Micro-Specialization

The Institute proposes to offer Micro-Specializations to UG students from the Spring Semester of the current Academic Session (2014-2015). The salient features are as follows:

1. Each Micro-Specialization has a defined structure in terms of three sequential components:
   a) **Component-I** – One Foundation Course (2-4 credits) that constitutes a Mandatory Requirement and also a Pre-Requisite for subsequent Components.
   b) **Component-II**- One/Two subjects (3-4 credits each) from a Specified list of subjects.
   c) **Component-III**- Project/Design/Term Paper (4 credits) OR one subject (4 credits) from a Specified list.
2. A Student would be required to complete 3-4 subjects (10-14 credits) from the specified list in order to earn a Micro-Specialization.
3. The subjects can be taken through the Breadth/Open Elective component of the curriculum or as Additional Subjects. **Micro credit subjects can also be a part of Micro-specialisation**.
4. A student has to register for a Micro-Specialization. The Registration can be done in the beginning of any Semester beyond first year.
5. In order to register for a Micro-Specialization the student must have completed all curricular requirements upto the previous semester and have a CGPA ≥ 7.0. Thereafter the student must maintain a CGPA or SGPA ≥ 7.5 without any Backlog in the subsequent semesters to keep the Micro-Specialization registration active.
6. GPA for the subjects contributing to the Micro-Specialization will be separately calculated. A minimum GPA of 6.00 is essential to earn the Micro-Specialization.

All students may please note that all subjects have been approved by Senate at its 311th Meeting held on 22/12/2014, 312th Meeting held on 18/03/2015 and 313th Meeting held on 26/05/2015 and 316th Meeting held on 13/04/2016.

In view of the fact that students will have to take the mandatory compulsory pre-requisite subject first before taking other subjects included in the list but may also serve as depth/breadth/HSS elective. Hence students should carefully plan out what do they want to take as micro-specialization right from the start of 2nd year of study and take the compulsory pre-requisite subject first.

Students should note that in case they have taken an elective subject of component 2 and 3 before taking the compulsory pre-requisite subject, they cannot re-take that elective subject again to complete the requirements for obtaining micro-specialization in a particular area. They will have to take alternative available elective subject from component 2 & 3. In case no other elective subject is available, they will not be eligible for the micro-specialization in the desired area.

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Name of the Micro-Specialization: Embedded Wireless Systems

1. **School/Center: G. S. Sanyal School of Telecommunications**

2. **Brief Description:**
   This course aims to disseminate necessary knowledge base on signal processing methodology, algorithms and protocols for design and development of embedded wireless communication systems.

3. **Number of Subjects needed to earn the Micro-Specialization :** *4 Subjects or 3 Subjects + 1 Project*

4. **Credits needed to earn the Micro-Specialization: 12-14 credits**

5. **Structure: Component I: One Subject (2-0-0)**
   Component II: Two Subjects (3-1-0/ 3-0-0)
   Component III: One Project (0-0-6) or One Subject (3-0-0)

A. COMPONENT- I: MANDATORY REQUIREMENT: (2 credit FOUNDATION COURSE) for those students who have not studied *Digital Communications (EC31002)* and passed successfully.

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
TE30002	Introduction to Wireless Communications	2-0-0	2	**Both Semesters**	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits each) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
TE61002	MIMO Communications	3-1-0	4	Spring	**TE30002**
TE61003	Communications Signal Processing and Algorithms	3-1-0	4	Autumn	**TE30002**
TE60003	Spread Spectrum Communications and Jamming	3-0-0	3	Autumn	**TE30002**
TE60114	Broadband Access Networks	3-1-0	4	Spring	**TE30002**

C. COMPONENT- III: PROJECT (4 credits) OR ANY ONE (3 credits) SUBJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
TE60006	Communication Services and Applications	3-0-0	3	Spring	TE30002
TE60004	Telecommunications Network Security	3-0-0	3	Spring	TE30002
TE67001	Project on Embedded Wireless Systems	0-0-6	4	Both Semesters	TE30002

Subject Details

TE30002: Introduction to Wireless Communications (L-T-P: 2-0-0; Credit: 02)

A. Syllabus:

- Introduction to wireless technology (1 Lecture Hr.);
- Bandpass signals and systems (3 Lecture Hr.);
- Baseband equivalent of narrow band signals and systems (5 Lecture Hr.);
- Noise in wireless receivers (3 Lecture Hr.);
- Wireless transceiver structures – link budget, RF stage, antenna (6 Lecture Hr.);
- Digital signal processing and digital design of wireless transceivers (4 Lecture Hr.);
- System level examples – Physical Layer and Medium Access Layer (6 Lecture Hr.);

B. Total Lecture Hours: 28

TE67001: Project on Embedded Wireless Systems (L-T-P: 0-0-6; Credit: 04)

A suitable executable project from any one of the following areas:

(a) Spread Spectrum transceiver with variable spreading gain over AWGN channel;
(b) Power control for multiuser interference mitigation;
(c) Design and implementation of cognitive transceivers;
(d) Design and implementation of codecs in DSP / FPGA;
(e) Wireless transceivers for body area network;
(f) Embedded sensing systems;
(g) Implementation of synchronization algorithms for cellular communications;
(h) Implementation of equalization algorithms;
(i) Machine to machine wireless communications;
(j) Embedded security procedures;
(k) Embedded components of software radio;
(l) Any other area, related to digital wireless systems, as may be offered by the School.

Name of the Micro-Specialization: Biomedical Devices and Instrumentation

1. **School/Center: School of Medical Science & Technology**

2. **Brief Description:**

This program is designed to provide the knowledge and skills needed for the development of medical devices and diagnostic techniques, including aspects of medical instrument/product regulation and also product development.

It is a rapidly advancing, inter-disciplinary research field for creation and development of new methods/systems to effectively process or manipulate biological materials with electronic devices and components. An interdisciplinary R&D work at SMST has been initiated to promote MEMS and Biosensor activity that encompasses design, fabrication and engineering of biomedical & micro-fluidic devices for its electro-physiological characterization, sensing various biological signals, Electrical mechanical and physical properties of bio molecules and cells. The research also involves development of different transducers and related technologies for sensing various biomedical signals for precise and appropriate diagnostics and therapeutics. Micro-fabrication technology is also being explored to develop various devices for deployment of in-vivo and in-vitro detection of biomedical signals and its characterization. One of the course of this program is designed to teach the fundamental background of state-of-the-art technologies for micro-sensor and micro-actuator system applications.

The course titled “Biomedical Instrumentation” will deal with fundamentals of medical instrumentation systems, sensors, and biomedical signal processing. For example instruments for cardiovascular and respiratory assessment. Biomedical transducers for measurements of bio-potentials, pressure, flow, concentrations, movement and temperature are discussed. Clinical laboratory measurements, therapeutic and prosthetic devices, and electrical safety requirements.

Engineered materials are increasingly used in medical applications, bone and dental implants, scaffolds for tissue engineering, replacement body parts, and biomedical and surgical devices. Biomaterials, as a subject, require a understanding of the properties of materials in general, and the interactions of materials with the biological environment in particular. Therefore biomaterials engineering is an important subject that needs to be learned for in-vivo applications of biomedical devices.

3. **Number of Subjects needed to earn the Micro-Specialization:** Two Subjects + One Project

4. **Credits needed to earn the Micro-Specialization: 12 credits**

5. **Structure: Component I: One Subject (3-1-0)**
   Component II: One Subject (3-1-0)
   Component III: One Project (0-0-6)

A. COMPONENT- I: MANDATORY REQUIREMENT: (4 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MM61501	Basic Human Anatomy Physiology and Pathology	3-1-0	4	Autumn	NA

B. COMPONENT- II ANY ONE SUBJECT (4 credits each) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MM61509	MEMS and Biosensor	3-1-0	4	Autumn	**MM61501**
MM61502	Biomedical Instrumentation	3-1-0	4	Spring	**MM61501**
MM61316	Biomaterials	3-1-0	4	Spring	**MM61501**

C. COMPONENT- III: ONE PROJECT (4 credits) FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MM77319	Minor Project-I	**0-0-6**	4	Autumn	**MM61501**
MM77320	Minor Project-II	**0-0-6**	**4**	Spring	**MM61501**

MM61501: BASIC HUMAN ANATOMY, PHYSIOLOGY AND PATHOLOGY (LTP: 3-1-0, CRD: 4)

SYLLABUS:

Introduction to Human Anatomy, Physiology, Pathology and Medical Technology. Introduction to Cellular-sub-cellular structure and function, extra cellular matrix, tissues, organs and systems from an integrated viewpoint. Introduction to genetics- proteomics metabolomics bio-regulatory pathways feedbacks-biorhythms, physiology of Membrane transport, RMP, neuromuscular transmission and muscle contraction (including Skeletal, cardiac and smooth muscle characteristics). Integumentary system: Basic structure function, circulation and interrelation with other systems. Musculoskeletal system: basic structure function, circulation and interrelation with other systems.

Blood, Lymphatics and other body-fluids: Basic structure function, own circulation and interrelation with other systems. Cardiovascular system: Basic structure function, own circulation and interrelation with other systems, Cardiac cycle, heart sounds and electrical activity of heart with basic ECG interpretation. Respiratory system: Basic structure function, own circulation and interrelation with other systems. Nervous system: Basic overview of structures and functions of neuron, Basic structure function, own circulation and interrelation with other systems, ANS, Motor and Sensory system), central regulation of visceral function, sensation, sleep and EEG, hunger, thirst, Control of posture and movement, joint mechanics and Gait Analysis. Special senses (vision, hearing, equilibrium, smell, taste), own circulation and interrelation with other systems. Endocrine system: Basic structure function, own circulation and interrelation with other systems.

Gastrointestinal system: Basic structure function, own circulation and interrelation with other systems. Reproductive system: Basic structure function, own circulation and interrelation with other systems (Basics of Reproductive physiology, sex differentiation, menstruations, pregnancy and lactation. Hypothalamic-pituitary axis, calcium metabolism and its regulation).

Renal system: Basic structure function, own circulation and interrelation with other systems (Nephron hemodynamics, clearance and regional transport, basics of acid-base disturbance). Bio-implants: Different implants and their interfaces as well as interaction with human systems. Introduction to necessity medical imaging and image analysis: A journey towards integrated

quantitative analysis of temporal and spatial features of human system in normal and diseased conditions. Human development biology: Basics-organogenesis system development. Fostering Dialogue amongst Medical sciences, Engineering sciences and Basic sciences: In terms of language, Terminology, History, Psychology, Logic interfaces, Social role and Application.

MM61502: BIOMEDICAL INSTRUMENTATION (LTP: 3-1-0, CRD: 4)

SYLLABUS:

Introduction to the physiology of cardiac, nervous and muscular and respiratory systems. Transducers and Electrodes: Different types of transducers and their selection for Biomedical applications, Electrode theory, Different types of electrodes Hydrogen Calomel, Ag-AgCl, pH, PCO_2 electrodes, selection criteria of electrodes.
Cardiovascular measurement: The cardio vascular system, Measurement of Blood Pressure, Blood flow, Cardiac output and Cardiac rate, Electrocardiography, Photocardio-graphy, balloistocardiography, Plethysmography, Magneta Cardiography,Cardiac pace-maker, computer applications. Measurement of Electrical Activities in Muscles and Brain: Electrimyography, Electroencephalograph and their interpretation.
Respiratory system Measurement: Respiratory mechanism, Measurement of gas volume, flow rate carbon dioxide and oxygen concentration in inhaled aided respiratory controller, Instrumentation for clinical laboratory: Measurement of pH value of blood, ESR measurements, hemoglobin measurement, oxygen and carbon dioxide concentration in blood, GS measurement, polarographic measurements, computer appilications.

MM61509: MEMS & BIOSENSORS (LTP: 3-1-0, CRD: 4)

SYLLABUS:

Fundamental of MEMS: Introduction to MEMS principles and fabrication technologies, fundamental MEMS structures, MEMS materials, MEMS design, fabrication, packaging, Fundamental mechanical, electrical optical, biochemical and fluidic characteristics of the basic microstructures.
Bio- MEMS for clinical detection: Fundamentals of micro and nano fabrication of biochips and lab-on-a-chips, molecular recognition and bio-immobilization principles and procedures, on-chip biochemical detection methods, introduction to micro/nano fluidics, basic components of lab-on-a-chips and its integration.

Biosensors and Biochips: Fundamentals of biosensors, fundamentals of electrochemisatry and electrochemical biosensors, micro-fluidic devices and systems, MEMS sensors and actuators for medical instrumentation and fundamental of bioelectronics for bio-signal conditioning and processing.

MM61316: BIOMATERIALS (LTP: 3-1-0, CRD – 4)

SYLLABUS:-

Introduction to Materials, General structure and properties. Classification of common materials and applications. Chemical Bonding, Crystalline, Amorphous.

Melting, Solidification, Nucleation, Phase diagrams. Metal and alloys in Medical application: Stainless steel, Cobalt based alloys. Titanium based alloys (including shape memory alloys). Ceramics and glasses- bioceramics: Type of Ceramics and their classification, Calcinations, Annealing, Sintering, Nearly insert ceramics, bio-reactive glasses and glass ceramics, Calcium phosphate ceramics. Introduction to polymers: Definition, classification, Polymerization Rubber, plastics, fibres and resins and structure-properties relationship. Biodegradable polymers; Natural polymers, Composites, Pyrolitic carbon, Carbon nano tubes. Bulk Proper Surface properties and modification of surface properties. Basic principles of engineering manufacturing, methods and applications of common manufacturing processes, milling, grinding, finishing, rolling, forging, Concept of biomimetic synthesis, Preparation of fiber and wire, Fabrication of Porous Materials, Direct moulding Technique, Different advanced fabrication technique.

Name of the Micro-Specialization: Engineering Systems Reliability

1. **School/Center:** Reliability Engineering Centre
2. **Brief Description:** UG students with various engineering backgrounds need to design, manufacture, operate and maintain engineering systems/services. Reliability engineering focuses on identification of weaker components/processes in a system and the methods of improvement so that the system becomes more reliable, safer and easily maintainable. Reliability engineering tools are structured, systematic, and objective approaches for quantitative and qualitative performance analysis. This specialization will help students to understand these tools, life testing, field failure data collection and analysis methods. This micro- specialization is designed with generic approach so that students from all disciplines get benefited.
3. **Number of Subjects needed to earn the Micro-Specialization:** 4 Subjects or 3 Subjects + 1 Project
4. **Credits needed to earn the Micro-Specialization: 12-14 credits**

5. Structure: Component I: One Subject (2-0-0)
Component II: Two Subjects (3-1-0/ 3-0-0)
Component III: Project (0-0-6) or One subject taken from Component II

A. COMPONENT- I: MANDATORY REQUIREMENT: (2 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RE20001	Introduction to Reliability Engineering	2-0-0	2	Both	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits each) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RE60021	Reliability Estimation and Life Testing	3-1-0	4	Autumn	**RE20001**
RE60011	Probabilistic Risk Assessment	3-1-0	4	Autumn	**RE20001**
RE60024	Software Reliability	3-0-0	3	Spring	**RE20001**
RE60018	Fault Diagnosis and Predictive Maintenance	3-0-0	3	Spring	**RE20001**
RE60002	Reliability Design	3-1-0	4	Spring	**RE20001**
RE60005	Quality of Service Analyses in Cloud Computing	4-0-0	4	Spring	**RE20001**
RE60015	Statistical Process Control	3-0-0	3	Spring	**RE20001**
CE60112	Risk and Reliability of Civil Infrastructure Systems	3-0-0	3	Spring	**RE20001**

C. COMPONENT- III: PROJECT (4 credits) FROM TABLE-III OR ANY ONE (4 credits) SUBJECT FROM TABLE-II

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RE67006	Project on System Reliability/Risk Analysis	0-0-6	4	Both	**RE20001**

Syllabus

RE20001: SUBJECT NAME- INTRODUCTION TO RELIABILITY ENGINEERING
LTP- 2-0-0, CRD- 2

SYLLABUS:-
Basic Definitions of reliability and maintainability terms. Failure rates such as constant, increasing and decreasing hazard rates. Reliability Block Diagram, Series, parallel, series-parallel, standby and k-out-of- modeling. Reliability prediction and estimation, Life Testing. The concepts of availability, maintainability, safety, and probabilistic risk of engineering products. Basic concepts of software reliability.

RE60003: SUBJECT NAME- RELIABILITY ESTIMATION & LIFE TESTING
LTP- 3-1-0,CRD- 4

SYLLABUS:-
Parameter Estimation, Regression analysis. Interval Estimation procedure for exponential, Gamma, Weibull, Log-normal and Fatigue life models. Point and interval reliability estimation. Testing reliability hypotheses for mean of distribution. Tests for Weibull, distribution, Reliability testing procedure, types of tests, accelerated life tests-parametric and nonparametric methods. Continuously increasing stress tests.

RE60011: SUBJECT NAME- PROBABILISTIC RISK ASSESSMENT
LTP- 3-1-0, CRD- 4

SYLLABUS:-
Concept of risk, objective and scope of risk assessment, probabilistic risk, risk perception and acceptability, Quantitative aspects of risk. Three levels of risk quantification, PRA management, preliminary hazard analysis, HAZOP and HAZAN, FMEA and FMECA analysis, Fault tree Analysis. Digraph and other approaches. Computation of Hazard probability, unavailability and other parameters using fault tree methodology. Monte Carlo Simulation technique, Event tree analysis, identification of initiating events, sequence and scenario development, system analysis, external events and dependent failures and quantification, Accident-consequence Analysis, uncertainty analysis, sensitivity analysis and importance measures, Bayesian approaches. Human Reliability Analysis.

RE60024: SUBJECT NAME- SOFTWARE RELIABILITY
LTP- 3-0-0, CRD- 3

SYLLABUS :-

Definition, errors-their cause and consequence, basic design principle of reliable software, requirements, objectives, and specifications, system architecture, program structure design, design practices, module design and coding, programming style. Software testing principles, module testing, functions and system testing, debugging, programming languages and reliability, computer architecture and reliability, proving program correctness, reliability models, software support systems.

RE60018: SUBJECT NAME- FAULT DIAGNOSIS & PREDICTIVE MAINTENANCE
LTP- 3-0-0, CRD- 3

SYLLABUS:-
Determining health of machines through parameter monitoring. Performance and auxiliary variables, vibration parameters, time and frequency domain signals, vibration identification and diagnostic tables, vibration standards, vibration monitoring instruments. Temperature monitoring, thermography, tem-plugs, thermo-paints. Lubrication monitoring, SOAP, wear particles analysis, ferrography, ferrographical analyzer. Noise-sound monitoring sound measurement, magnetic tape recorders, sound level meters and analyzers, sound level data processing.

RE60002: SUBJECT NAME- RELIABILITY DESIGN
LTP- 3-1-0, CRD- 4

SYLLABUS :-

Functional Designs, design simplifications, de-rating and human factors and optimal design selection. Allocation problem, reliability, redundancy and optimal reliability and redundancy allocation. Failure and repair rate allocation. Various design problems and their relevant solution techniques. Optimal maintenance strategies. Spare parts provisioning and policies. Optimal manpower planning.

RE67006: SUBJECT NAME- MICRO SPECIALIZATION PROJECT

LTP- 0-0-6, CRD – 4

Possible areas:

1. Accelerated Life Testing on components and products
2. Fault Diagnosis of Engineering Systems
3. Reliability Prediction of products
4. Failure data analysis and reliability estimation
5. Software reliability and quality
6. Risk analysis of engineering systems

Name of the Micro-Specialization: Rubber Engineering

1. School/Center: Rubber Technology Centre (RTC)

3. Brief Description: Rubbers and Elastomers are very special class of Polymers that occupy a pivotal position in the materials field today. In performance characteristics, application prospects and diversity, they offer novelty and versatility not found in other kind of materials. This Micro-specialization course will primarily focus on the basic understanding of the science, technology and engineering of rubbers, fundamentals concepts behind engineering design with rubbers and various routes of processing of rubbers and rubber like materials for various applications like tyres, automotives, cables, hoses, belts etc. The course has been designed to have an interdisciplinary relevance for mechanical engineering, chemical engineering etc.

4. Number of Subjects needed to earn the Micro-Specialization: Three Subjects

5. Credits needed to earn the Micro-Specialization 10 credits

6. Structure:

Component I: One Subject (2-0-0)
Component II: One Subject (3-1-0)
Component III: One subject (3-1-0)

A. COMPONENT- I: MANDATORY REQUIREMENT (2 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RT30001	Basic Science and Technology of Rubbers	2-0-0	2	Autumn	NA

B. COMPONENT- II ONE SUBJECT (4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RT60016	Engineering Design with Rubbers	3-1-0	4	Spring	**RT30001**

C. COMPONENT- III: ONE SUBJECT (4 credits) FROM TABLE-III

TABLE-III

Sub no.	*Sub Name*	*LTP*	*Credits*	*Offering Semester*	*Pre-Requisite (if any)*
RT30003	Processing of Rubbers and Rubber like Materials	3-1-0	4	Autumn	**RT30001**

Name of the Micro-Specialization: Electronic Materials & Applications

1. School/Centre: MATERIALS SCIENCE CENTRE

2. Brief Description: Nano-electronics have enjoyed explosive growth in the past few years. In particular, nanofabrication techniques have advanced tremendously in recent years. Obviously revolutionary changes in the ability to measure, organize, and manipulate matter on the nanoscale are highly beneficial for electronics with its persistent trend of downscaling devices, components, and integrated systems. In turn, the miniaturization required by electronics is one of the major driving forces for nanomaterials. Thus for the basic ideas needed to understand recent developments in materials & processes, as applied to nanoelectronics, are the focal theme of this Micro - specialization.

3. Number of Subjects needed to earn the Micro - Specialization: 3 Subjects or 2 Subjects +1 Project

4. Credits needed to earn the Micro – Specialization: 10 - 11 credits

5. Structure: Component I: One Subject (3-0-0)
Component II: One Subject (3-1-0/ 3-0-0) or Project (0-0-6)
Component III: Project (0-0-6) or One subject (3-1-0)

A. COMPONENT- I: MANDATORY REQUIREMENT: (3 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MS60009	Fundamentals of Electronic Materials	3-0-0	3	Both	NA

B. COMPONENT- II ANY ONE SUBJECTS (3/4 credits) OR PROJECT FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MS61015	Materials for High Frequency Applications	3-1-0	4	Autumn	**MS60009**
MS31001	Photonic Materials & Applications	3-0-0	3	Autumn	**MS60009**
MS60032	Optoelectronic Materials and Devices	3-1-0	4	Spring	**MS60009**
MS67103	PROJECT*	0-0-6	4	Both	**MS60009**
MS61015	Materials for High Frequency Applications	3-1-0	4	Autumn	**MS60009**

C. COMPONENT- III: PROJECT (4 credits) OR ANY ONE (4 credits) SUBJECT FROM TABLE-III

TABLE-III

Sub no.	***Sub Name***	***LTP***	***Credits***	***Offering Semester***	***Pre-Requisite (if any)***
MS60023	Epitaxy of Compound Semiconductors	3-1-0	4	Autumn	**MS60009**
MS60044	Technology of Ceramics for Electronic Applications	3-1-0	4	Spring	**MS60009**
MS60052	Introduction to Nanotechnology and Nano-structured Materials	3-1-0	4	Spring	**MS60009**
MS60038	Polymers for Electronic and Photonic Applications	3-1-0	4	Spring	**MS60009**
MS67104	PROJECT*	0-0-6	4	Both	**MS60009**

***PROJECT -** A student is allowed to take PROJECT only in one semester. Project would be offered on following major disciplines (i) Polymer materials, (ii) Ceramic Materials, (iii) Semiconducting Materials, (iv) Nanostructured Materials

Name of the Micro-Specialization: BIOENERGY

1. **School**: School of Energy Science & Engineering (SESE)
2. **Brief description**: Opening with an introductory foundation course on Bioenergy, this micro-specialization shall provide the students with a wide-angle view of Bioenergy, ranging from its fundamentals through bioresource management, biofuels technology and bioreactor design to biopollution control. The student shall also get an opportunity to engage in Bioenergy research through mini-projects on Biohydrogen, Biomethane, Bioethanol, Biodiesel, Microbial Fuel Cell, etc.
3. **Number of Subjects needed to earn the Micro - Specialization:**4 Subjects or 3 Subjects+1 Project
4. **Credits needed to earn the Micro - Specialization 12 - 13 credits**
5. **Structure: Component I: One Subject (2-0-0)**
   Component II: Two Subjects (3-1-0/ 3-0-0)
   Component III: One subject (3-1-0) or Project (0-0-6)

A. COMPONENT- I: MANDATORY REQUIREMENT: (2 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
ES30001	Introduction to Bioenergy	2-0-0	2	Autumn	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
BT41002	Bioresource Technology	3-0-0	3	Spring	**ES30001**
CH60016	Fundamentals Of Bioenergy	3-0-0	3	Spring	**ES30001**
BT41013	Bioreactor Analysis And Design	3-0-0	3	Autumn	**ES30001**
ES60002	Waste To Wealth: Microbial Intervention	3-1-0	4	Spring	**ES30001**

C. COMPONENT- III: PROJECT (4 credits) OR ANY ONE (4 credits) SUBJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
ES67001	Innovative Student Project On Renewable Energy	0-0-6	4	Both	**ES30001**
CE60028	Industrial Water Pollution Control	3-1-0	4	Spring	**ES30001**
ES61001	Characterization And Analysis Of Biomass And Biofuel	3-1-0	4	Autumn	**ES30001**

**** if any:** The "Innovative Student Project on Renewable Energy" listed in Table III shall be a student-driven project that will be conceived by the student and mentored by the faculty members of PK Sinha Center for Bioenergy.

ES30001: Introduction to Bioenergy (2-0-0; 2 credits)

Objective: The aim of this course is to provide the undergraduate students with an overview of the contemporary global narratives of Bioenergy, and familiarize them with the fundamentals of the engineering science of Bioenergy. As an introductory course to the Micro-specialization on Bioenergy, this foundation course would prime the students with the necessary pre-requisites needed for them to credit the elective courses in the Bioenergy Micro-specialization.

Syllabus:

Definition of Bioenergy, Sources of Bioenergy, Classification of Bioenergy: Solid, Liquid, gaseous, Bioenergetic pathways, Microorganisms for Bioenergy production, Stoichiometry of Bioprocesses, Bioreactor analysis, Process design and scale-up

Reference Books:

1. Bioenergy, Judy D. Wall, Caroline S Harwood, Arnold Demain, ASM Press, Washington. DC2008
2. Biogas from Waste and Renewablke sources, Dieter Deublein and Angelika Steinhauser, Wiley-VCH , Weinheim, 2011
3. Biohydrogen production: Fundamentals and Technology advances, D.Das, N. Khanna, C. NagDasgupta, CRC Press, New York, 2014

ES60002: Waste to Wealth: Microbial Intervention (3-1-0; 4 credits)

Objective:

Aim of this course is to expose the students to the recent frontier areas of Bioenergy studies and its importance. The main objective of this course is to familiarize the graduate and undergraduate students to the different types of organic pollutants and their control through microbiological intervention. By opting for this course, students will find an opportunity to learn the advance techniques adopted presently for conversion of the organic solids as well as liquid wastes to wealth.

Syllabus:

Introduction: Glimpses of microbial world towards biofuel/bioenergy production from biomass; Biomass characterization (Biophysical, Biochemical, Physicochemical, thermal, etc.); Microbial Growth kinetics of pure and mixed culture; Mechanisms of Reactions: Pathways involved in waste to energy production; Metabolic and media engineering in biomass conversion; Microbiology of aerobes and anaerobes; Mechanism of bioconversion process; Trends in biofuel production: First, second, third and fourth generation biofuel; Biohydrogen; Oleaginous biodiesel production; Microbial fuel cells; Bioremediation of heavy metals, xenobiotics and hazardous wastes; Biofertlizers; Value added product development and its cost effective recovery; Conventional and nonconventional techniques adopted for product

Reference Books:

1. Environmental Microbiology by Raina M. Maier, Ian L. Pepper, Charles P. Gerba, Academic Press Elsiver 2006.
2. Environmental Biotechnology by Bhattacharyya BC and Banerjee R, Oxford Univ Press, 2007.
3. Manual of Environmental Microbiology by Christon J. Hurst, Guy R. Knudsen, Michael J. McInerney, Linda D. Stetzenbach, Michael V. Walter, ASM Press Washington DC, 1997.

ES61001: Characterization And Analysis Of Biomass And Biofuel (3-1-0; 4 credits)

Analysis of biomass and biofuel quality plays an important role in biofuel research. This course will help PG students/Research scholars to acquire state of the art knowledge of analysis, characterization techniques and their interpretations with regards to biofuels production.

Introduction: Biomass, diversity, sources, availability etc. Constitutional analysis of biomass: Qualitative and quantitative Proximate and ultimate analysis of biomass. Biochemical analysis using analytical tools: Total carbon, total organic carbon, protein, nitrogen, carbohydrate (Starch, cellulose, hemicellulose), lipid, total sugar, reducing sugar, non-reducing sugar, pectin and fibre, determination of lignin and its derivatives, determination of organic and inorganic elements which include C, H, N, S, P, K, macro and micronutrient analysis Toxicity test of the biomass.

Analysis of liquid bio-fuel such as bio-ethanol, bio-butanol, bio-alkane, bioalkenes, biodiesel etc.

Analysis of different constituents and contaminants present in the targeted product. Analysis of recovered biomass: Microscopic and spectroscopic studies for structural analysis and its interpretation, pore size determination, 3D microstructure analysis Analysis of gaseous bio-fuel: Determination of CH_4, CO_2, CO, H_2S, H_2 in biogas Determination of volatile fatty acid (VFA) and its constituents, alkalinity (Total and partial), biological oxygen demand (BOD), Chemical oxygen demand (COD) and conversion efficiency Analysis of syngas and compressed gas.

Analysis of fuel qualities/properties: Bomb calorimeter, Junker's calorimeter, Flash point, pour point, viscosity, kinematic viscosity, acid value, saponification, fatty acid composition, iodine value, cetane index, octane value, oxidative stability and shelf life determination.

Objective:

Aim of this course is to expose the students to the recent techniques used in Energy Research. The main objective of this course is to familiarize the students with the latest sophisticated analytical tools used for the characterization of biomass and biofuel which play a crucial role in bioenergy production. This elective course can be taken by the graduate and undergraduate students.

Module No.	Course Content	Class Hours
1	Introduction: Biomass, diversity, sources, availability etc. Constitutional analysis of biomass: Qualitative and quantitative Proximate and ultimate analysis of biomass.	3
2	Biochemical analysis using analytical tools: Total carbon, total organic carbon, protein, nitrogen content Carbohydrate (Starch, cellulose, hemicellulose), lipid, pectin and fibre estimation Estimation of total sugar, reducing sugar, non-reducing sugar Determination of lignin and its derivatives Determination of organic and inorganic elements which include C, H, N, S, P, K, macro and micronutrient analysis Toxicity test of the biomass.	5

3	Analysis of liquid bio-fuel such as Bio-ethanol ,Bio-butanol ,Bio-alkanes ,Bioalkenes ,Biodiesel	5
4	Analysis of different constituents and contaminants present in the targeted product. Analysis of recovered biomass: Microscopic and spectroscopic studies for structural analysis and its interpretation, pore size determination, 3D microstructure analysis	10
5	Analysis of gaseous bio-fuel: Determination of CH_4, CO_2, CO, H_2S, H_2 in biogas Determination of volatile fatty acid (VFA) and its constituents, alkalinity (Total and partial), biological oxygen demand (BOD), Chemical oxygen demand (COD) and conversion efficiency Analysis of syngas and compressed gas	6
6	Analysis of fuel qualities/properties: Bomb calorimeter, Junker's calorimeter, Flash point, pour point, viscosity, kinematic viscosity, acid value, saponification, fatty acid composition, iodine value, cetane index, octane value, oxidative stability and shelf life determination.	7
7	Advanced tools and techniques for bio-fuel research	6

Reference Books:

1. Catalysis for the Conversion of Biomass and Its Derivatives, by M.a.A.D. Behrens, Ed. Berlin, Germany: Max Planck Research Library for the History and Development of Knowledge.
2. Introduction to Biomass Energy Conversions by Sergio Capareda, CRC Press, 2013
3. Plant Biomass Characterization: Application of Solution- and Solid-State NMR Spectroscopy. In: Aqueous Pretreatment of Plant Biomass for Biological and Chemical Conversion to Fuels and Chemicals by Yunqiao Pu, BassemHallac and Arthur J. Ragauskas, John Wiley & Sons, Ltd, 2013
4. Analytical Methods And Techniques Applied To Crude Oil And Petroleum Products by James G. Speight, Encyclopedia of Life Support Systems(EOLSS)
5. Biodiesel Analytical Methods by J. Van Gerpen, B.Shanks, and R. Pruszko; D. Clements; G. Knothe. National Renewable Energy Laboratory, 2004.

Teachers: Prof Rintu Banerjee & Prof. Tapas K. Bandopadhyay

Name of the Micro-Specialization: Entrepreneurship & Innovation

1. **School :** Rajendra Mishra School of Engineering Entrepreneurship
2. **Brief Description**: Innovation, entrepreneurship, and enterprise are inextricably related. An executive is expected to possess entrepreneurial qualities for effective decision making that call for innovative thinking about enterprise resources. The proposed micro specialization has been structured to impart knowledge in a balanced way so as to equip the future executives with the necessary inputs to effectively use innovative thinking for maximizing value creation for the enterprise.
3. **Number of Subjects needed to earn the Micro - Specialization :** Four
4. **Credit needed to earn the Micro – Specialization 11 - 12 credits**
5. **Structure: Component I: One Subject (3-0-0)**
   Component II: Two Subjects (3-0-0) / (2-1-0) / (0-0-3)
   Component III: One subject (3-0-0)

A. COMPONENT- I: MANDATORY REQUIREMENT: (3 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
EP60020	Foundations of Entrepreneurship	3-0-0	3	Both	NA

B. COMPONENT- II ANY TWO SUBJECTS FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
EP60021	Engineering B-Plan Development – I	2-1-0	3	Autumn	**EP60020**
EP60042	Engineering Design Process	3-0-0	3	Spring	**EP60020**
EP60003	Product Development	3-0-0	3	Autumn	**EP60020**
					EP60020
EP60031	Entrepreneurial Exit Strategies	3-0-0	3	Autumn	**EP60020**
EP60005	Financial and Legal aspects of business	3-0-0	3	Autumn	**EP60020**
EP60010	Financing New Venture	3-0-0	3	Spring	**EP60020**
BM49002	Financial Analytics Lab	0-0-3	2	Spring	**EP60020**
EP60006	Management of Growth Ventures	3-0-0	3	Spring	**EP60020**

C. COMPONENT- III: ONE SUBJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
EP60007	Techno – Entrepreneurial Leadership	3-0-0	3	Autumn	**EP60020**
EP60018	Innovation Management	3-0-0	3	Spring	**EP60020**
EP60008	Economics of Entrepreneurship	3-0-0	3	Spring	**EP60020**

Name of the Micro-Specialization: Drug Discovery

1. **School :** Chemistry & Bioscience
2. **Brief Description**: this course aims to disseminate necessary knowledge base on the use of chemical and biological principles for the development of drugs.
3. **Number of Subjects needed to earn the Micro - Specialization :** Four
4. **Credit needed to earn the Micro – Specialization 11 - 15 credits**
5. **Structure: Component I: Two Subjects (2-0-0/3-1-0)**
   Component II: Two Subjects (3-1-0/3-0-0)
   Component III: One subject (3-0-0/3-1-0)

A. COMPONENT- I: MANDATORY REQUIREMENT: (Any ONE FOUNDATION COURSES)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
CY20103	Organic Chemistry-I	2-0-0	2	Autumn	NA
BT21101	Biochemistry	3-1-0	4	Autumn	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
CY41018	Structure and Function of Biomolicules	3-0-0	3	Spring	**CY20103 or BT21101**
CY60004	Biophysical Chemistry	3-0-0	3	Spring	**CY20103 or BT21101**
BT60007	Computation Structural Biology	3-1-0	4	Autumn	**CY20103 or BT21101**
BT61030	Protein Engineering	3-0-0	3	Spring	**CY20103 or BT21101**
BS60001	Pharmacokinetics and Pharmacogenomics	3-0-0	3	Autumn	**CY20103 or BT21101**
BS41004	Advances in Protein Structure & Function	3-1-0	4	Spring	**CY20103 or BT21101**
BS41002	Structure Determination of Biomolecules	3-1-0	4	Spring	**CY20103 or BT21101**

C. COMPONENT- III: ONE SUBJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
CY60005	Drug design and development	3-0-0	3	Autumn	**CY20103 or BT21101**
CY61030	Medicinal Chemistry	3-0-0	3	Spring	**CY20103 or BT21101**
BS67001	Project/Term Paper	0-0-6	4	Both	**CY20103 or BT21101**

Name of the Micro-Specialization: Micro Fluidics and Nano Patterning

1. **Department/School/Center: Chemical Engineering/ Mechanical Engineering/ School of Nano Science & Nano Technology**
2. **Brief Description:** This micro specialization will allow the students to understand how the nature of fluid flow changes under severely confined conditions. The specialization will focus on hos the effect of different forces change/ get altered in the meso scale, due to enhanced effect of surface tension, capillary forces as well as dispersion forces. The course will introduce to a student how scaling relations influence the transport properties at this length scale. Further, experimental investigation at this length scale also requires significant knowledge on micro and nano scale fabrications. The specialization thus aims at covering the essential concepts of fluidics and micro fabrication techniques, providing the students advanced expertise and knowledge in this cutting edge area of research.
3. **Number of Subjects needed to earn the Micro-Specialization:** Four
4. **Credits needed to earn the Micro-Specialization 15-16 credits**
5. **Structure: Component I: One Subject (3-1-0)**
   Component II: Two Subjects (3-1-0/3-0-0)
   Component III: One subject (3-1-0)

A. COMPONENT- I: MANDATORY REQUIREMENT: (Any ONE 4 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
CH61011	Adv. Fluid Mechanics	3-1-0	4	Autumn	NA
ME60011	Fluid Mechanics	3-1-0	4	Autumn	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
CH62039	Micro Scale Transport Process	3-0-0	3	Autumn	**CH61011 or ME60011**
CH30012	Transport Phenomena	3-1-0	4	Spring	**CH61011 or ME60011**
NT70002	Introduction to Nano Technology	3-1-0	4	Spring	**CH61011 or ME60011**
ME60310	Micro Fluidics	3-1-0	4	Spring	**CH61011 or ME60011**

C. COMPONENT- III: ONE SUBJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
CH62052	Instability and patterning of thin polymer films	3-1-0	4	Spring	**CH61011 or ME60011**

Name of the Micro-Specialization: PHOTONICS

1. **Department/School/Center: Physics**
2. **Brief Description:** Photonics is a growth area, and is strongly dependent on the science underpinning the topics. The course aims to teach this underlying science, leading to an appreciation of how this science can be used in the development of devices and systems. The program has been designed to prepare students for an exciting career in industries or pursue research and development work. The graduates with this micro-specialization will find opportunities in the industries or venture out for entrepreneurship. Consistent with the Institute's mission "dedicated to the service of the nation", the program aims to transform students into learned men and women who are capable of fulfilling the need of the nation's Photonics community, business and industry. A broader mission is to enable undergraduates to acquire knowledge and experiences to prepare them to pursue lifelong learning, advanced study, leadership roles in business and community.
3. **Number of Subjects needed to earn the Micro-Specialization:** 4 Subjects or 3 Subjects+1 Projects
4. **Minimum Credits needed to earn the Micro-Specialization 11-13 credits**
5. **Structure: Component I: One Subject (3-0-0)**
   Component II: Two Subjects (3-1-0/3-0-0)
   Component III: One subject (0-0-3) or Project (0-0-3)

A. COMPONENT- I: MANDATORY REQUIREMENT: (3 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
PH41004	OPTICS	3-0-0	3	**Autumn**	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
PH58038	NON LINEAR OPTICS	3-0-0	3	**Spring**	**PH41004**
PH60032	LASER SPECTROSCOPY	3-1-0	4	**Spring**	**PH41004**
PH60201	PHYSICS OF PHOTONIC DEVICES	3-0-0	3	**Autumn**	**PH41004**
PH60202	ATOMIC, MOLECULAR AND OPTICAL PHYSICS	3-0-0	3	**Autumn**	**PH41004**
PH60203	OPTICAL FIBER TECHNOLOGY	3-0-0	3	**Spring**	**PH41004**
PH60204	PHYSICS AND TECHNOLOGY OF LASERS	3-0-0	3	**Spring**	**PH41004**
PH60408	BIOPHOTONICS	3-0-0	3	**Autumn**	**PH41004**
PH60037	OPTO-ELECTRONIC MATERIALS AND DEVICES	3-1-0	4	**Autumn**	**PH41004**

C. COMPONENT- III: One SUBJECT / PROJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
PH59008	Laboratory on Modern Optics	0-0-3	2	**Spring**	**PH41004**
PH67002	Project	0-0-3	2	**Spring**	**NA**

PH59008: Laboratory on Modern Optics (0-0-3; 2 credits)

Laboratory- Experiments:

1. GaAlAs Diode laser
   Characteristics of current threshold, temperature behaviour and beam geometries of a visible diode laser. Investigate modulation behavior.
2. Introduction to Optical Fibers
   Introduction to splicing and cleaving fibers. Efficient launching of light into a single mode fiber , and measurement of splice losses.
3. Fiber Interferometry
   Employment of Mach-Zehnder interferometer as a sensitive temperature sensor.
4. Fiber Optic Communications
   The investigation of the properties of optical fibers that are relevant to long-distance communications.
5. Birefringent Fiber Experiment
   Analysis of the temperature response of the output of a hi-bi fiber in order to locate the fiber axes.
6. Acousto-optic Modulator
   Alignment and investigation RF-strained crystal to produce variable diffraction efficiencies. Characterization in terms of beam-size and modulation limit.
7. Erbium –Doped Fiber Amplifier
   The study of noise and gain characteristics of Erbium –Doped Fiber Amplifier.
8. Fourier Optics Experiment
   Alignment of 4F optical system. Use of this system as a spatial filter to remove noise from a signal.
9. Holographic Interferometry
   Use of real time Holographic Interferometry to perform simple strain measurements.
10. Laser Mode Structures and resonator Optics
    Alignment of He-Ne laser cavity. Characterization of transverse modes Use of a confocal Febry-perot interferometer to detect the longitudinal modes.
11. Optical Design
    Examine the some of the practical aspects of optical design, and to compare the experimental results with the predictions of a ray tracing program.
12. Phase Sensitive Detection
    Introduction to the PSD as a device for recovering signal from noise. Use in improving the convenience and accuracy of optical measurements.
13. Twyman-Green interferometer
    Use of a computer package to analyze aberrations in optical components. Compare theoretical behavior with interferometrically – derived experimental patterns.
14. Q-switched Diode-pumped Nd:Yag Laser
    Alignment of laser cavity containing acoust0-optic Q-switch. Characterization of Q-switched laser.
15. Fiber Micro-bending
    Investigation of the effect of periodic small bends on fiber transmission. Use of the effect as an environmental sensor.
16. Optical Network Analysis
    Investigation of the losses in the optical network using optical time domain reflectometry.

17. The Atomic force Microscope
    Use of an AFM to investigate the surface tomography of a number of optical and optoelectronic components including diffractive optical elements.
18. Laser Diode coherence properties
    Alignment and use of a Michelson-Morley interferometer with a spectrally modulated source to characterize the coherence length of a semiconductor diode laser.
19. White-Light Fourier Transform Spectrometry
    This experiment shows how the common technique of Fourier Transform spectrometry can be used to obtain information about the optical phase and absorption properties of a sample.
20. Principles of optical wave guiding
    Investigations of principles and design rules of optical wave guides.
21. Thin-Film Optical Design
    Design and analysis of thin film optical coatings.
22. Computer aided Optical Design
    Introduction to optical design using the code V-package
23. Surface relief gratings
    Study of surface relief gratings of varying periodicity on polymers.
24. Optical Tweezers
    Introduction to technique with which small particles can be moved using a tightly focused laser beam.
25. Fiber Bragg Grating
    The basic principles of Fiber Bragg Grating for sensors
26. Computer controlled of scientific instruments
    The study of Computer controlled of scientific instruments using Labview.
27. Principles of Lasers
    Introductions and characteristics of Er-doped fiber laser
28. Three dimensional imaging with diffractive optics
    Demonstrate and validate three dimensional imaging using a Lens and a diffractive optical elements.
29. ZEMAX-based computer aided optical design
    Introduction to optical design using the ZEMAX
30. WDM components, WDM systems and Bragg Grating

Introduction of areas relevant to WDM component, DWDM systems 1310/1550nm WDM systems & Bragg Gratings.

Name of the Micro-Specialization: Industrial Safety Engineering

1. **Dept/School/Center**: Industrial & Systems Engineering
2. **Brief Description**:

Today industries and organizations, particularly in India, are facing stiff challenges in meeting the safety and health requirements of the stakeholders and there are reasons for it. These are, for example, (i) abysmally poor preparedness, (ii) absence of trained personnel, (iii) lack of scientific research, and (iv) weak industry academic institution partnership. Although attempts have been made to improve safety at the industry and organization levels, there is no visible improvement at the national level. For example, in Indian manufacturing sector, the fatal accident rate is close to 100 fatalities per million employees against the range from 10 to 30 in advanced countries. In mines, the statistic is abysmally poor with more than 200 fatalities per year. This increasing trend of fatal and serious accidents in industries, causing huge loss of property and people, calls for immediate attention towards improving overall safety scenario across industries in India. In line with these requirements, Ministry of Labour and Employment (Government of India) has stated the following in the national safety policy:

(i) Continuous reduction in the incidence of the work related injuries, fatalities, diseases, disasters, and loss of national assets.
(ii) Improved coverage of work related injuries, fatalities and diseases and provide a more comprehensive data base for facilitating better performance and monitoring.
(iii) Continuous enhancement of community awareness regarding safety, health and environment at workplace related areas.
(iv) Continually increasing community expectation of workplace health and safety standards.
(v) Improving safety, health and environment at workplace by creation of “green jobs” contributing to sustainable development.

Upon assessing the present status on safety engineering in relation to the objectives of the national policy, it is observed that there is a large gap which needs to be bridged. Salient loopholes against each of the above objectives are given below.

- Objective-1: Scattered work in progress & lack of any knowledge inference engine
- Objective-2: No national database, at present
- Objective-3: Lack of safety culture - requires continuous effort
- Objective-4: Lack of safety knowledge among people
- Objective-5: Possible, only if the earlier objectives are realised

IIT Kharagpur, being an internationally recognized technical institution of India having a number of experts with proven knowledge, expertise, and research experiences in industrial safety engineering, systems safety design and control, and risk management, should take a lead in educating and producing fresh engineering graduates capable in design, installation, operation, maintenance, management, and improvement of safety of products, processes, and work systems across industries in India and the globe.

2.1 Relevance of the courses offered

Industrial work systems are an integrated whole of people, material, information, equipment, and energy for production of goods and services, the key ingredients of a nation’s growth. Design of integrated worksystem is a critical but important component that every engineer must know. When people are integrated into a system, their safety is of utmost important. As industries vary from mining, chemical,

construction, etc. to IT and services on one hand and from manual to mechanised on the other, the hazards involved are of different kinds. From energy perspective, these can be chemical, mechanical and electrical to potential energy. So, people at work are exposed to different kinds of hazards and whose quantity (risk) varies between industries and also within industrial activities. To protect people at work, several standards and guidelines have been framed by regulatory and government agencies (e.g., OSHAS 18001) which need to be implemented and followed by every organization. In addition, organization must develop, implement and monitor effective safety management system for surveillance, prevention of accidents and mitigation of impacts. Upon undergoing the subject "Introduction to industrial safety" (Table I), the students will learn the different facets and aspects of industrial safety, the stakeholders with roles and responsibilities, standards and guidelines, safety management principles, and hazard control hierarchy. In addition, the four dimensions of safety namely engineering safety, organizational safety, behavioural safety, and laws and enforcements will be taught. It's the basic course and every students doing thin specialization in ISE must take this. The different dimensions of this basic course will be discussed under eight electives (see Table II) and depending on the choice a student can take 3 such electives. The need for these electives is given below:

The first step to ensure safety to people at work is engineering out hazards from work system. The key concept here is "safety by design". The subject "Engineering systems safety design and control" (IM60045) will cover this. Engineering systems safety evolves around socio-technical system theory keeping technology at the core and aligning hazard control mechanisms around the core. It also integrates quality management principles with system safety tools. Upon completion of the course, the students will be equipped with concepts of engineering systems safety, dimensions of engineering systems safety, safety design and analysis mathematics, design for engineering systems safety and control for safety, and integrating safety with other operational goals such as quality.

To engineer out hazards, the students must know what is a hazard, how to quantify its potential, how do these hazards occur, etc. Other way, some critical questions that must be answered by every safety manager are: (i) What can go wrong?, (ii) How can it go wrong?, (iii) How likely is its occurrence?, (iv) What would be the consequences?, (v) What is the risk level?, (vi) How to prioritize risk?, (vii) What is the uncertainty in risk values?, and (viii) Where to put resources for improvement? Two electives are proposed in this regard; one from general risk assessment point of view (RE60011 – probabilistic risk assessment) and another one from chemical industry point of view (CH62038: Hazard analysis and risk management in chemical industry).

No matter how good a system is from engineering safety point of view, it is obvious that the system components will deteriorate over time. Maintenance of system components is a must. The subject "Fault diagnosis and predictive maintenance" (RE60018) will cover this. The reliability and safety issues of maintained systems will be explored in light of maintenance policy selection such as preventive, predictive and corrective maintenance. Another important aspect to be considered is maintainability design. Upon going through the subject the students also will learn how to measure and monitor the health of machines for maintenance related decision making to improve both safety and reliability.

Another two important issues of industrial safety are fire safety, and rescue and disaster management. There are a large number of fire sources in every industrial organization. Statistics shows that one of the disastrous events is fire which spread across all industries around the globe. Students must be prepared to design out fire from industrial activities and in case it occurs, its mitigation as well as emergency preparedness is a must. The subject "Fire safety engineering" will cover all these. The subject "Rescue and disaster management" (MI50003) covers emergency prepared for disastrous events like fire,

explosion, inundation etc. It also covers pre- and post-disaster emergency planning for preparedness and evacuation.

Every industry spends substantially to improve safety. But the world statistics says that much more is needed to do. The key question is there that with such a large number of accidents occurring every year across the industries worldwide, are we learning from our mistakes? Similarly, are we using data and information inter alia generated from different functions of an organization? The answer is “no”. This is because of lack of knowledge of data analytics. The subject “safety analytics” will cover this.

No knowledge is complete unless it is transferred and implemented to those for which it is developed. The students after going through the core and elective subjects must take a real-life-problem solving project, or a design project, or a term paper. This is highlighted in Table III.

3. **Number of Subjects needed to earn the Micro-Specialization**: 3 Subject + 1 Project/Design/ Term Paper
4. **Credits needed to earn the Micro-Specialization 12-14 credits**
5. **Structure: Component I: One Subject (2-0-0)**
   Component II: Two Subjects (3-1-0/3-0-0)
   Component III: Project/Design/Term Paper (0-0-6)

A. COMPONENT- I: MANDATORY REQUIREMENT: (2 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
I**M40001**	Introduction to industrial safety	2-0-0	2	Both	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
IM60045	Engineering Systems Safety Design And Control	3-1-0	4	Autumn	I**M40001**
IM61020	Safety Analytics	3-1-0	4	Spring	I**M40001**
RE60018	Fault Diagnosis And Predictive Maintenance	3-1-0	4	Spring	I**M40001**
RE60011	Probabilistic Risk Assessment	3-1-0	4	Autumn	I**M40001**
CH62038	Hazard Analysis And Risk Management In Chemical Industry	3-1-0	4	Spring	I**M40001**
MI60058	Fire Safety Engineering	3-0-0	3	Spring	I**M40001**
MI50003	Rescue And Disaster Management	3-0-0	3	Autumn	I**M40001**
MI45008	Safety Engineering	3-0-0	3	Spring	I**M40001**

C. COMPONENT- III: PROJECT/DESIGN/TERM PAPER (4 credits)

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
IM67003	Project/design/term paper	0-0-6	4	Both	I**M40001**

Name of the Micro-Specialization: Intelligent Learning System Design

1. **School/Centre:** Centre for Educational Technology

2. **Brief Description:**

To cope up with growing needs and cost, education sector is undergoing a rapid change with the adoption of Information and Communication Technology. Smart Education Technology applies and integrates intelligent techniques towards the goal of imparting personalized and engaging education. As Intelligent Tutoring System (ITS) is a first step towards individualized education, it has been kept as a foundational subject in this specialization. Notion of stand-alone educational systems has been replaced by web-based education. To make smart web-based education systems, semantics of educational entities on the web is needed to be modelled in the form of Semantic Web. This specialization will provide an introduction to semantic web technologies and their relations to educational technology and digital library. Textual discourse plays important role in instruction delivery, assessment and social feedback. Language processing for eLearning deals with smart techniques towards automation of different educational processes through analysis of textual discourses. Serious games have been proved to be very effective in engaged and inquiry based learning. Intelligent game design provides foundations on application of Artificial Intelligent techniques in designing intelligent games.

Specific objectives of this specialization are as follows:

- To analyze different modules involved in design of ITS
- To provide in depth analysis of textual discourses in eLearning through language processing techniques
- To provide foundation on semantic web technologies, related programming paradigms and their relevance to smart educational systems.
- To provide pedagogic implications of game-based learning paradigm.
- To apply AI algorithms in designing serious games.
- To implement project ideas integrating smart techniques like language processing, semantic web and intelligent game design.

3. **Number of subjects needed to earn the Thin Specialization:** 3 Subjects + 1 Project

4. **Number of credits needed to earn the Thin Specialization:** 12-13

5. **Structure:** **Component I: One Subject (2-0-0)**
Component II: Two Subjects (3-1-0/3-0-0)
Component III: One Project (0-0-6)

A. COMPONENT- I: MANDATORY REQUIREMENT: (2 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
ET30002	Intelligent Tutoring system	2-0-0	2	Spring	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
ET61002	Language Processing for e-learning	3-1-0	4	Spring	**ET30002**
ET60019	Knowledge Modelling and Semantic Technology	3-0-0	3	Autumn	**ET30002**
ET60021	Intelligent Game Design	3-0-0	3	Autumn	**ET30002**

C. COMPONENT- III: PROJECT (4 credits)

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
ET67003	Learning System Design Project	0-0-6	4	Autumn	**ET30002**

ET30002: Intelligent Tutoring System (2-0-0; 2)

Course Description

Intelligent Tutoring System (ITS) is focused towards providing individualized learning experience to the students through application of artificial intelligence techniques. This course covers different topics that relate to student and teacher modelling, development of adaptive systems using core AI techniques like knowledge representation, Bayesian belief networks, cognitive modelling.

Course Objective

Upon completion of the course the students will be able to

- identify and describe different components in ITS architecture
- identify parameters and strategies to evaluate ITSs
- describe and compare different approaches to student modeling
- describe and compare different approaches to teaching knowledge modeling
- explain and compare different cognitive modeling approaches towards ITS development
- classify different types of ITSs
- analyze the features and working principles of different types of ITSs

Course Content

- **Introduction(4):**Foundation of the field, computers in education, ITS architecture and design principles, evaluation.
- **Knowledge Representation (5):** Student model (modeling skill, procedure, affect, complex problems, bug library, planning and plan recognition), Features of teaching knowledge, learning theory based teaching model (Socratic learning theory, cognitive learning theory, constructivist theory, situated learning), animated pedagogical agent
- **Cognitive Modelling and ITS (9):** ACT-R and Cognitive tutor, Constraint-based modelling, Knowledge tracing, Example-tracing
- **Analysis of ITS systems (8)**: Cognitive Tutor (Carnegie learning), Model tracing tutor (ANDES), Constraint-based Tutor (SQL-Tutor), Inquiry-based Tutor (Rashi, Crystal Island), Dialog-based Tutor (AutoTutor, Why2-Atlas)

Books

1. Building Intelligent Interactive Tutors: Student-centered strategies for revolutionizing e-learning, Beverly Park Woolf
2. Student Modeling: The Key to Individualized Knowledge-Based Instruction, Jim E. Greer and Gordon I. McCalla, Springer

References

1. Intelligent Tutoring Systems: An Overview, Hyacinth S. Nwana, Artificial Intelligence Review, (1990) 4, 251-277
2. Theoretical Foundations for Intelligent Tutoring Systems, John Self, Journal of Artificial Intelligence in Education, 1990, 1(4), 3-14
3. (1990), 42(1), 7-49
4. The Construction and Application of Student Models in Intelligent Tutoring Systems, Journal of Computer and Systems Sciences, 1994, 32(1).
5. Cognitive Mastery Learning in the ACT Programming Tutor, Albert Corbett, AAAI Technical Report, 2000
6. Cognitive Tutors: Lessons Learned, Anderson et al., Journal of the Learning Sciences, 1996, 4 (2)
7. Instructional Interventions in Computer Based Tutoring: Differential Impact on Learning Time and Impact, Albert Corbett and Holly Trask, Proceedings of ACM CHI'2000
8. Fifteen years of constraint-based tutors: what we have achieved and where we are going, User Modelling and User-Adapted Interaction, 2012, 22(1-2), 39-72,
9. Using Bayesian Networks to Manage Uncertainty in Student Modelling, Conati C., Gertner A., VanLehn K. User Modelling and User-Adapted Interaction. (2002) 12(4)
10. A New Paradigm for Intelligent Tutoring Systems: Example-Tracing Tutors, Aleven et al., International Journal of Artificial Intelligence in Education 19 (2009) 105-154
11. The Behavior of Tutoring Systems, Kurt VanLehn, International Journal of Artificial Intelligence in Education, 2006, 16

ET61002: Language Processing for e-learning(3-1-0; 4)

Course Description

Text is an important media for delivering education. Thus innovative use of text processing techniques has drawn interest of many researchers in text processing domain in developing effective and interesting e-learning applications. The course will explore text processing techniques like syntactic and semantic analysis, entity extraction, discourse processing, question answering, computational affect analysis etc. and their applications to e-learning domains. As e-learning has got enormous research and business opportunities, aspiring entrepreneurs and researchers will get acquainted with recent challenges and advances in developing text processing-based e-learning applications.

Course Objective

Upon completion of the course the students will be able to

a) Identify different text processing techniques for developing an e-learning applications

b) Design e-learning systems through text analysis
c) Experiment with benchmark datasets available for different e-learning tasks
d) Assemble different text processing techniques to develop an e-learning application
e) Analyze architectures of different text-based e-learning applications

Course Content

- **Introduction (3):** e-learning, text processing relevant to e-learning
- **Text Processing Fundamentals (4):** Morphological analysis, POS tagging, parsing, lexical resources, ontology, machine learning tools.
- **Computer Assisted Language Learning (CALL) (5):** Categorization, Pedagogical perspective, Vocabulary learning, Grammar learning and error correction, Semantic analysis and discourse processing for intelligent CALL, second language acquisition.
- **Readability Level Assessment (5):** mental lexicon, cognitive models of text comprehension, visual word recognition, Language dependence of readability measures, Lexical and grammatical feature based readability assessment, Statistical approaches towards readability assessment, text cohesion, Coh-Metrix.
- **Text Adaptation (5):** Encyclopedic annotations of text, Lexical and morphology-based simplification, paraphrasing, text entailment, syntactic and discourse level simplification
- **Automatic Question Generation (5):** Pedagogy driven question categorization, vocabulary assessment, MCQ generation, factual question generation, Evaluation metrics.
- **Automatic essay/answer grading (5):** Writing dimensions and evaluation features, Lexical, syntactic and discourse processing for automatic grading, Research prototypes: e-Rater, C-Rater, BETSY, reliability and validity, norming and scaling, Bayesian analysis.
- **E-learning and Web 2.0 (4):** Educational metadata standards, ontology and semantic web, Pedagogic and topical metadata annotation of learning materials, ontology learning, Issues in collaborative learning
- **Dialogue-based Tutoring (4):** Natural language intelligent tutoring system, mixed initiative dialogues, mixed mode dialogues, AutoTutor, ITSPOKE, BEETLE, CIRCSIM-Tutor, learner affect analysis.

Books

1. Speech and Language Processing, Daniel Jurafsky, James H. Martin
2. Handbook of Natural Language Processing, NitinIndurkhya, Fred J. Damerau
3. Computer-Assisted Language Learning: Context and Conceptualization, Michael Levy
4. Automated Essay Scoring: A cross disciplinary perspective, MD Shermis, J Burstein
5. Handbook of Automated Essay Evaluation: Current Applications and New Directions edited by Mark D. Shermis, Jill Burstein

References

1. Educational Natural Language Processing, Tutorial at COLING 2008 and AIED 2009, Delphine Bernhard
2. Opportunities for Natural Language Processing Research in Education, Computational Linguistics and Intelligent Text Processing (2009), pp. 6-27, Jill Burstein

3. A Comparative Evaluation of Deep and Shallow Approaches to the Automatic Detection of Common Grammatical Errors, Proceedings of Empirical Methods in Natural Language Processing 2007, Joachim Wagner, Jennifer Foster and Josef van Genabith
4. Self-Assessment of Motivation: Explicit and Implicit Indicators in L2 Vocabulary Learnin, Proceedings of the 15th International Conference on Artificial Intelligence in Education, Dela Rosa, K. and Eskenazi, M.
5. Reconstructing readability: Recent developments and recommendations in the analysis of text difficulty. Educational Psychology Review, 24, Benjamin, R. (2012).
6. A connectionist multiple-trace memory model for polysyllabic word reading. Psychological Review; Psychological Review, 105(4):678, Ans, B., Carbonnel, S., and Valdois, S. (1998).
7. Early decomposition in visual word recognition: Dissociating morphology, form, and meaning. Language and Cognitive Processes, 23(3):394–421, Marslen-Wilson, W., Bozic, M., and Randall, B. (2008).
8. Morphology and meaning in the english mental lexicon. Psychological Review, 101(1):3, Marslen-Wilson, W., Tyler, L., Waksler, R., and Older, L. (1994).
9. Abstractness, allomorphy, and lexical architecture. Language and Cognitive Processes, 14(4):321–352, Marslen-Wilson, W. and Zhou, X. (1999).
10. Coh-metrix: Analysis of text on cohesion and language. Behavior Research Methods, 36(2):193–202, Graesser, A., McNamara, D., Louwerse, M., and Cai, Z. (2004).
11. Predicting reading difficulty with statistical language models. Journal of the American Society for Information Science and Technology, 56(13):1448–1462, Collins-Thompson, K. and Callan, J. (2005).
12. The Automated Text Adaptation Tool, Jill Burstein, Jane Shore, John Sabatini, Yong-Won Lee & Matthew Ventura, ACL 2007
13. A monolingual tree-based translation model for sentence simplification, Zhemin Zhu, Delphine Bernhard, and IrynaGurevych, COLING'10

ET60019: Knowledge Modelling and Semantic Technologies(3-0-0; 3)

Course Description

Knowledge modelling is a process of formalizing the knowledge of a domain through formal knowledge representation frameworks. Apart from many other knowledge driven systems, knowledge modelling through ontology has helped in realization of embedding semantics to current hypertext-based web. The semantic web vision has shown enormous promise to revolutionize current World Wide Web dramatically. This envisionment rides on the idea of embedding semantics of web data so that the contents become machine processible. Driving technologies in semantic web vision include explicit metadata, ontologies, formal logic, inferencing and intelligent agents. Huge potential and advantages of semantic web have sparked significant interest in industry and government. Semantic web has shown great promise in eLearning domain.

This course aims at developing foundations in semantic web technology addressing web scale semantic knowledge modelling techniques and related programming paradigms and applications.

Course Objective

Upon completion of the course the students will be able to

- explain features, rational and advantages of semantic web technologies
- describe and compare features of markup languages for semantic web
- explain semantic data modelling through RDF and RDF schema
- analyse the requirements and features of web ontology language (OWL)
- explain description logic framework as semantics of OWL
- build and analyse ontologies with ontology editors
- use programming paradigms for working with RDF data model and OWL
- analyze application scenarios in data integration, data exchange, knowledge management, e-learning, and digital library.

Course Content

Semantic Web Concepts

- **Introduction to Knowledge Modelling (3):** Knowledge-based systems, Knowledge representation formalisms, fundamentals of reasoning.
- **Semantic Web Vision (3):** Current web, current web to semantic web, semantic web technologies, standardization, semantic web layer cake
- **Foundations of Semantic Web (8):** Extensible Markup Language, Resource Description Framework (RDF), RDF Schema (RDFS), Semantics for RDF and RDFS, Inference system for RDF and RDFS, Querying RDF
- **Ontology for Semantic Web (10):** Semantic modelling through ontology, evolution of ontology languages, Web Ontology Language (OWL), OWL semantics with Description Logic, OWL reasoning, ontology engineering.
- **Sources of Semantic Data (3):** Friend of a Friend (FOAF) ontology, Simple Knowledge Organization System (SKOS), Dublin Core (DC), Linked Data Cloud

Semantic Web Programming

- **Programming with RDF (5):** RDF serialization, RDF querying with SPARQL, RDF inference with Jena and/or sesame, programming with DBpedia
- **Ontology engineering (5):** Ontology development with Protégé, Ontology visualization, OWL API

Semantic Web Applications

- **Applications (5):** Semantic web services, Social semantic web, Semantic search, e-learning, digital library

Books

1. Semantic Web for the Working Ontologist, Dean Allemang and James Hendler, Morgan Kaufmann
2. Programming the Semantic Web, Toby Segaran, Colin Evans and Jamie Taylor, O'Reilly
3. A Semantic Web Primer, Grigoris Antoniou and Frank van Harmelen, MIT Press

References

1. Education and the Semantic Web, Vladan Devedzic, International Journal of Artificial Intelligence in Education, 2004, 14

2. Ontologies and Semantic Web for E-Learning, D. Dicheva, Handbook on Information Technologies for Education and Training, 2008
3. Key Issues in Next-Generation Web-Based Education, Vladan B. Devedzic, IEEE Transactions on Systems, Man and Cybernetics, 2003, 33(3)
4. JeromeDL–adding semantic web technologies to digital libraries, SR Kruk, S Decker, L Zieborak, Database and Expert Systems, 2005
5. Defrosting the Digital Library: Bibliographic Tools for the Next Generation Web, Duncan Hull, Steve R. Pettifer, Douglas B. Kell, PLOS Biology, 2008

ET60021: Intelligent Game Design(3-0-0; 3)

Course Description

Game-based instruction is a very effective pedagogic approach in increasing learner engagement motivation. This course provides a foundation on application of artificial intelligence techniques in development of intelligent games. Topics covered in this course are oriented towards game design primitives like movement, path-finding, waypoint tactics, strategic moves. Interactive storytelling is an essential technique in designing immersive games and is very effective in educational games. Topics covered in this part are narratology, computational storytelling, interaction design and narrative-based educational games.

Course Objective

Upon completion of the course the students will be able to

- identify the role of serious games in education
- explain rational and advantages of game-based pedagogy and the role game AI in this
- analyse and apply AI algorithms in intelligent game design primitives like movement, pathfinding, decision making, tactical analysis
- explain and analyse algorithms relevant to game execution environment
- explain design choices relevant to graphics level of detail
- explain and analyse algorithms for sense management
- describe the roles of story and plot in interactive storytelling
- explain, analyze and compare computational models of storytelling
- analyze narrative-based educational games (e.g., Crystal Island)

Course Content

- **Introduction (3):** Serious games in education, game-based learning pedagogy, issues in designing intelligent games, game AI
- **Basic Techniques (18):** Movement (Kinematic movement algorithms, Steering behaviors, Predicting physics, Jumping, Co-ordinated movement, Motor control,), Path-finding (Path-finding graph, Dijkstra algorithm, A* algorithm, Hierarchical path-finding, Continuous time path-finding, Movement planning), Decision making (Decision tree, state machines, fuzzy decision making, Goal oriented behaviour, Blackboard architectures, Scripting, Action execution), Tactical and strategic AI (Waypoint tactics, Tactical analyses, Tactical path-finding, coordinated action),

Learning (learning basics, action prediction), Board games (Mini-maxing, Transposition tables, Memory-enhanced test algorithms, Turn-based strategy games)

- **Supporting Technologies (8):** Execution management (Scheduling, Anytime algorithms, level of details,), World interfacing (Event managers, Polling stations, Sense Management), Tools and content creation (Knowledge for waypoint and path-finding, Knowledge for movement, Knowledge for decision making)
- **Interactive Storytelling Games (10):** Story, narratology, Textual and cinematic discourse, Interaction, Computational storytelling, World and character modeling, Narrative-based educational games

Books

1. Artificial Intelligence for Games, Ian Millington, Morgan Kaufmann
2. Programming Game AI by Example, Mat Buckland, Wordware Publishing Inc.
3. AI for Game Developers, David Bourg and Glenn Seemann, O'Reilly

References

1. Narratology for Interactive Storytelling: A Critical Introduction. Marc Cavazza, David Pizzi. TIDSE 2006
2. A Platform for Symbolically Encoding Human Narratives. David K. Elson, Kathleen R. McKeown. 2007. In Proceedings of the AAAI 2007 Fall Symposium on Intelligent Narrative Technologies
3. Cinematic Visual Discourse: Representation, Generation, and Evaluation. ArnavJhala and R. Michael Young, (under review) IEEE Transactions of Computational Intelligence and AI in Games, 2010.
4. A Declarative Model for Simple Narratives. Raymond Lang. In Narrative Intelligence, Michael Mateas and Phoebe Sengers (Ed.). 2003.
5. An Intent-Driven Planner for Multi-Agent Story Generation. Mark Riedl and R. Michael Young. Proceedings of the 3rd International Joint Conference on Autonomous Agents and Multi Agent Systems, New York, 2004

ET67003: Learning System Design Projects (0-0-6; 4)

List of projects:

Project proposals centered around the following themes will be sought of student groups and assigned subjected to approval from course instructor.

- Design of cognitive tutor for teaching algebra
- Design of adaptive courseware generation based on different student modeling parameters (learning style, learner category etc.)
- Automatic generation of assessment items from text documents.
- Design of automated short answer grading system
- Design of ontology-based MCQ generation system
- Design of semantic search functionality using linked data cloud.
- Design of semantic web technology based digital library
- Strategic educational games for teaching mathematics
- Interactive storytelling games for teaching conceptual and informative subjects.

The design project workflow is as follows:

1. Formation of group
2. Submission of informal proposal
3. Initial review and approval by course instructors
4. A formal project proposal
5. Final Technical report
6. Final demonstration and presentation

Name of the Micro-Specialization: Intellectual Property Rights

1. **Department/School/Center:** Rajiv Gandhi School of Intellectual Property Law
2. **Brief Description:** There is a greater need to protect intellectual property rights in today's often challenging dynamic environment. Solutions need to be contextual with an international dimension. The art of solving client problems in this area requires practical understanding into the aspect of IPR. The objective of the micro- specialization course is to equip
   - Practical skills into IP search, analysis and drafting
   - Practical understanding of IP licensing
   - Understanding IP portfolio and strategy to devise effective protection mechanisms

   The student shall get an opportunity to engage in projects relevant to industry and practice in this area (practical drafting/search and analysis of IP in relevant domain area).
3. **Number of Subjects needed to earn the Micro-Specialization: Four**
4. **Credits needed to earn the Micro-Specialization: 14 credits**
5. **Structure: Component I: One Subject (2-0-1)**
   Component II: Two Subjects (3-1-0)
   Component III: One subject (2-1-0)

A. COMPONENT- I: MANDATORY REQUIREMENT: (3 credit FOUNDATION COURSE) from Table - I

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
IP60133	General Principles of Law for Engineers	2-0-1	3	Autumn	NA

B. COMPONENT- II ANY TWO SUBJECTS (4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
IP60102	Copyright	3-1-0	4	Spring	**IP60133**
IP60119	Law Of Patent-I	3-1-0	4	Autumn	**IP60133**
IP60123	Trademark And Design	3-1-0	4	Autumn	**IP60133**
IP60129	IP Management And Technology Transfer	3-1-0	4	Autumn	**IP60133**

C. COMPONENT- III: ONE SUBJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
IP60174	Intellectual Property and Competition law	2-1-0	3	Spring	**IP60133**
IP60158	Competition law	2-1-0	3		**IP60133**
IP60164	Music and entertainment Industry law	2-1-0	3		**IP60133**

Name of the Micro-Specialization: Optimization Theory and Applications

1. **Department/School/Center: Mathematics**

2. **Brief Description:** Theory of optimization plays an important role in Engineering management and mathematics and is closely related to several other field in the decision science. The objective of this micro specialization framework is to provide a solid foundation of various optimization techniques and their applications.

3. **Number of Subjects needed to earn the Micro-Specialization: Four**

4. **Credits needed to earn the Micro-Specialization 12-13 credits**

5. **Structure: Component I: Two Subjects**
   Component II: One Subject (3-1-0)
   Component III: One subject (3-1-0/3-0-0)

A. COMPONENT- I: MANDATORY REQUIREMENT: (TWO FOUNDATION COURSES)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MA30014	Operations Research	3-0-0	3	Spring	NA
MA39014	Operations Research Lab	0-0-3	2	Spring	**MA30014**

B. COMPONENT- II ANY ONE SUBJECTS (4 credits) FROM TABLE-II

TABLE-II

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MA41010	Non linear Programming	3-1-0	4	Spring	**MA30014 and MA39014**
MA41109	Optimization by Vector Space Method	3-1-0	4	Spring	**MA30014 and MA39014**

C. COMPONENT- III: ONE SUBJECT FROM TABLE-III

TABLE-III

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
MA61061	Optimization Methods in Finance	3-0-0	3	Autumn	**MA30014 and MA39014**
MA60044	Multi Objective Programming	3-1-0	4	Spring	**MA30014 and MA39014**
MA61053	Numerical Optimization	3-1-0	4	Autumn	**MA30014 and MA39014**

Name of the Micro-Specialization: Rural Innovation and Management

1. **Department/School/Center: Rural Development Centre**

2. **Brief Description:** Improving the quality of life and liveliness in rural India is of significant importance as 64% Indians live in rural areas. Accordingly, the primary focus of the Ministry of Rural Development (India) is on the "sustainable and inclusive growth of rural India through a multipronged strategy for eradication of poverty by increasing livelihoods opportunities, providing social safety net and developing infrastructure for growth". IIT Kharagpur, being within the rural belt in West Bengal has its well established Rural Development Centre, serving for the purpose since 1975. Today's young generation is keen to contribute to the development of rural people. Collectively the contribution could be in providing food, safety, security and health infrastructure and effectively managing them. This is possible only when effective knowledge and skills are imparted to the meritorious youth who are motivated and committed to the development of rural sectors in India. In light of this perspective, the Rural Development Centre of IIT Kharagpur aims to offer a **"Micro-Specialization in Rural Innovation and Management" (RIM)** for the UG students from all engineering and science disciplines.

   We all know that the people residing in the rural areas are lagging behind their urban counter parts in respect of certain key indicators of development such as poverty ratio, literacy rate, nutritional status, housing situation and access to basic amenities. Several developmental schemes are being taken up during various planned phases in our country. However, the rate of improvement is still not to the mark since the first 5-year Plan was introduced. The students will require to know why do so happen and how to overcome these. Nevertheless, it is pertinent to understand (i) the issues related to rural development such as poverty, equity, health, education, infrastructure, social barriers, safety and security, (ii) strategies and policies of rural development, and (iii) management and implementation approaches. All these things among others will be taught in the subject named "Fundamentals of Rural Innovation and Management" (see Table I). It's the basic course giving an idea of Innovative Actions of Rural Development and every students doing micro specialization in RIM must take this. The different dimensions of this basic course will be discussed under six electives in two groups like Technology component and Management component (see Table II) and depending on the choice a student can take one such electives from each group. The need for these electives is given below:

   The students must understand the main differences between rural and urban communities as this is important for understanding the distinguishing characteristics of the rural life. As such in the rural development context no single description or analysis is applicable throughout the country – there are variations between regions, sub-regions, and also between religious, castes and various ethnic groups. Such variations due to the extent or degree of differential responses explain the diversity as well as the unity that characterises Indian rural society. In line with this, the issues related to rural economics and marketing, and rural infrastructure development and management are extremely important. Promoting sustainable and inclusive rural development requires deeper understanding of the factors that constrain or promote rural development and addressing them through appropriate policies and institutions. Peculiarities of rural development lead to imperfections in input and output markets resulting in distortions to efficient functioning of market mechanisms and hence social welfare. In addition, lack of capabilities and adequate

access to markets limit inclusiveness of the development process. Accordingly, two more electives namely “Economics of Rural Sectors” and “Rural Infrastructure Development and Management” are introduced. In addition, one more subject “Foundation of Entrepreneurship” has been included in the course to provide basic knowledge on rural enterprise development and employment generation in rural sector. These subjects are grouped as Elective subjects under management subcomponent. (see Table II).

Rural economy is primarily dependent on agricultural products. The pertinent issues are agri-land utilization, enhanced crop production, storage and distribution in addition to farm supplies, agro processing, agricultural marketing, and agricultural finance. In the current development paradigm, adequate knowledge of issues relating to structural adjustment of agriculture and rural industries, generation of agricultural surplus, enhancement of productivity, development of markets, technological and institutional innovations, international trade, natural resource conservation and management, etc. are very important. Innovation and technological approach towards any developmental activity includes the three major interrelated components like, development of innovative and appropriate technologies, proper transfer and successful adoption of those. Since a technological innovation is not applicable or transferable to all situations, it needs to be made an appropriate one that is suited to the economic and social conditions and level of civilization of a given population in a specific zone or area. On the other hand, follow of proper technique for transferring a technological innovation leads to a successful and effective adoption of the same. Three electives namely “Transfer and Adoption of Rural Technology” and “Food Processing and Agri-value Chain” and “Alternative Energy sources” are introduced under Technology subcomponent of electives (see Table II).

No knowledge is complete unless it is transferred and implemented to those for which it is developed. The students after going through the core and elective subjects must take a real-life-problem solving project, or a design project, or a term paper. This is highlighted in Table III.

3. Number of Subjects needed to earn the Micro-Specialization: Four

4. Credits needed to earn the Micro-Specialization: 13 - 14 credits

5. Structure: Component I: One Subject
Component II: Two Subjects (3-0-0/3-1-0)
Component III: One Subject

A. COMPONENT- I: MANDATORY REQUIREMENT: (ONE FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RD30005	Fundamentals of Rural Innovation and Management	3-0-0	3	Both	NA

B. COMPONENT- II ANY TWO SUBJECTS (3/4 credits) FROM TABLE-II (One each from 2 Elective groups)

TABLE-II

Sub No.	Name	L-T-P	Credit	Offering Semester	Pre-requisite (if any)
Elective I (Technology component)					
RD30007	Transfer and Adoption of Rural Technology	3-0-0	3	Both	**RD30005**
RD30006	Food Processing and Agri-value Chain	3-0-0	3	Spring	**RD30005**
RD30009	Economics of Rural sectors	3-0-0	3	Autumn	**RD30005**
Elective II (Management component)					
AG60002	Alternative energy sources	3-1-0	4	Spring	**RD30005**
RD30011	Rural Infrastructure Development and Management	3-0-0	3	Both	**RD30005**
EP60020	Foundations of Entrepreneurship	3-0-0	3	Both	**RD30005**

C. COMPONENT- III: ONE SUBJECT FROM TABLE-III

TABLE-III

Sub No.	Name	L-T-P	Credit	Offering Semester	Pre-requisite (if any)
RD67001	Project/design/term paper	0-0-0	4	Both	**Subjects of Table I and Table II**

Name of the Micro-Specialization: Simulation Methods and Applications

1. **Department/School/Center: Centre For Theoretical Studies**

2. **Brief Description:** The aim of this micro specialization is to introduce students to some methods in simulations and also provide them with adequate exposure on how such methods are applied in diverse problems in the science and engineering. As is clear from the structure of the micro specialization, the foundation (base) course provides the background and the electives involve applications ranging across disciplines in science and engineering.

3. **Number of Subjects needed to earn the Micro-Specialization: Three**

4. **Credits needed to earn the Micro-Specialization: 11 - 12 credits**

5. **Structure:** **Component I: One Subject**
   Component II: One Subject (3-0-0/2-0-3)
   Component III: One Subject

A. COMPONENT- I: MANDATORY REQUIREMENT: (ONE FOUNDATION COURSE)

TABLE-I

Sub no.	Sub Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
TS70009	Methods In Molecular Simulations	3-1-0	4	Spring	NA

B. COMPONENT- II ANY ONE SUBJECT (3/4 credits) FROM TABLE-II

TABLE-II

Sub No.	Name	L-T-P	Credit	Offering Semester	Pre-requisite (if any)
CE60103	Monte Carlo Simulations in Engineering	3-0-0	3	Autumn	**TS70009**
TS62001	Simulations In Collider Physics And Cosmology	2-0-3	4	Autumn	**TS70009**
TS62002	Quantum Methods In Molecular Simulations	2-0-3	4	Spring	**TS70009**

C. COMPONENT- III: ONE SUBJECT FROM TABLE-III

TABLE-III

Sub No.	Name	L-T-P	Credit	Offering Semester	Pre-requisite (if any)
TS67001	Project/ term paper	0-0-0	4	Both	**TS70009**

Name of the Micro-Specialization: Quality Engineering

1. **School/Center:** SubirChowdhury School of Quality and Reliability (Former Reliability Engineering Centre
2. **Name of the Micro Specialization:** Quality Engineering
3. **Brief Description:** This micro-specialization is open to the UG students with various engineering backgrounds. This specialization will help them understand the concepts of quality and expose to the ways and means to assess, improve, implement and manage the same in every sphere of activities. The specialization provides courses on general quality concepts, quality engineering, off-line and on-line quality control techniques. Further, the specialization also offers courses on quality of services, power, water, air, and food products which have become very important in the present industrial and globalization scenario in India. This specialization will help students to understand various quality problems and use of appropriate tools and techniques for addressing the same. This micro specialization is designed with generic approach so that students from all disciplines get benefited.
4. **Number of Subjects needed to earn the Micro Specialization (3-4 subjects):** 4
5. **Minimum Credits needed to earn the Micro Specialization (10-14 credits):** 11
6. **Structure:**

A. COMPONENT- I: MANDATORY REQUIREMENT (2 credit FOUNDATION COURSE)

TABLE-I

Sub no.	Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RE30003	Introduction to Quality	2-0-0	2	Both	Uploaded in ERPand Approved by Senate

B. COMPONENT- II:TWO SUBJECTS (3/4 credits each) FROM TABLE-II

TABLE-II

Sub no.	Name	LTP	Credits	Offering Semester	Pre-Requisite (if any)
RE60015 (OR) IM 31005	Statistical Process Control (OR) Quality Design and Control	3-0-0 3-1-0	3 4	Spring Spring	RE30003
RE60005	Quality of Services Analysis in Cloud Computing	4-0-0	4	Spring	RE30003
RE60025	Software Quality Assurance	3-0-0	3	Autumn	RE30003
IM 31002 (OR) IM 60062	Quality Engineering (OR) Six Sigma Fundamentals & Applications	3-1-0 3-0-0	4 3	Autumn Spring	RE30003
IM 60057	Total Quality Management	3-0-0	3	Spring	RE30003

C. COMPONENT- III PROJECT/DESIGN/TERM PAPER (4 credits) OR ONE (3/4 credit) SUBJECT

TABLE-III

Sub no.	Name	LTP	Credits	Offering Semester	**Pre-Requisite (if any)**
RE47001	Project/Term Paper on Quality	0-0-6	4	Both	RE30003
CE 31304	Air Quality Management	3-0-0	3	Spring	RE30003
EE 60025	Power Quality	3-0-0	3	Autumn	RE30003
AG 31032	Water Quality Management	3-1-0	4	Spring	RE30003
AG 60127	Food Quality and Safety Standards	3-0-0	3	Autumn	RE30003

5. Additional Remarks, if any:

The component – I will provide the necessary background to the concepts of quality specialization. Component-II will cover the three important traditional quality areas, viz., Statistical Quality Control and Acceptance Sampling, Quality through Design and Experimentation, and Quality Management. As some courses in this component are similar in contents, an OR logic needs to be applied to avoid taking them by the same students (See Table – II). The component –III will help the student to apply the quality concepts to real problems. The Component – III also gives options for the students to understand quality problems in important functional areas (which directly affect the day to day life) and to address them adequately.

HOC/HOS/Chairman

Detailed Syllabi of Courses

RE30003 Introduction to Quality

LTP- 2-0-0,CRD- 2

Basic concepts of Quality, Quality philosophies, Quality Costs and Statistics for Quality, Applications of Quality in Day-to-day Life: Air, Water, Food, and Power Quality. Quality Management Practices, Tools and Standards, Concepts of Service quality, Customer relations, Design for Quality, Concepts of Quality Control and Acceptance Sampling, Concepts of zero defects and six sigma, Quality Improvement- Roles of Management, Manufacture and Operators, Vendor Relations, Inspection and Tests, Quality Measurement, Field Relations and Quality

Text Books:
AmitavaMitra, "Fundamentals of Quality Control and Improvement", Wiley.
J.M. Juran and Frank M. Gryna, Jr., "Quality Planning and Analysis", McGraw-Hill.
InteazAlli, "Food Quality Assurance: Principles and Practices', CRC Press.
J. Andres Vasconcellos, "Quality Assurance for the Food Industry: A Practical Approach", CRC Press
E. Alley, "Water Quality Control Handbook", WEF Press.
Angelo Baggini, "Handbook of Power Quality", Wiley.

SUBJECT NO-RE60015, SUBJECT NAME- STATISTICAL PROCESS CONTROL
LTP- 3-0-0,CRD- 3

SYLLABUS:-

Process variation and causes, statistical basis for quality control, concept of rational sub-grouping. Quality characteristics-variables and attributes, Pattern on control charts, control charts for mean and range mean and standard deviation, individual units, cumulative sum, moving average, trend and acceptance, control charts for variables: O.C. curves control charts for fraction nonconforming (p-charts), number of nonconforming items (np-chart), number of non-conformities (c-charts), number of non-conformities per unit (u-chart), demerits per unit (U-chart). Process capability analysis.

Text Books:
AmitavaMitra, "Fundamentals of Quality Control and Improvement"

SUBJECT NO RE 60005 Quality of Services Analysis in Cloud Computing

LTP - 4-0-0, CRD (4)

SYLLABUS :-

History of Cloud Computing: Paradigms in Computing, Parallel Computing, Distributed Computing, Grid Computing, Service Computing; Service Oriented Architecture (SOA), Web Services. (**1 Lectures)**

Basics of Cloud Computing: Definition, Characteristics, Architecture, Service Models, Deployment Models, Virtualization: Server, Storage, Network, Desktop; Hypervisor, Virtual Machine, Multi-tenancy, Opportunities and Risks, Quality Concepts, Quality Control, Quality Assurance Strategies. (**2 Lectures**)

Cloud System Reliability: Risks of Essential Cloud Characteristics, Risks of Service Models, Risks of Deployment Models, Risk Management, Risk Hedging, Reliability and Availability Risks of Virtualization, Reliability Analysis of Virtualization Techniques, Software Failure Rate Analysis,Failure analysis of Cloud System, Eight - Ingredient Framework,Reliability modeling, Service Reliability Metrics, Reliability Evaluation, Design Principles for Reliable Cloud, Availability and Disaster Recovery, Service Availability Metric, Hardware reliability, Capacity Planning, Capacity Management Risks, Recovery Models, Recovery Oriented Computing. (**15 Lectures**)

Cloud Security: Cloud Security Fundamentals, Vulnerability Assessment, Security and Privacy in Cloud, Cloud Computing Security Architecture: Identity Management and Access Control, Autonomic Security; VM Specific Security Techniques. (**3 Lectures**)

Cloud performance: Real time monitoring, Scheduling, admission control, traffic control, dynamic resource provisioning. (5 Lectures)

Cloud Service Level Agreement (SLA): Definition, Contract Design, Types of SLA, SLA Life Cycle, Issues **Related to Cloud SLA, SLA Frameworks:**WS-Agreement, WSLA, WSOL, Slang, Bilateral Protocol; Translation of SLAs into Monitoring Specifications, Dynamic Creation of Monitoring Infrastructures,

Penalty Management, Runtime Prediction (4 Lectures)

Managing Big Data: Cloud File Systems:GFS and HDFS, Big Table, HBase and Dynamo; Map Reduce Programming Model, Hadoop: Hadoop Fundamentals, Hama and other Hadoop Related Services, Security Threats and attacks to Big Data, authentication protocols to secure Big Data, Hardware solutions to Big Data Security. (8 Lectures)

Some Case Studies: Xen Hypervisor, Amazon Web Service, Windows Azure, Google App Engine, Eucalyptus, Open Stack, Open Nebula (3 Lectures)

RE60025 Software Quality Assurance

LTP - 3-0-0, CRD (3)

SYLLABUS :-

Basics of software quality: Introduction, Definition, needs and objectives, Software quality models, McCall's model, Boehm's model, ISO 9126 model, Software quality metrics, Metrics, their classification, implementation and limitations, Quality assurance and certification, Quality management system, quality management standards, ISO, IEEE, CMM/CMMI, Software quality assurance management: Software development, Software processes and different development life cycles, 3S development, Software quality management, SRS template and development, customer management, security management and risk mitigation and management, Resources and organization management, Software quality issues with different team structures. Software quality assurance techniques: Planning and analysis, Cost analysis, budget analysis, time analysis, Verification and validation, Errors, bugs and failure, Defect prevention and reduction, root cause analysis, Software testing, Different testing strategies: graph-based, model-based. Software reliability for QoS: Fundamental reliability metrics, Time interval, failure interval, failure intensity, Factors influencing software reliability, First and second definitions, Models for reliability prediction, Classic model, failure model, architecture-based model, Statistical models, advanced models

Text and reference books:

Software Quality Assurance by Daniel Galin, Pearson/Addison Wesley Publishing, 2009

Software Quality: Theory and Management by Alan C. Gillies, Thomson Computer Press, 1997
Software Testing and Quality Assurance by KshirsagarNaik and PriyadarshiTripathi, Wiley, 2008
Handbook of Software Quality Assurance edited by G. Gordon Schulmeyer, Artech House, 2008

SUBJECT NO-IM31002, SUBJECT NAME- QUALITY ENGINEERING
LTP- 3-1-0,CRD- 4

SYLLABUS :-
Prerequisites: IM31005 Quality Design and Control Experimental designfundamentals; Statistical concepts; Features of experimentation; Analysis ofvariance (ANOVA): no-way, one-way, two-way, and three-way ANOVA, Critique of Ftest;Some experimental designs: Factorial experiments (2k), role of contrasts,confounding, fractional replication, and other aspects; 2k-p fractionalfactorial experiments; Response Surface Methodology (RSM).Taguchi philosophy;Loss function; Orthogonal arrays: Steps in designing, conducting, and analyzing an experiment; Parameter and tolerance design concepts: control and noisefactors; Analysis of inner/outer array experiments: signal-to-noise ratio andperformance measures; Applications to attribute data.

Books: Montgomery, D.C.(2004), Design and Analysis of Experiments, John Wiley

SUBJECT NO-IM31005, SUBJECT NAME- QUALITY DESIGN AND CONTROL
LTP- 3-1-0,CRD- 4

SYLLABUS :-
Prerequisites: IM21003 Operations Research-1

History and Evolution of Quality Control and Management.Management of Quality: Meaning of Management of Quality, Quality Engineering, Strategic Management of Quality, Management Programs for Quality, Fundamentals of Total Quality Management (TQM), Quality Loop, Quality System Standards (ISO 9000).Probability Models for Quality Control, Descriptive Statistics, Sampling, and Inferences.Statistical Process Control (SPC):(a)Control Chart Principles: Causes of Variation, Statistical Aspects of Control Charting, Concept of Rational Subgrouping, Detecting Patterns on Control Chart, (b) Control Charts for Attributes: p, np, c, u, and U charts, (c) Control Charts for Variables: R, X, S, and X charts, (d) Special Control Charts: Cusum, Trend, Modified and Acceptance, Moving Average, Geometric Moving Average, and Multivariate Control Charts, (e) Specifications and Tolerances: Natural Tolerance Limits and Specification Limits, Process Capability Ratios, and Process Capability Analysis.Acceptance Sampling: (a) Fundamental Concepts, (b)Acceptance Sampling by Attributes: Single, Double, Multiple, and Sequential Sampling Plans, MIL-STD-105E, Dodge-Romig, and ANSI-ASQC-Z1.4 Plans, Continuous Sampling Plans, (c) Acceptance Sampling by Variables: Types of Plans, Plans for a Process Parameter, Plans to Control the Lot Percent Nonconforming, MIL-STD-414 and ANSI/ASQC Z 1.9. Reliability Prediction and Life Testing: Reliability of a System, Exponential Model in Reliability, Life Testing using Exponential and Weibull Models, Fundamentals of Maintenance Management, Concept of Total Productive Maintenance (TPM).Product and Process Design: (a) Experimental Designs: Completely Randomized Design, Randomized Block Design, Latin Square Design, (b) Factorial Experiments, (c) Taguchi Methods in Design and Quality Improvement: Taguchi Philosophy, Loss Function, S/N Ratio and Performance Measures, Experimental Design and Parameter Design in Taguchi Methods.

Textbook:
Mitra, A.Fundamentals of Quality Control and Improvement, Prentice-Hall, 2nd Edn.(1998), ISBN 0-13-645086-5

References:
Duncan, A. J., Quality Control and Industrial Statistics,
Richard D. Irwin, 5th ed. (1986).
Montgomery, D. C., Introduction to Statistical Quality Control, John Wiley, 3rd ed. (1996).
Banks, J., Principles of Quality Control, John Wiley, 1989.
Grant, E. L. and Leavenworth, R. S., Statistical Quality Control, McGraw Hill, 5th ed.(1988)

SUBJECT NO-IM60057, SUBJECT NAME- TOTAL QUALITY MANAGEMENT
LTP- 3-0-0,CRD- 3

SYLLABUS :-
Fundamentals of TQM; Some important philosophies and their impact on quality(Deming, Juran, Crossby), Features of MalcomBalridge quality award;Identification and measurement of quality costs; Issues related to products,processes, organization, leadership, and commitment for total qualityachievement; Tools and techniques used in TQM: seven tools, new seven,essential features of QCC, ZD, Kaizen, and JITprogrammes; Fundamental conceptsabout Quality Function Deployment (QFD); Components of Total Quality System(TQS) in organizations, Quality Auditing: Introduction to ISO 9000 and 14000standards. Case studies.

Books
1. Total Qualtiy Management – Dr B Janakiraman, Prof R K Gopal – PHI, 2005
2. Quality Management Creating And Sustaining Organizational Effectiveness – CS Summers – Pearson/PHI, 2004

Keller, P. (2005). “Six Sigma Demystified”. Tata McGraw-Hill, New Delhi

SUBJECT NO-IM60062, SUBJECT NAME- SIX SIGMA FUNDAMENTALS & APPLICATIONS
LTP- 3-0-0, CRD- 3
SYLLABUS :-
Introduction to Six Sigma: Definitions and success stories, six sigma framework, DMAIC – the six sigma improvement process, statistics and six sigma, difference between six sigma and TQM.
Preparing for Deployment: Elements of successful deployment, personal requirements – champions, black belts, and green belts, and focusing on deployment – customer focus, project selection, and QFD.
Six Sigma Tools: Exploratory tools – Charts, diagrams, and metrics, Data collection and monitoring tools – primary and secondary data, instrument design and sample survey, gage R&R, and attribute measurement systems, and SPC, Analysis tools – Diagrams, Hypothesis testing, ANOVA, correlation and regression (linear and logistic), and FMECA.

Six Sigma Methodology (DMAIC): Define – objectives, process thinking, process mapping, balanced scorecard, project selection and tracking, Measure – objectives, measurements (discrete vs continuous), measurement as a process, baseline estimation, performance metrics, and measurement system analysis, Analysis – objectives, value stream analysis, analyzing sources of variations, and determining process drivers, Improve – objectives, defining new process, benchmarking, prioritizing and selecting a solution, and corrective action matrix, Control – objectives, more on SPC, visual control, best practices and lessons learned, and documenting process changes.
Case studies: Selective cases with hands on exercises.
Textbooks and References:

1. Keller, P. (2005). “Six Sigma Demystified”. Tata McGraw-Hill, New Delhi.
2. Breyfogle, F. W. III, Cupello, J. M. and Meadows, B. (2001). “Managing Six Sigma”. John Wiley and Sons, New York.
3. Pyzdek, T. (2003). “Six Sigma Handbook”. McGraw-Hill, New York.

SUBJECT NO-RE47001
SUBJECT NAME: Project/Term Paper on Quality LTP- 0-0-6, CRD – 4

Objectives: The objective of the project to enable the student to apply the concepts of quality in real situations or industrial problems. Instead, the student can write a Term Paper or research paper on a selected recent topic. Term paper is intended to describe an event, a concept, or argue a point with adequate supporting documents or literature in the domain of Quality. The term paper must be a written original work discussing a topic in detail with latest relevant literature, usually several typed pages in length and is due at the end of the semester.

Possible areas:

1. Statistical Process Control
2. Quality Engineering
3. Quality Management
4. Quality Standards
5. Software Quality

SUBJECT NO-CE60022, SUBJECT NAME- AIR QUALITY MANAGEMENT
LTP- 3-1-0, CRD - 4
SYLLABUS :-

Air pollutants-Sources, classification, Combustion processes and pollutant emission, Effect on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects- Smoke, smog and ozone layer disturbance, Atmospheric diffusion of pollutants and their analysis, Transport,

transformation and deposition of air contaminants on a global scale, Air sampling and pollutant measurement methods, principles and instruments, ambient air quality and emission standards, control, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods, Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods

SUBJECT NO- EE 60025 POWER QUALITY LTP - 3-0-0, CRD 3

Introduction: Definition of power quality, its impacts and evaluation procedure with emphasis on deregulated environment; General classes of power quality problems; Transients: impulsive transient, oscillatory transient; Long-duration voltage variations: overvoltage, undervoltage, sustained interruptions; Short-duration voltage variations: interruption, sags, swells; Voltage imbalance; Waveform distortion; Voltage fluctuations; Power frequency variations.
Voltage Sags and Interruptions: Sources of sags and interruptions; Voltage sag performance estimation; Principles of protection; Solutions at end-user level: ferroresonant transformers, magnetic synthesizers, active series compensators, on-line and standby UPS, SMES devices; Cost estimation for voltage sag events.
Transient Overvoltages: Sources of transient overvoltages: capacitor switching, lightning, ferro-resonance; Principles of protection: surge arrestors, isolation transformers, low-pass filters, low-impedance power conditioners.
Harmonics: Harmonic sources: fluorescent lighting, adjustable speed drive, industrial load, cyclic load, power converter; Harmonic distortion evaluation; Harmonic control: reduction of harmonic load current, filtering, modification of system frequency response; Harmonic control on utility feeders and at end-user facility; Devices for harmonic distortion control: in-line reactors, zigzag transformers, passive and active filters.
Long-Duration Voltage Variations: Voltage regulation principles; Regulating devices: tap-changing transformers, isolation devices with separate voltage regulators, capacitors, SVC, STATCOM, DVR, active power line conditioner; Flicker: sources, calculation and mitigation techniques.
Power Quality Benchmarking: RMS voltage variation indices; Harmonics indices; Power quality contracts; Power quality insurance; Inclusion of power quality in distribution planning; Power quality state estimation.
Distributed Generation (DG) and Power Quality: Resurgence of DG; DG technologies; Interface to the utility system; Power quality issues; Operating conflicts; DG in low-voltage distribution systems.
Power Quality Monitoring: Basic concepts and monitoring considerations; Power quality measuring instruments: wiring and grounding test devices, multimeters, oscilloscopes, disturbance analyzers, harmonic and spectrum analyzers, flicker meters, energy monitors; Power quality data assessment techniques: time-frequency analysis of signals (Fourier and Wavelet transforms), Kalman filtering, disturbance/event classification.

SUBJECT NO-AG31032, SUBJECT NAME- WATER QUALITY MANAGEMENT
LTP- 3-0-0, CRD - 3
SYLLABUS :-

Water Quality: Terminology, Sources of water pollutants, pollution kinetics and reaction mechanism. Water Quality Standards: International and Indian Standards for drinking, irrigation, industrial and aquatic use. Water Quality Analysis: Methods and Instruments for analysis of all water quality parameters. Working principles of theInstruments. Water Purification: Mechanical, biological and membrane filters. Reverse Osmosis: Principle, application and related instruments. Water Treatment Methods: Aeration, nitrogen removal, pH control, removal of solids and gases in water, disinfection and ion-exchange. Use of chlorine, bromine, iodine, $KMnO_4$ etc. for disinfection.
Water Treatment Plant: Components and Working Principles. Waste Water Treatment: Methods and Instruments. Water Quality Index: Principle, International and Indian standards, parameters considered for surface and ground water indexing. Water Pollution due to Pesticides and Toxic Metals: Sources of pollution and control

Water Quality Modeling: Use of modeling technique, Study of the available models for water quality modeling.

SUBJECT NO-AG60127, SUBJECT NAME- FOOD QUALITY AND SAFETY STANDARDS
LTP- 3-0-0, CRD - 3
SYLLABUS :-

Statutory meaning of food, essential commodity, food quality, safety & sanitations; changing nature of food quality and standards; food policy in India; regulations and methods for prevention of food adulteration; food safety and sanitations standards and methods; statutory grading of agricultural produce; regulations for supply, distribution, trade and commerce of essential commodities. Food standards authority – Indian & International; Bureau of Indian Standards (BIS); quality control and inspection in export and import of food items; international agreements on sanitary and phyto-sanitary measures; harmonization of food regulations; emerging methods, trends and issues; case studies. Plant safety, hygienic process design, HACCP, GMP, ISO and CIP