge, interest, partisanship, and media use in opinion formation and change. Influence of public opinion on private and public institutions in a democratic society and the role of the mass media in opinion formation. Nature of persuasion in establishing or modifying public opinion, and perspectives on the social responsibilities of communications. Dimension of public opinion and how opinion polls structure political and organizational opinion. It also explores the conceptualization of how attitude, values, and opinions structure political and business arenas.

MAM 625 ADVERTISING MANAGEMENT

Current practices related to media selection, types of advertising, sales promotion, consumer markets, and demand creation. Advertising management, social and buyer issues, Creative and media strategy, agency, and domestic and global aspects. Fundamental principles and practices of marketing communications planning and management, with emphasis on advertising, publicity and sales promotion. Theories of advertising management and application of sales methods through discussion.

MAM 626 MEDIA AND EVENT MANAGEMENT

Modes of communications within an organizational structure. Understanding of their influence on the decision-making

processes. Investigation of the elements of the promotional mix focusing on public relations (media relations, information, and journalism) and personal contact (community relations, socialization, word-of-mouth). Advertising, sponsorship, licensing, incentives, and atmospherics. Investigation of the need and current applications of information technology and database management in organizations of all levels. The operating structures, procedures, regulatory environment, rules, and contemporary issues of information technology in organizational environments.

URM 601 CITY GOVERNANCE

Cities are hub of economic activity, industrial development, vast energy user, emit greenhouse gases. But now cities are faced with rapid pace of urbanization due to push and pull factors and high population growth. Infrastructure in cities is at threshold of decline and fast drifting to collapse law and order is getting out of control.

URM 602 LOCAL GOVERNMENT AND FINANCIAL MANAGEMENT

Three tiers of Government. Local Government functions at grass root level and performs functions entrusted under local bodies act like: Preventive health, sanitation, solid waste management i.e. collection, transportation, disposal of solid waste at landfill sites, curative health or medical care, Road and building works maintenance, Collection of Local taxes.

URM 603 URBAN PLANNING AND MODERN TRENDS IN PLANNING

History of civilization and growth of communities Pre-historic towns and its development: Nile Valley, Mesopotamia, Indus Valley, Mohenjo-Daro, Harappa, Ghandara Cities, Greek, Roman Cities. Medieval Planning, Planning during Moghal era, British Planning Era, The Garden City concept by Ebenzar Howard.

URM 604 INFRASTRUCTURE PLANNING, DEVELOPMENT AND MANAGEMENT

Types of infrastructure: Social Infrastructure, like community facilities schools, playgrounds, dispensaries, community centres, parks while Physical Infrastructure: like Water Supply, sewerage, drainage, roads, electricity, natural gas, bridges, culverts, transportation system etc. Infrastructure planning, development and management is based on specific stand prudent practices of engineering discipline. Demand modelling and demand management is an important input in infrastructure development planning.

URM 605 SUSTAINABLE DEVELOPMENT AND PLANNING

Sustainable development planning is that planning and development that is technically feasible, lasting, lifecycle cost effective and affordable by beneficiary.

URM 606 URBAN CONVERSATION AND URBAN RENEWAL

Downtown or old city areas have deteriorated and damaged with dangerous buildings. These areas have historical

significance, heritage and give character and significance to city like walled city Lahore. Renovation, urban renewal is needed to protect and develop such areas to regenerate or revive the city center. Conservation and preservation of historically culturally valuable structure would lead to value addition of the area.

URM 607 HAZARDS AND DISASTER MITIGATION

Hazard or Disaster is a sudden occurrence that creates panic chaos and may result in loss of life or property. 2 types of hazards or disasters: Natural like Tsunami, Earthquake, Floods, Urban Floods, Cyclone etc. Manmade hazards like: fire, terrorists attack. Management or mitigation of hazard or disaster is important and follows a sequence: a proactive approach is preparedness, preventive measure before occurrence of disaster.

AVM 620 INTRO. TO AVIATION INDUSTRY AND AVIATION MANAGEMENT

Historical perspective of the development of the field of aviation and aerospace. Basic concepts of aviation business, principles and practices associated with the aviation industry. History covers interesting aspects of aviation for initial days of the age of the pioneers to world wars and cold war to commercial aviation and space travel. All essential and preliminary aspects of the aviation industry and its management is covered.

AVM 621 AVIATION LAW

This course is designed to provide students with essential knowledge about Aviation and Business law. The students are expected to learn about the current laws and regulations within Pakistan as well as international domains specifically regarding the International Civil Aviation Organization (ICAO). The students will be expected to analyze case studies and be aware of the common mistakes committed in the aviation industry.

AVM 622 AIRLINE OPERATION AND MANAGEMENT

The Course presents an integrated study of airline operations and functions, domestic and international regulation of air carriers and the industry's changing structure due to alliances and globalization are addressed. Airline economics, airline marketing and pricing, computer reservation and revenue management systems, fleet planning and scheduling, aircraft maintenance, aircraft finance, labor relations, organizational structure, and strategic planning.

AVM 623 AIRPORT OPERATIONS AND MANAGEMENT

The course presents an integrated study of airport operations and functions, along with domestic and international regulation of airports. Global trade representative of airports, the Airports Council International (ACI) is also reviewed. The course includes airports' interests with governments and international organizations; study is done on international standards, policies and

recommended practices for airports. The course also aims to provide an overview of safety and security around the airports. Environmental aspects are studied in the course as well. Airport finance, labor relations, organizational structure, and strategic planning.

AVM 624 AIR CARGO LOGISTICS MANAGEMENT

Planning and operations of air cargo systems. These topics include identifying the main components of an air cargo system, the competition between air cargo and other surface-transportation modes, network and capacity planning, demand analysis and trends in the domestic and international markets, air cargo revenue management, cargo strategic alliances, revenue proration agreements, supply chain in air cargo management, shipper and forwarder interaction, ground/sorting operations, airport relations, e-commerce in air cargo management, marketing air cargo service, and air cargo security. Study cases in air cargo management and market analysis.

AVM 625 AVIATION BUSINESS POLICY AND DECISION MAKING

Examine applications of long-term planning and management tools in aviation-related industries to formulate strategic vision and policies. Concepts of strategic management, total quality management, continuous quality improvement, reengineering, customer-driven management, and other evolving management methodologies will be examined. Domestic and

international activities of airlines, airports, manufacturing, and government to sustain a long-term competitive advantage.

