

## BE INSTRUMENTATION AND CONTROL ENGINEERING

### SEMESTER - VII

#### 19U701 LOGIC AND DISTRIBUTED CONTROL SYSTEM

3 0 0 3

**COMPUTER BASED PROCESS CONTROL** : Data loggers - Data Acquisition Systems (DAS) - Functional block diagram of computer control systems - sampling considerations - Supervisory Control and Data Acquisition Systems (SCADA): Hardware and software, Remote terminal units, Master station, communication architectures. (8)

**PROGRAMMABLE LOGIC CONTROLLER (PLC)** : Introduction - architecture of PLC - working principle - memory types - Input/Output modules - sink and source I/O cards - programming methods - programming device - Basic Programming Instructions: User and bit Instructions, Instruction addressing, branch instructions, internal relay instructions - Ladder diagram for Boolean Gates - Concept of Latching and Unlatching - Timer instruction - Counter instruction (9)

**ADVANCED FUNCTIONS IN PLC** : Program Control Instructions: Master Control Reset, Jump, SKIP and Subroutines - Data Manipulation Instructions: Data transfer, Data Compare - Math instructions: Addition, Subtraction, Multiplication, Division - Sequencer instructions - PID functions - Design of alarm and interlocks -Networking of PLC - PLC installation, maintenance and troubleshooting. (10)

**DISTRIBUTED CONTROL SYSTEMS (DCS) AND COMMUNICATION FACILITIES** : DCS - Various Architectures and Comparison - Local control unit (LCU) - Process interfacing issues - Operator Interfaces - Engineering Interfaces - Redundancy concept - Interoperability and Interchangeability - Communication facilities: HART Protocol, Wireless HART, Foundation Field bus and Profibus - Case Study of any one DCS (10)

**ADVANCED TOPICS IN AUTOMATION** : Introduction to Networked Control systems - Plant wide control – Industrial Internet of things (IIoT) - Cloud based Automation - Introduction to OLE for Process Control(OPC) - Safety PLC (8)

**Total L: 45**

#### TEXT BOOKS:

1. John W Webb, Ronald A Reis , "Programmable Logic Controllers - Principles and Applications", 5<sup>th</sup> Edition, Pearsons Education, 2008.
2. Michael P Lukas , "Distributed Control Systems", 1<sup>st</sup> Edition, Van Nostrand Reinhold Co., New York, 1986..

#### REFERENCES:

1. Stuart A. Boyer , "SCADA: Supervisory Control and Data Acquisition Systems", 4<sup>th</sup> Edition, ISA Press, 2010.
2. Curtis Johnson , "Process Control Instrumentation Technology", 8th Edition, Pearson Education, 2014.
3. Frank D. Petruzella , "Programmable Logic Controllers", 3rd Edition, Tata McGraw Hill, New York, 2010.
4. John Park, Steve Mackay, Edwin Wright , "Practical Data Communications for Instrumentation and Control", 1<sup>st</sup> Edition, Elsevier, 2003.

#### 19U702 ANALYTICAL INSTRUMENTATION

3 0 0 3

**INTRODUCTION TO SPECTROSCOPY** : UV-Visible Spectroscopy - Electromagnetic radiation and its interaction with matter - Absorption spectroscopy - Absorption laws - Types of electronic transitions - Radiation sources - Monochromators - Filters - Prisms - Diffraction gratings - Detectors - Choice of solvents for UV -Visible spectrometers - single-beam and double-beam instruments. (9)

**INFRA-RED SPECTROSCOPY** : Basic principles - Hooks law - Calculation of wave numbers - Degrees of freedom - Types of vibrations - IR sources - Cells - Detectors - Sample preparation. Analysis using Attenuated Total Reflectance (ATR). Atomic absorption spectrometry (AAS) - Wavelength choice - Sources - Cells - Detectors. Flame emission spectrometry. Atomic fluorescence spectrometry. (9)

**NMR AND X-RAY SPECTROSCOPY** : Nuclear magnetic Resonance (NMR) spectroscopy - Basic principles -The NMR phenomenon - Magnetic moments - Number of signals - Chemical shift - Continuous wave NMR spectrometer - Pulsed Fourier Transform NMR spectrometer - NMR applications. X-ray absorption methods - X-ray fluorescence methods - X-ray diffraction. Radioactive measurement - Units of radioactivity - Application of radio nuclides in analysis - Radioactivity detectors (9)

**CHROMATOGRAPHY** : Basic principles of chromatography - Types of Chromatography - Gas chromatography - Column details - Detectors for chromatography - Thermal conductivity detector - Flame ionization detector - Flame photometric detector - Electron capture detector - Effect of temperature programming - High pressure liquid chromatography (HPLC). Mass spectrometry - Instrumentation - Base peak - Molecular ion peak - metastable peak - Isotopic peaks - Applications. (9)

**SAMPLING AND ELECTROCHEMICAL TECHNIQUES** : Sample collection for gas, liquid and solid analysis. Ion selective

electrodes - Glass and reference electrodes. pH measurement - pH meter and its calibration. Electrical conductivity measurement - Measuring circuit. Flue gas analysis for pollution control - Measurement of Oxygen, Carbon monoxide, Carbon dioxide, NOX and SOX, dust and smoke measurement, Continuous Emission Monitoring System. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Willard H H, Merit L.L, Dean J A and Seattle F L , "Instrumental Methods of Analysis", 7<sup>th</sup> Edition, CBS Publishing and Distribution, New Delhi, 1996.
2. Ewing G W , "Instrumental Methods of Analysis", 5<sup>th</sup> Edition, McGraw-Hill, New York, 2013.

**REFERENCES:**

1. Robert D Braun , "Introduction to Instrumental Analysis", BSP Books P Ltd, Hyderabad, 2016.
2. Skoog D A, James Holler F and Stanley R Crouch , "Principles of Instrumental Analysis", Cengage India P Ltd, New Delhi, 2017.
3. Liptak B G , "Instrument Engineers Handbook: Process Measurement and Analysis", 3<sup>rd</sup> Edition, CRC Press, Boca Raton, 2005.
4. Khandpur R S , "Handbook of Analytical Instruments", 3<sup>rd</sup> Edition, McGraw-Hill Education (I) P Ltd, Chennai, 2017.

**19U710 INDUSTRIAL AUTOMATION LABORATORY**

**0 0 2 1**

**LIST OF EXPERIMENTS :**

1. Implementation of basic logic operations Using PLC
2. Implementation of timer operations using PLC
3. Implementation of counter operations using PLC
4. Study of Analog and Digital I/O interfacing in PLC
5. Implementation of actuator control using PLC
6. Implementation of sequential control using PLC sequencer function
7. Implementation of PLC programming for practical applications
8. Study of various function blocks in DCS
9. Implementation of control logic using DCS
10. On-line monitoring and control using DCS
11. Study of IoT based Automation using PLC

**Total P: 30**

**REFERENCES:**

1. Frank D. Petruzella , "Programmable Logic Controllers", 3rd Edition, Tata McGraw Hill, New York, 2014.
2. Department of Instrumentation and Control Systems Engineering , "Laboratory Manual", 2019.

**19U711 INDUSTRIAL AND VIRTUAL INSTRUMENTATION LABORATORY**

**0 0 2 1**

**LIST OF EXPERIMENTS :**

1. Study of zero elevation and zero suppression in differential pressure transmitter
2. Design of alarm circuit
3. Linearization of thermistor and cold junction compensation of thermocouple
4. Design of temperature transmitter
5. Calculation of discharge co-efficient of orifice plate, venturi and pitot tube
6. Implementation of GUI for a transducer output with options to moderate static characteristics
7. 7 ) Signal acquisition and creation of GUI for real-time display and data logging from a temperature sensor (RTD/Thermistor)
8. Signal Acquisition from thermocouple and creation of GUI with compensation
9. Implementation of virtual PID controller
10. Implementation of single loop and multi loop controllers using virtual instrument

**Total P: 30**

**REFERENCES:**

1. Bela G Liptak , "Process Measurement and Analysis", 4<sup>th</sup> Edition, CRC Press, 2003.
2. Jovitha Jerome , "Virtual Instrumentation Using LabVIEW", PHI, 2010.

## 19U720 PROJECT WORK I

0 0 4 2

- Identification of a real life problem in thrust areas.
- Developing a mathematical model for solving the identified problem.
- Finalisation of system requirements and specification.
- Proposing different solutions for the problem based on literature survey.
- Future trends in providing alternate solutions.
- Consolidated report preparation.

Total P:60

## SEMESTER – VIII

### 19U820 PROJECT WORK II

0 0 8 4

The Project involves the following:

- I) Preparing a project — brief proposal including
  - Problem Identification
  - A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
  - List of possible solutions including alternatives and constraints
  - Cost benefit analysis
  - Time line of activities
- II) A report highlighting the design finalization [based on functional requirements & standards (if any)]
- III) A presentation including the following:
  - Implementation Phase (Hardware / Software / both)
  - Testing & Validation of the developed system
  - Learning in the Project
- IV) Consolidated report preparation

Total P:120

## PROFESSIONAL ELECTIVES

### 19U001 BIOMEDICAL INSTRUMENTATION

3 0 0 3

**BIOELECTRIC POTENTIALS AND ELECTRODES** : Cells and their structures - Transport of ions through cell membrane - Biopotential - action and resting potential - propagation of action potential - Bioelectric potential - Biopotential electrodes – Types of electrodes: surface, needle and microelectrodes (12)

**CARDIOVASCULAR SYSTEM AND MEASUREMENTS** : Heart and cardiovascular system — ECG — 12 lead system - principle of vector cardiography - blood pressure and its measurement — heart sound and its measurement - Defibrillator : principle and types -pacemakers: principle and types. (9)

**NERVOUS SYSTEM AND MEASUREMENTS** : Central and peripheral nervous system - parts of human brain- Action potential of brain - brain wave - EEG- 10-20 electrode system. (8)

**RESPIRATORY SYSTEM AND MEASUREMENTS** : Physiology of respiratory system - Principle of pneumograph - Spirometer - ventilators: principle and types. (8)

**MEDICAL IMAGING** : X-ray imaging - Computed Tomography (CT) - Ultrasonic Scanner - Magnetic Resonance Imaging - Positron Emission Tomography (PET). (8)

Total L: 45

#### TEXT BOOKS:

1. Leslie Cromwell, Fred J Weibell, Erich A. Pfeiffer , "Biomedical Instrumentation and Measurements", Prentice Hall, 2010.
2. Khandpur RS , "Handbook of Biomedical Instrumentation", McGraw Hill Education,2014.

#### REFERENCES:

1. John G Webster, "Medical Instrumentation: Application and Design", John Wiley and Sons,2010.
2. Joseph J Carr, John M Brown, "Introduction to Biomedical Equipment Technology", Pearson, 2002.

3. L.A.Geddes, L.E. Baker, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, 2009.
4. Richard Aston, "Principles of Biomedical Instrumentation and Measurement", Merrill Publishing Company, New York, 1990.

### 19U002 FIBER OPTICS AND LASER INSTRUMENTATION

**3 0 0 3**

**OPTICAL FIBERS AND THEIR PROPERTIES :** Characteristics of optical radiation, luminescence - Fiber materials and their characteristics - Principles of light propagation through a fiber - Types of optical fibers - Properties - Transmission characteristics - Absorption losses - Scattering losses - Dispersion - Fibers splicing, connector and couplers - Optocouplers – Optodes (9)

**OPTICAL SOURCES AND DETECTORS :** LED — LED power and efficiency - Structures, planar, dome, ELED, SLED, super luminescent LEDs, characteristics and applications - General characteristics of photodetectors - Photodiode - Junction photodiodes - Heterojunction diode and PIN diode - APD - Special detectors – Schottky barrier diode - Photo-transistor and photo- thyristor - Solar cells (9)

**INDUSTRIAL APPLICATION OF OPTICAL FIBERS :** Fiber optic sensors - Fiber optic instrumentation system - Application in instrumentation: interferometric method of measurement of length - Moiré fringes - Measurement of pressure, temperature, current, voltage, liquid level and strain - Fiber optic gyroscope - Cavity dumping - Polarization maintaining fibers (9)

**LASER FUNDAMENTALS :** Characteristics of lasers - Three level and four level lasers - Properties of laser - Laser modes - Resonator configuration — Q switching and mode locking — Cavity dumping - Types of lasers: gas lasers, solid lasers, liquid lasers, semi conductor lasers (9)

**INDUSTRIAL APPLICATIONS OF LASER :** Laser for measurement of distance, length, velocity, acceleration, current, voltage and atmospheric effect - Material processing: laser heating, welding, melting, scribing, splicing and trimming of materials, removal and vaporization - Hologram: Principle of holography — Methods and holographic components - Holographic interferometry and applications, holography for nondestructive testing - Medical applications of lasers: laser and tissue interaction — Laser instruments for brain surgery, plastic surgery and oncology (9)

**Total L: 45**

**TEXT BOOKS:**

1. John M Senior , "Optical Fiber Communication: Principles and Practice", Prentice Hall,2010.
2. R P Khare , "Fibre Optics and Optoelectronics", 1<sup>st</sup> Edition, Oxford Press, 2004.

**REFERENCES:**

1. Wilson, J.F.B. Hawkes , "Introduction to Opto Electronics", Prentice Hall of India, 2001.
2. Nambiar K R , "Laser: Principles, Types and Applications ", New Age International, 2010.
3. S.C. Gupta , "Opto Electronic Devices and Systems", Prentice Hall of India, 2010.
4. A Donald, Sterling Jr , "Technicians Guide to Fiber Optics", Vikas Publishing House,, 2009.

### 19U003 INSTRUMENTATION SYSTEM DESIGN

**3 0 0 3**

**DESIGN OF SIGNAL CONDITIONING CIRCUITS :** Design of V/I and I/V converters - Analog and Digital filter design- Signal conditioning circuit for pH measurement - Temperature compensation circuit - software and hardware approaches - Thermistor linearization. (10)

**DESIGN OF TRANSMITTERS :** RTD and thermocouple based temperature transmitter- Capacitance based level transmitter - Air purge system for level measurement - Smart transmitters. (10)

**DESIGN OF DATA ACQUISITION SYSTEM AND CONTROLLERS :** Design of ON / OFF controller using linear integrated circuits- Electronic PID controller- Selection of ADC and DAC - Microcontroller based design: Measurement system and digital PID controller. (8)

**DESIGN OF ORIFICE AND ROTAMETER, CONTROL VALVE SIZING :** Orifice Sizing - Liquid - gas and steam services - Rotameter design - Control valves - Valve body- Commercial valve bodies- Control valve sizing - Liquid - gas and steam services- Selection criteria. (10)

**DESIGN OF ALARM AND ANNUNCIATION CIRCUIT :** Alarm and Annunciation circuits - Thyristor Power Controller - Design of Interlocks- software and hardware approaches. (7)

**Total L: 45**

**TEXT BOOKS:**

1. John P Bentley , "Principles of Measurement Systems", 4<sup>th</sup> Edition, Pearson Education,2004.

2. C. D. Johnson , "Process Control Instrumentation Technology", 8<sup>th</sup> Edition, Pearson Education, 2014.

**REFERENCES:**

1. Miller R. W. , "Flow Measurement Engineering Handbook", 3<sup>rd</sup> Edition, McGraw Hill, 1996.
2. Gregory K Mc Millan and Douglas M Considine , "Process/ Industrial Instruments and Controls Handbook", 5<sup>th</sup> Edition, Tata McGraw Hill, 2009.
3. Norman.A.Anderson , "Instrumentation for Process Measurement and Control", 3<sup>rd</sup> Edition, CRC Press, 2010.
4. Andrew W G and Williams H B , "Applied Instrumentation in the Process Industries", 3<sup>rd</sup> Edition, Houghton Mifflincom, 2002.

## 19U004 POWER PLANT INSTRUMENTATION

**3 0 0 3**

**OVERVIEW OF POWER GENERATION:** Methods of power generation: Hydro, Thermal, Nuclear, Solar and Wind power, Ocean Energy System, Geothermal Energy, Energy from Bio mass. Building Blocks of Thermal power plant - Combined Cycle System — Combined Heat and Power System: Sub Critical and Supercritical boilers — Operating Pressure and Temperature ranges — Overview of Instrumentation System in Thermal power plant. (9)

**MEASUREMENTS IN POWER PLANTS:** Measurement of feed water flow, Fuel flow, Airflow and Steam flow with correction factor - Steam pressure and temperature measurement-Turbine speed and vibration measurement. (9)

**ANALYZERS IN POWER PLANTS:** Analysis of impurities in feed water and steam: Dissolved oxygen analyzer — Chromatography pH meter - Fuel analyser — Flue gas oxygen analyser - Pollution monitoring instruments – SOX and NOX measurements. (9)

**CONTROL LOOPS IN BOILER:** Combustion control—Air/fuel ratio control—Furnace draft control—Main steam and reheat steam temperature control — Super heater control— Distributed control system in power plants — Interlocks in boiler operation. (9)

**NUCLEAR POWER PLANT INSTRUMENTATION :** Different types of Nuclear power plant, Nuclear reactor control loops, Reactor dynamics, Control and Safety instrumentation, Reliability aspects. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Sam G Dukelow , "The Control of Boilers", 2<sup>nd</sup> Edition, Instrument Society of America, 1991.
2. David Lindsley , "Power Plant Control and Instrumentation", Institution of Electrical Engineers, London, 2000.

**REFERENCES:**

1. Elonka S M, Kohal A L , "Standard Boiler Operations", McGraw Hill, New Delhi, 1994.
2. Jain R K , "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi, 2009. Pergamon Press, Oxford, 1971.
3. Bela G Liptak , "Process Measurement and Analysis", Vol 1, CRC press, 2003.
4. M.W.Jervis, British Electricity International, "Modern Power Station Practice – Instrumentation, Controls and Testing", Vol.6, Pergamon Press, Oxford, 1971.

## 19U005 INSTRUMENTATION AND CONTROL IN PETRO CHEMICAL INDUSTRIES

**3 0 0 3**

**PETROLEUM PROCESSING:** Petroleum exploration - Recovery techniques - Refining of crude oil - Constituents of Crude Oil -Refining Capacity in India - Consumption of Petroleum products in India. (9)

**CONTROL OF DISTILLATION COLUMN:** P and I diagram of petroleum refinery - Atmospheric Distillation of Crude oil – Vacuum Distillation process - Thermal Conversion process - Control of Distillation Column – Temperature Control - Feed Control - Reflux Control - Reboiler Control (9)

**CONTROL OF CHEMICAL REACTORS AND DRYERS:** Temperature Control - Pressure Control - Control of Dryers - Batch Dryers - Atmospheric and Vacuum Dryers - Continuous Dryers. (9)

**CONTROL OF HEAT EXCHANGERS AND EVAPORATORS:** Variables and Degrees of freedom - Liquid to Liquid Heat Exchangers - Steam Heaters - Condensers - Reboilers and Vaporizers - Cascade Control - Feed forward Control-Types of Evaporators (9)

**CONTROL OF PUMPS:** Centrifugal pump: On-Off Level control - Pressure control - Flow control - Throttling control. Rotary pumps: On-Off pressure control. Reciprocating Pumps: On-Off control and Throttling control. Effluent and Water Treatment Control: Chemical Oxidation - Chemical Reduction - Neutralization – Precipitation (9)

**Total L: 45**

**TEXT BOOKS:**

1. Balchan J G, Mumme K I , "Process Control Structures and Applications", Van Nostrand Reinhold Company, 1998.
2. Waddams A L , "Chemicals from Petroleum", Butter and Janner Ltd. , John Murray Publishers, 1978.

**REFERENCES:**

1. Liptak B G , "Instrument Engineer's Handbook, Vol. 2: Process Control and Optimization", CRC Press, 2005.
2. Austin G T , " Shreve's Chemical Process Industries", McGraw Hill Book Co, 1984.
3. Liptak B G , "Instrumentation in Processing Industries", Chilton book Company, 1994.
4. Wiseman P , "Petrochemicals", John-Wiley and Sons Inc,1986.

**19U006 OPTIMAL AND ADAPTIVE CONTROL SYSTEMS****3 0 0 3**

**OPTIMAL CONTROL:** Statement of optimal control problem - Problem formulation and types of optimal control — Selection of performance measure, cost function and norms — Hamilton Jacobi Equation - Pontryagin's minimum principle — State inequality constraints — Necessary conditions for optimality –optimal control problems by Transfer function approach and State variable approach. (10)

**LINEAR QUADRATIC CONTROL PROBLEMS:** Choice of weighting matrices- LQG control — Matrix Ricatti equation and solution methods of state regulator and discrete systems — Optimal control law - Optimal estimation. (8)

**IDENTIFICATION METHODS:** Conventional techniques of identification – Identifications of systems with dead time – Discrete systems — ARMA process — Discrete state model — Least squares techniques — Recursive Least Squares algorithms – Minimum variance method. (9)

**INTRODUCTION TO ADAPTIVE CONTROL:** Development of adaptive control problem-The role of Index performance (IP) in adaptive systems- Development of IP measurement process model. Pole placement design - Self tuning controller – Minimum variance controller. (8)

**ADAPTIVE CONTROL OF DETERMINISTIC SYSTEMS :**Gain scheduling controller — Model reference adaptive control — Adaptive predictive control — The MIT rule — Determination of adaptation gain - Minimum prediction error adaptive controls — Adaptive control of time varying systems. BIBO Stability — Model free adaptive control - Applications of adaptive control. (10)

**Total L: 45****TEXT BOOKS:**

1. Donald E. Kirk , "Optimal Control Theory: An Introduction", Prentice-Hall Networks Series, 2004.
2. Karl J Astrom, Bjorn Wittenmark , "Adaptive Control", Pearson Education Inc, 2003.

**REFERENCES:**

1. Desineni Subbaram Naidu , "Optimal Control Systems", CRC Press, 2009.
2. Arun K. Tangirala , "Principles of System Identification: Theory and Practice", CRC Press, 2014.
3. Nagrath I J, Gopal M , "Control System Engineering", 6th Edition, New Age International Pvt Ltd, 2018.
4. Ljung L , "System Identification: Theory for the User", Prentice Hall, Englewood Cliffs, 1999.

**19U007 SYSTEM IDENTIFICATION****3 0 0 3**

**INTRODUCTION TO IDENTIFICATION AND MODELS :** System Identification Procedure - Identifiability - Signal to Noise ratio - Over fitting - Models: Definition of a model, Classification of models - Models for discrete time linear time invariant Systems - Models for time varying systems and nonlinear systems, Models for linear stationary processes (9)

**ESTIMATION METHODS :** Types of estimation problems - Goodness of Estimators: Fisher information, Bias, Variance, Efficiency, Sufficiency, Cramer Rao's inequality - Asymptotic bias, Mean square error, Consistency — Estimation methods: Method of moments estimators - Least squares estimators - Nonlinear least squares - Maximum likelihood estimators - Bayesian estimators (9)

**IDENTIFICATION OF PARAMETRIC TIME-SERIES MODELS :** Nonparametric descriptions and parametric descriptions: - Estimation of AR models - Estimation of MA models - Estimation of ARMA models (9)

**IDENTIFICATION OF NON-PARAMETRIC AND PARAMETRIC INPUT – OUTPUT MODELS :** Identification of Non-Parametric Input Output Models:- Impulse response estimation - Step response estimation - Estimation of frequency response function - Identification of Parametric Input Output Models: - Prediction error minimization (PEM) methods - Properties of the PEM estimator (9)

**STATISTICAL ELEMENTS OF MODEL BUILDING :** Informative Data - Input design for identification – Data preprocessing - Model development (9)

**Total L: 45**

**TEXT BOOKS:**

1. Arun K Tangirala , "Principles of System Identification: Theory and Practice", 1<sup>st</sup> Edition, CRC Press, 2014.
2. Lennart Ljung , "System Identification: Theory for the User", 2<sup>nd</sup> Edition, Prentice Hall, Englewood Cliffs, 1999.

**REFERENCES:**

1. Michel Verhaegen, Vincent Verdult , "Filtering and System Identification: A Least Squares Approach", Cambridge University Press, 2007.
2. Johan Schoukens, Rik Pintelon, Yves Rolain , "Mastering System Identification in 100 Exercises", Wiley-IEEE Press, 2012.
3. Thomas Kailath, Ali H Sayed, Babak Hassibi , "Linear Estimation", Pearson, 2000.
4. Jer Nan Juang , "Applied System Identification", Pearson, 1994.

## **19U008 INDUSTRIAL CHEMICAL PROCESSES**

**3 0 0 3**

**UNIT OPERATIONS:** Unit processes and equipments – Combustion – Mixing processes – Separation processes - Mechanical operations: Principles and equipment— Concepts of equilibrium and rate. (9)

**HEAT MASS AND MOMENTUM TRANSFER:** Entropy balance – Material balance – Heat transfer concepts and equipment—Heat exchangers—Furnaces—Evaporators—Refrigeration process. (9)

**MASS TRANSFER CONCEPT OF STAGED PROCESSES:** Distillation Drying Adsorption Humidification Crystallization. (9)

**FLUID FLOW EQUIPMENT:** Pipe fittings: Pumps, compressors and blowers – Chemical reactors: isothermal and non-isothermal operations – Concepts of reactor stability. (9)

**CASE STUDIES OF OPERATION:** Paper and pulp manufacturing – Thermal power plant – Iron and steel manufacturing – Petrochemical refinery. (9)

**Total L: 45**

**TEXT BOOKS:**

1. McCabe W L, Smith J C, Peter Harriot , "Unit Operations of Chemical Engineering", 7<sup>th</sup> Edition, McGraw Hill, 2005.
2. Austin G T , "Shreve's Chemical Process Industries", McGraw Hill, 1985.

**REFERENCES:**

1. Liptak B G , "Instrument Engineers Handbook: Process Measurement and Analysis", Butterworth Heinemann, 2003.
2. Luyben W C , "Process Modelling, Simulation and Control for Chemical Engineers", McGraw Hill, 1990.
3. Waddams A L , "Chemicals from Petroleum", John Murray Publishers, 1978.
4. Norris Shreve R , "Chemical Process Industries", McGraw Hill, 1967.

## **19U009 APPLIED SOFT COMPUTING**

**3 0 0 3**

**NEURAL NETWORKS :** Introduction - Differences between biological and artificial neural networks - architecture - activation functions - single layer perceptron - multilayer perceptron - back propagation algorithm - Hopfield's networks - Kohonen's self organizing maps (9)

**NEURAL NETWORKS FOR CONTROL :** Pattern recognition - Control and Process Monitoring - Model identification - direct and indirect neuro control schemes - adaptive neuro controller - case study (9)

**FUZZY LOGIC SYSTEMS:** Fuzzy sets - Operations on Fuzzy sets - Fuzzy reasoning - Linguistic variables - Fuzzy propositions - fuzzy compositional rules of inference - fuzzy relations - methods of defuzzification – membership value assignments. (9)

**FUZZY LOGIC FOR CONTROL:** Mamdani and Takagi-Sugeno model of fuzzy logic control - Stability analysis of fuzzy control systems- fuzzy pattern recognition - fuzzy controllers - control and estimation. (9)

**GENETIC ALGORITHM:** Biological background - encoding - fitness function - reproduction - inheritance operator - crossover - mutation operator - bitwise operator - convergence of genetic algorithm - applications and advances in genetic algorithm (9)

**Total L: 45**

**TEXT BOOKS:**

1. Laurene V. Fausett , "Fundamentals of Neural Networks, Architectures, Algorithms and Applications", 1<sup>st</sup> Edition, Pearson Education, 2011.
2. Timothy J Ross , "Fuzzy Logic with Engineering Applications", 3<sup>rd</sup> Edition, Wiley, 2011.

#### REFERENCES:

1. Simon Haykin , " Neural Networks: A comprehensive Foundation", 2<sup>nd</sup> Edition, Pearson, 2008.
2. S.Rajasekaran and G.A. Vijayalakshmi Pai , "Neural Networks, Fuzzy logic and Genetic algorithms: Synthesis and Applications", 2<sup>nd</sup> Edition, PHI Learning Pvt. Ltd., 2014.
3. David E Goldberg , "Genetic Algorithms in search, Optimization and Machine Learning", 1<sup>st</sup> Edition, Pearson Education, 2012.
4. Yaochu Jin , "Advanced Fuzzy Systems Design and Applications", 1<sup>st</sup> Edition, Springer, 2010.

### 19U010 VLSI DESIGN

3 0 0 3

**VLSI DESIGN METHODOLOGY:** VLSI design process - Layout styles: Full-custom - Semi-custom approaches. Electrical Properties of MOS and CMOS Circuits: MOS Transistor - Threshold voltage - Basic DC equations - Second order effects - Small signal AC characteristics. nMOS and CMOS inverters - Inverter delay – Power consumption in CMOS gates: Static dissipation - Dynamic Dissipation. Pass transistor - Transmission gate. (10)

**VLSI FABRICATION TECHNIQUES :** CMOS processes - n well - p well - Twintub - Silicon on insulator . Design rules - Mead Conway design rules for the silicon gate nMOS - CMOS process - CMOS. Sheet resistance - Resistance estimation - Capacitance estimation - Driving large capacitive loads. Layer representations - Stick diagrams - nMOS design style - CMOS design style - Simple layout examples. (8)

**LOGIC DESIGN:** Switch logic- Pass transistor and transmission gate. Other forms of CMOS logic: Dynamic CMOS logic - Clocked CMOS logic - Precharged domino CMOS logic - Combinational logic design examples. Clocked sequential circuits - Two phase clocking - Charge storage - Dynamic register element - nMOS and CMOS Dynamic shift register - JK flip flop. (8)

**SUBSYSTEM DESIGN PROCESS :** General arrangement of a 4-bit arithmetic processor - Design of a 4-bit shifter - Design of an ALU subsystem - Implementation of ALU functions with an adder - Carry look ahead adder - Multipliers: Serial parallel multipliers - Pipelined multiplier array. (9)

**VHDL :** Introduction-identifiers-data objects- data types - operators- structural modeling - dataflow modeling- behavioral modeling- hardware modeling examples: encoder - clock divider - pulse shifter - adder - multiplexer - demultiplexer - decoder - parity generator and checker. (10)

**Total L: 45**

#### TEXT BOOKS:

1. Douglas A Pucknell, and Kamran, Eshraghian , "Basic VLSI design", Prentice Hall of India, New Delhi, 2015.
2. Bhasker J, "VHDL Primer", Pearson Education, 2016.

#### REFERENCES:

1. Jan M Rabaey, A Chandrakasan and Nikolic B, "Digital Integrated Circuits: A Design Perspective", Pearson, 2017.
2. James D. Plummer, Michael D. Deal and Peter B. Griffin, "Silicon VLSI Technology : Fundamentals Practice and Modeling", Prentice Hall, 2011.
3. Neil H E Weste, David Money Harris , "CMOS VLSI Design : A Circuits and Systems Perspective", Pearson Education, New Delhi, 2016.
4. Wayne Wolf , "Modern VLSI Design: System on Chip Design", Pearson Education, New Delhi, 2008.

### 19U011 OPERATING SYSTEMS

3 0 0 3

**INTRODUCTION :** Operating system objectives and functionalities - Types of Operating System - Structure of Operating system - Computer architecture support to operating systems: - Instruction execution, Interrupts, Memory hierarchy, - Cache memory, Direct Memory Access - Multiprocessor and Multicore organization – Time sharing - system programs and calls (8)

**MEMORY MANAGEMENT:** Single contiguous allocation - Partitioned allocation - Paging - Virtual memory concepts - Swapping - Demand paging - Page replacement algorithms - Segmentation - Segmentation with paging. (8)

**PROCESS MANAGEMENT :** Introduction to processes - Scheduling objectives - Scheduling Criteria - Types of scheduling algorithms - Performance comparison - Inter- process communications - Synchronization - Semaphores - Types of Semaphores - Deadlock: - Principles of Deadlock - Deadlock Prevention – Deadlock Avoidance - Deadlock Detection and Recovery (12)

**REAL-TIME OPERATING SYSTEMS :** Characteristics of real-time operating systems - classification of real-time systems, - architectures of real-time systems, - micro-kernels, Memory management schemes - scheduling in RTOS - rate monotonic scheduling, - Inter-task communication, Shared data problem, - priority inversion - Selection of RTOS - Design and implementation of a multitasking application using RTOS (9)



**DEVICE INPUT OUTPUT AND FILE MANAGEMENT :** Principles of I/O hardware and software - Device controllers - Device drivers - Interrupt driven device management - Interaction between operating system, - drivers and devices, File Systems - Files-Directories - File system implementation - Allocation methods - Security- Protection mechanisms. (8)

**Total L: 45**

**TEXT BOOKS:**

1. Dhamdhare D M , "Operating Systems: A Concept-based Approach", 2nd edition, Tata McGraw Hill, 2011.
2. William Stallings , "Operating Systems: Internals and Design Principles", 2nd edition ,Pearson, 2018.

**REFERENCES:**

1. Silberschatz A, Galvin P and Gagne G , "Operating Systems Concepts", 6th edition, John Wiley and Sons, Newyork, 2010.
2. Andrew S Tanenbaum , "Modern Operating System", 3rd edition ,Pearson, 2018.
3. Jane W S Liu , "Real Time Systems", 3rd edition, Pearson, Noida, 2016.
4. Deitel H M, "Operating Systems", 3rd edition , Prentice Hall of India, New Delhi, 2009.

## **19U012 ROBOTICS AND AUTOMATION**

**3 0 0 3**

**INTRODUCTION TO ROBOTIC SYSTEMS:** Structure of a Robot, Classification of Robots: Cartesian, Cylindrical, Spherical, Articulated, SCARA - Accuracy, Resolution and Repeatability of Robots, Degrees of Freedom of Serial and Parallel Manipulators, Robot Application in Manufacturing: Material Transfers - Machine Loading and Unloading - Processing Operations - Assembly and Inspection. (9)

**TRANSFORMATIONS AND KINEMATICS:** Homogeneous Coordinates, Coordinate Reference Frames, Homogeneous Transformations for the Manipulator, D-H Representation, Forward and Inverse Problem of Manipulator Kinematics (9)

**DRIVES AND SENSORS :** Hydraulic and Pneumatic Systems, Mechanical Power Drive, Rotary to Linear Motion Conversion Mechanisms, Electric Drive Systems: DC Motor, Servo Motor and Stepper Motor, Internal and External State Sensors, Touch and Tactile Sensors, Force and Torque Sensors, Proximity and Range Sensors, Vision Systems, Robot End Effectors, Gripper Force Analysis. (9)

**DYNAMICS AND CONTROL :** Differential Motion of Manipulators, Trajectory Planning, Manipulator Dynamics, Jacobian in terms of D-H Matrices, Manipulator Control, Controller Architecture, Robot Programming. (9)

**COMPUTER AIDED MANUFACTURING APPROACHES :** Robot Interface, Networking and Bus Standards, Flexible Manufacturing Systems (FMS), Computer Integrated Manufacturing (CIM) - Role of Robots in FMS and CIM – Case Studies. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Saeed B. Niku , "An Introduction to Robotics: Analysis, Systems and Applications", Pearson Education, 2009.
2. Nagrath I J, Mittal R K , "Robotics and Control", Tata McGraw Hill, 2010.

**REFERENCES:**

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey , "Industrial Robotics", Tata McGraw Hill, 2010.
2. Richard D Klaffer, Michael Negin , "Robotics Engineering", Prentice Hall, 2009.
3. S K Saha , "Introduction to Robotics", Tata McGraw Hill, 2010.
4. Mikell P. Groover , "Automation, Production Systems and Computer Integrated Manufacturing", 3<sup>rd</sup> Edition, Prentice Hall, 2011.

## **19U013 PRODUCT DESIGN AND DEVELOPMENT**

**3 0 0 3**

**INTRODUCTION:** Product Development- Successful Product Development - Duration and Cost- Challenges. Product Planning: Planning Process- Identifying Customer Needs (10)

**PRODUCT SPECIFICATIONS:** Establishing Target Specification- Setting the Final specification. Concept Generation: The Activity of Concept Generation. Concept Selection: Concept Screening-Concept Scoring- Concept Testing (8)

**PRODUCT ARCHITECTURE:** Implications-Establishment-Delayed Differentiation — Platform Planning — Related System Level Design Issues. Industrial Design: Assessing the Need-The Impact-The Industrial Design Process- Management and Assessment. Design for Manufacturing. Prototyping-Basics-Principles-Prototyping Technologies- Planning. Robust Design (10)

**PATENTS AND INTELLECTUAL PROPERTY :** Formulate a Strategy and Plan- Study Prior Inventions- Outline Claims- Write the Description of the Invention- Refine Claims- Pursue Application- Reflect on the Results and the Process (7)

**PRODUCT DEVELOPMENT ECONOMICS:** Elements of Economic Analysis- Build a Base –Case Financial Model- Perform Sensitivity Analysis- Use Sensitivity Analysis to Understand- Consider the influence of the Qualitative Factors on Project Success- Carrying out Qualitative Analysis. Managing Projects: Understanding and Representing Tasks- Baseline Project Planning- Project Execution-Postmortem-Project Evaluation (10)

**Total L: 45**

**TEXT BOOKS:**

1. Karl. T. Ulrich, Steven D Eppinger , "Product Design and Development", 2nd Edition, Irwin McGraw Hill, 2000.
2. Kevin Otto, Kristin Wood , "Product Design", 1st Edition, Pearson Education, 2003.

**REFERENCES:**

1. A C Chitale, R C Gupta , "Product Design and Manufacturing", 6th Edition, Prentice Hall of India, New Delhi, 2003.
2. Timjones , "New Product Development", 1st Edition, Butterworth Heinmann, 1997.
3. Geoffery Boothroyd, Peter Dewhurst, Winston Knight , "Product Design for Manufacture and Assembly", 3rd Edition, Taylor and Francis, 2002.

### 19U014 MEASUREMENT DATA ANALYTICS

**3 0 0 3**

**INTRODUCTION:** Terms pertaining to quantity - Measurement and statistics - Instruments and standards Distribution function (9)

**EVALUATION OF MEASUREMENT DATA:** Evaluation of validity of extreme values of measurement results - Evaluation of the means obtained from two sets of measurement results - Comparison of variances of two sets of measurement results - Measurements concerning travelling standards - F-test for internal and external consistency - Standard error of the overall mean - Analysis of variance - Tests for uniformity of variances (9)

**ERROR PROPAGATION :** Propagating the error in a single-variable function - Propagating the error through a multi- variable function - Experimental strategy based on error analysis - Combined experiments - The weighted mean (9)

**UNCERTAINTY IN CALIBRATION OF ELECTRICAL INSTRUMENTS:** Uncertainty in calibration of RF power sensor - Uncertainty in calibration of a Digital Instrument - Uncertainty calculation for correlated input quantities - Vector Measurands. Least-squares fitting with uncertainties in both variables - More complex error surfaces - Monte Carlo methods - Bootstrap methods (9)

**ESTIMATION OF PARAMETERS :** Simple Linear Regression - Multiple Linear Regression - Interpretation of regression coefficients - Visualizations - Visual Data Analysis techniques - Interaction techniques - Systems and applications (9)

**Total L: 45**

**TEXT BOOKS:**

1. Semyon G. Rabinovich , "Measurement Errors and Uncertainties – Theory and Practice", 3rd Edition, Springer Publication, 2005.
2. S.V. Gupta , "Measurement Uncertainties: Physical Parameters and Calibration of Instruments", Springer Publication, 2012.

**REFERENCES:**

1. Ifan Hughes, Thomas Hase , "Measurements and Their Uncertainties: A Practical Guide to Modern Error Analysis", Oxford University Press, 2010.
2. Michael, Grabe , "Measurement Uncertainties in Science and Technology", 2nd Edition, Springer Publication, 2014.
3. Patrick F. Dunn , "Measurement and Data Analysis for Engineering and Science", 2nd Edition, CRC Press, 2010.
4. Hugh W. Coleman, W. Glenn Steele , "Experimentation, Validation, and Uncertainty Analysis for Engineers", 4th Edition, John Wiley and Sons, 2018.

### 19U015 ADVANCED DIGITAL SIGNAL PROCESSING

**3 0 0 3**

**MULTIRATE SIGNAL PROCESSING:** Review of discrete time system - Decimation- Interpolation –time-domain characterization-frequency-domain characterization- Multirate identities — Polyphase representations - Design of quadrature filter bank — PR condition- Application of filterbank in speech and image coding. (9)

**TIME-FREQUENCY ANALYSI:** Fourier Transform — Limitation of Fourier Transform — Short Time Fourier Transform — Continuous Wavelet Transform — Discrete Wavelet Transform — Implementation of Discrete Wavelet Transform through Lifting Scheme and Filter bank — Applications of wavelet transform in instrumentation and image processing. (9)

**RANDOM PROCESS:** Random variables — Ensemble average — Gaussian random variables — Stationary processes — Wide sense Stationarity — Ergodicity — Types of random process — Auto regressive (AR), Moving Average (MA) and Autoregressive Moving Average Processes (ARMA). (9)

**POWER SPECTRUM ESTIMATION** : Nonparametric methods — The periodogram — Performance of the periodogram — The Modified Periodogram — Bartlett's method — Welch Method — Blackman- Tukey method- Parametric methods -Performance comparisons (9)

**ADAPTIVE FILTER** : Need for Adaptive filter - Wiener filter - limitations - Gradient Descent algorithm - LMS algorithm - variants of LMS algorithm - introduction to RLS algorithm - Applications of adaptive filter (9)

**Total L: 45**

**TEXT BOOKS:**

1. Vaidyanathan P.P , "Multirate Systems and Filter Banks", Pearson Education, 2005.
2. Monson H Hayes , "Statistical Digital Signal Processing and Modelling", John Wiley and Sons, 2006.

**REFERENCES:**

1. Sidney Burrus, Ramesh A. Gopinath, Haito Guo , "Introduction to Wavelets and Wavelet Transforms: A Primer", Prentice Hall, 2005.
2. Behrouz Farhang-Boroujeny , "Adaptive Filters: Theory and Applications", Wiley, 2013.
3. Sophoncles J. Orfanidis , "Optimum Signal Processing", McGraw Hill, 2000.
4. Steven M. Kay , "Modern Spectral Estimation Theory and Practice", Prentice Hall,2009.

## 19U016 DIGITAL IMAGE PROCESSING

**3 0 0 3**

**DIGITAL IMAGE FUNDAMENTALS:** Pixel-Relationship between pixels - Gray level - resolution - image sampling and quantization - elements of image processing system. (9)

**IMAGE TRANSFORM:** Need for image transform - Fourier transform - Discrete Cosine Transform - KL transform - Singular Value Decomposition -Introduction to Wavelet transform. (9)

**IMAGE ENHANCEMENT:** Gray level transformation - histogram equalization - spatial domain filtering: smoothing, sharpening filters - frequency domain filters. (9)

**IMAGE DENOISING:** Types of noise in digital image - Methods to minimize impulse noise: Median filter and its variants - Spatial domain and frequency domain approach to minimize speckle noise - methods to minimize periodic noise. (9)

**IMAGE SEGMENTATION AND COMPRESSION:** Point, line and edge detection - Different edge detection operators - thresholding approach - region based segmentation - Watershed algorithm - Feature extraction techniques – Need for compression - Types of compression - Transform based compression - Compression Standards (9)

**Total L: 45**

**TEXT BOOKS:**

1. Rafael C Gonzalez and Richard E Woods , "Digital Image Processing", Pearson, 2008.
2. Anil K Jain , "Fundamentals of Digital Image Processing", Pearson,2004.

**REFERENCES:**

1. Milan Sonka, Vaclav Hlavac, Roger Boyle , "Image Processing, Analysis, and Machine Vision", 3rd Edition, CL Engineering, 2007.
2. Alan C Bovik , "Handbook of Image and Video Processing", Elsevier, 2005.
3. John W. Woods , "Multidimensional Signal, Image, and Video Processing and Coding", Academic Press, 2011.
4. Kenneth R Castleman , "Digital Image Processing", Pearson, 2006.

## 19U017 COMPUTER ARCHITECTURE

**3 0 0 3**

**BASICCOMPUTERORGANISATION:**Classification ofArchitectures:CISCandRISC–Instructions–Timing and Control — Instruction Cycle — Fetch and Decode — Execution –Processor clock- Measuring computer system performance (9)

**CENTRAL PROCESSOR ORGANISATION:** Introduction to CPU design-Hard wired control-Micro-programmed control-General register organization — Stack organization — Instruction formats — Addressing modes —Data transfer andmanipulation—Programcontrol—Addresssequencer—Datapathstructure. (9)

**ARITHMETIC PROCESSING:** Number system and representation- IEEE 754 representation– Addition, Subtraction, Multiplication and divisionAlgorithms-Role of Flag register- Fixed -point and Floating pointArithmetic operations — Design of Arithmetic units. (9)

**MEMORY AND INPUT/OUTPUT ORGANISATION:**Basic concepts – Memory Hierarchy – Main memory – Auxiliary

memory – Associative memory – Cache and Virtual memory concepts – Performance considerations– Input – Output interface– Modes of transfer: Asynchronous Data transfer– Direct memory access. (9)

**INTRODUCTION TO PARALLEL PROCESSING :** Parallelism in uniprocessor systems- Pipeline execution- Instruction level parallelization– Parallel Computer architecture classifications — Data level parallelization - Graphical Processing Unit – Typical applications. (9)

**Total L: 45**

**TEXT BOOKS:**

1. David A. Patterson, John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 4th Edition, Elsevier, 2009.
2. Morris Mano. M , "Computer System Architecture", 3<sup>rd</sup> Edition, Prentice Hall India, 2008.

**REFERENCES:**

1. John P Hayes , "Computer Architecture and Organization", 3rd Edition, Tata McGraw Hill, 1998.
2. William Stallings , "Computer Organization and Architecture – Designing for Performance", 8th Edition, Pearson Education, 2010.
3. Behrooz Parhami , "Computer Architecture from up to Super Computer", Reprinted, Oxford press, 2014.
4. Carl Hamacher, Zvonkoran Vranesic, Safwatzaky , "Computer Organization", 6th Edition, Tata McGraw-Hill, 2011.

### 19U018 NON LINEAR SYSTEMS THEORY

**3 0 0 3**

**NONLINEAR SYSTEMS:** State space representation of nonlinear systems - Autonomy - Basic characteristics of nonlinear systems - Bifurcation - Chaos - Limit cycles - Types of nonlinear elements (9)

**MATHEMATICAL BACKGROUND:** Manifolds - Tangent and cotangent Spaces - Vector fields and flows - Lie bracket and Lie derivatives - Distributions and co distributions - Frobenius theorem (9)

**PHASE PLANE ANALYSIS:** Concepts of phase plane analysis - Phase portraits - Construction of phase portrait - Isocline and delta methods - Singular points - Phase plane analysis of linear system and nonlinear system - Existence of limit cycles (9)

**DESCRIBING FUNCTION ANALYSIS:** Describing function fundamentals - Computing describing functions for common nonlinearities in control systems - Describing functions analysis of nonlinear systems - Stability analysis (9)

**STABILITY ANALYSIS:** Linearization method - Stability analysis based on Lyapunov's direct method - Krasovski's method - Variable gradient method (9)

**Total L: 45**

**TEXT BOOKS:**

1. Jean-Jacques E. Slotine , "Applied Nonlinear Control", Prentice Hall Englewood Cliffs, New Jersey, 1991.
2. Khalil, H.K , "Nonlinear Systems", Third Edition, Prentice Hall Englewood Cliffs, New Jersey, 2002.

**REFERENCES:**

1. Vidyasagar. M , "Nonlinear System Analysis", Prentice Hall Englewood Cliffs, New Jersey, 1978.
2. Strogatz, S. H , "Nonlinear Dynamics & Chaos, with Applications to Physics, Biology, Chemistry and Engineering", 2nd Edition, Westview Press, 2014.
3. Harry G. Kwatny Gilmer L. Blankenship , "Nonlinear Control & Analytical Mechanics: a Computational Approach", Springer, 2017.
4. M. Gopal , "Digital Control and State Variable Methods", 4th Edition, McGraw Hill Education, 2017.

### 19U019 FUNDAMENTALS OF PNEUMATICS AND HYDRAULICS

**3 0 0 3**

**INTRODUCTION TO PNEUMATIC CONTROL:** Characteristics of compressed air - Elements of pneumatic control system - Pneumatic Actuators: Linear and rotary types - End position cushioning, sealing (6)

**PNEUMATIC VALVES:** Symbolic representation as per ISO 1219 and ISO 5599 - Direct and indirect actuation pneumatic cylinders - Use of memory valve - Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling - Use of quick exhaust valve - Signal Processing Elements - Use of Logic gates — OR and AND gates - Pressure dependent controls: types - Time dependent controls : principle, construction (12)

**INTRODUCTION TO HYDRAULIC POWER :** Elements of hydraulic system - Source of hydraulic power: Pumping theory - Classification of pumps - Gear pumps, vane pumps and piston pumps - Performance of pumps - Selection of pumps (9)

**HYDRAULIC ACTUATORS AND VALVES:** Linear hydraulic actuators - Hydraulic motors: gear motors, vane motors, piston

motors - Control valves: Directional control valves, Constructional features and working principle – Pressure control valves: Direct and pilot operated types - Flow control valves (9)

**HYDRAULIC CIRCUIT DESIGN AND ANALYSIS** : Control of single and double acting hydraulic cylinders - Speed control of hydraulic actuators - Regenerative circuit - Pump unloading circuit - cylinder synchronizing circuits – Accumulators (9)

**Total L: 45**

**TEXT BOOKS:**

1. Anthony Esposito , "Fluid Power with applications", 5th Edition, Pearson education, 2000.
2. Andrew Parr , "Hydraulics and Pneumatics: A technician's and engineer's guide", 3rd Edition, Butterworth Heinemann (Elsevier), 2011.

**REFERENCES:**

1. Niranjana Murthy, R.K.Hegde , "Hydraulics & Pneumatics Fundamentals of Fluid Power Engineering", 1st Edition, Sapna Book House, 2014.
2. Majumdar, S.R , "Pneumatic Systems – Principles and Maintenance", 1st Edition, Tata McGraw Hill, 2017.
3. Srinivasan. R , "Hydraulic and Pneumatic Control", 2nd Edition, Tata McGraw - Hill Education, 2012.
4. Shanmugasundaram.K , "Hydraulic and Pneumatic controls", 1st Edition, Chand & Co., 2006.

## 19U020 SAFETY INSTRUMENTED SYSTEMS

**3 0 0 3**

**INSTRUMENTATION STANDARDS:** Significance of codes and standards — Overview of various types of codes and standards - Introduction of various instrumentation standards — review, interpretation and significance of specific standards - Examples: Usage of standards on specific applications. (9)

**INTRODUCTION TO SAFETY INSTRUMENTATION:** Hazards and Risk – Process Hazards Analysis (PHA) – Safety Life Cycle - Allocation of safety functions to protective layers - SIS design and engineering. (9)

**PROTECTION LAYERS:** Process plant design - Process control system - Alarm systems - Physical protection. Mitigation layers:- Containment system - Scrubbers and flares - Fire and gas systems - Evacuation procedure. (9)

**SAFETY INTEGRITY LEVEL:** SIL determination methods - ALARP - Risk matrix - Risk graph - LOPA - Examples for design of SIL. (9)

**SELECTION OF TECHNOLOGY:** Relay systems - Solid-state systems - Microprocessor based systems - PLC based systems - Safety PLCs - Safety system complexity - Communication with other systems. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Paul Gruhn, Harry Cheddie , "Safety Instrumented Systems: Design, Analysis, and Justification", 2nd Edition, ISA,, 2006.
2. Glisente Landrini, Basilio Abbamonte, Tino Vande capelle , "Safety Instrumented System", 5th Edition, GM International, 2017.

**REFERENCES:**

1. W.M.Goble, Harry Cheddie , "Safety Instrumented Systems Verification: Practical Probabilistic Calculations", ISA, 2005.
2. Id Goettsche , "ISA - Maintenance of Instruments and Systems.", 2nd Edition, ISA, 2011.
3. Swapan Basu , "Safety Instrumentation Systems", Elsevier, 2017.
4. Bela G. Liptak , "Instrument Engineers' Handbook", 4<sup>th</sup> Edition, CRC Press -ISA, 2003.

## 19U021 SMART SENSORS AND ACTUATORS

**3 0 0 3**

**SENSOR SYSTEMS IN ENGINEERING:** Role of sensors and sensor systems — Innovative sensor Technologies — Application scenarios - Instrumentation Process — Instrumentation Steps — Application examples. Smart sensor basics - General sensing system — Classical sensor Model — Smart sensor model — Monolithic integrated smart sensor - Hybrid integrated smart sensor. (9)

**SIGNAL CONDITIONING FOR SMART SENSORS:** Instrumentation Amplifier – Step mode operational amplifier – Rail to rail Op-Amp — Switched Capacitor Amplifier — 4 to 20 mA Signal Transmitter — Inherent power supply rejection – Separate Versus Integrated Signal Conditioning – Digital Conversion. (9)

**INTEGRATED SMART SENSORS:** Monolithic sensor interface — MCU's for sensor interface — DSP for sensor interface — Techniques and system considerations: Linearization — PWM Control — Auto-zero and Auto range — Diagnostics. Software tools and support – Sensor integration – Alternative views of smart sensing. (9)

**MICROMACHINED ACTUATORS** : Micro valves — Micro motors — Micro Pumps — Micro dynamometer — Micro steam engines—Actuators in other semiconductor materials—Various Micromachined structures: Cooling channels— Micro optical actuator—Micro grippers. (8)

**COMMUNICATION AND STANDARDS FOR SMART SENSORS:** Automotive Protocols: SAEJ 1850 – CAN protocol – Industrial networks. Industrial usage of CAN — Protocols in Silicon: MI-Bus. IEEE 1451 family of standards — Extending the system to network. (10)

**Total L: 45**

**TEXT BOOKS:**

1. Randy Frank , "Understanding Smart Sensors", 3rd Edition, Artech House, 2013.
2. Ananthasuresh G K, Vinoy K J, Gopalakrishnan S, Bhat K N, Aatre V K , "Micro and Smart Systems", Wiley Publishers, 2011.

**REFERENCES:**

1. Subhas Chandra Mukhopadhyay , "Smart Sensors, measurement and Instrumentation", Springer Heidelberg, New York, 2013.
2. Clarence W de Silva , "Sensors and Actuators: Control Systems Instrumentation", 2nd Edition, CRC Press, New York, 2014.
3. Tai Ran Hsu , "MEMS and Microsystems: Design and Manufacture", Tata Mcgraw Hill Publishing Co Ltd, 2017.
4. Gerord C M Meijer , "Smart Sensor Systems", John Wiley and Sons, 2008.

## 19U022 INDUSTRIAL INTERNET OF THINGS

**3 0 0 3**

**INTRODUCTION TO INTERNET OF THINGS:** : Overview of Internet of Things - The Edge, Cloud and the Application Development - Anatomy of the Thing - Industrial Internet of Things (IIoT - Industry 4.0) - Quality Assurance - Predictive Maintenance - Real Time Diagnostics - Design and Development for IoT - Understanding System- Design for IoT - Design Model for IoT (9)

**SYSTEM DESIGN OF CONNECTED DEVICES:** : Embedded Devices, Embedded Hardware - Connected Sensors and Actuators, Controllers - Battery Life Conservation and designing with Energy Efficient Devices, SoCs - CC3200 Architecture - CC3200 Launchpad for Rapid Internet Connectivity with Cloud Service Providers (9)

**UNDERSTANDING INTERNET PROTOCOLS:** : Simplified OSI Model - Network Topologies, Standards - Types of Internet Networking — Ethernet, WiFi - Local Networking, Zigbee, Sub 1 GHz, RFID, NFC - Proprietary Protocols - SimpliciTI - Networking Design - Push, Pull and Polling - Network APIs (9)

**SYSTEM DESIGN PERSPECTIVE FOR IOT:** : Products vs Services - Value Propositions for IoT - Services in IoT - Design views of Good Products - Understanding Context - IoT Specific Challenges and Opportunities (9)

**ADVANCED DESIGN CONCEPTS FOR IOT** : Software UX Design Considerations - Machine Learning and Predictive Analysis - Interactions, Interusability and Interoperability considerations - Understanding Security in IoT Design - Design requirements of IoT - Security Issues and challenges - Privacy - Overview of Social Engineering (9)

**Total L: 45**

**TEXT BOOKS:**

1. Joe Biron & Jonathan Follett , "Foundational Elements of an IoT Solution – The Edge, The Cloud and Application Development", 1st Edition, O'Reilly Media Inc., 2016.
2. Elizabeth Goodman, Alfred Lui, Martin Charlier, Ann Light, Claire Rowland , "Designing Connected Products: UX for the Consumer Internet of Things", 1st Edition, O'Reilly Media Inc., 2015.

**REFERENCES:**

1. Lucas Darnell , "The Internet of Things (A Look at Real World Use Cases and Concerns)", Kindle Edition, 2016.
2. Perry Lea , "Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", Kindle Edition, Packt Publishing Ltd., 2018.
3. Arshdeep Bahga and Vijay K. Madiseti , "Internet of Things: A Hands-on Approach", 1st Edition, Orient Blackswan Private Ltd., 2015.
4. Honbo Zhou , "The Internet of Things in the Cloud: A Middleware Perspective", Kindle Edition, CRC Press, 2013.

## 19U023 NON-CONVENTIONAL ENERGY SYSTEMS

**3 0 0 3**

**BACKGROUND OF ENERGY SCENARIO** : Energy Demand Scenario in India - Energy resources in India and its sustainability - Different types of conventional Power Plant - Limitation of fossil fuels - Pollution aspects and impact of various power plants - Industrial and transport emissions (5)

**SOLAR PHOTO-VOLTAIC SYSTEM** : Solar radiation and its measurement - Insolation and Temperature - Solar cells and

characteristics, Solar PV module, PV system design and applications - Maximum Power Point Tracking algorithms - Stand-alone and grid connected systems (12)

**WIND POWER GENERATION** : Components of Wind Energy Conversion Systems - Classification of wind turbines - aerodynamic operation of wind turbine, extraction of wind turbine power, wind turbine power curve, horizontal axis wind turbine generator - modes of wind power generation - stand-alone and grid connected system (6)

**FUEL CELL SYSTEM AND HYBRID ENERGY SYSTEMS** : Principle of operation of fuel cell, technical parameters of fuel cell - Type of fuel cell - Advantages of fuel cell power plants, energy output, efficiency and emf of fuel cell - operating characteristics, applications - Hybrid energy systems: Need for hybrid systems, types, configuration and coordination, electrical interface - PV-Diesel, Wind-diesel, wind-PV, wind-PV- fuel cell (14)

**BIOMASS AND GEOTHERMAL ENERGY RESOURCES:** Biomass conversion Technologies - Feedstock pre- processing and treatment methods - Geothermal Energy resources: Ocean Thermal Energy Conversion – Tidal Energy (8)

**Total L: 45**

**TEXT BOOKS:**

1. Boyle G , "Renewable Energy: Power for a Sustainable Future", 2nd edition, Oxford University Press, 2012.
2. B H Khan , "Non-Conventional Energy Resources", 2nd edition, The McGraw –Hill, 2010.

**REFERENCES:**

1. G D Rai , "Non-conventional Energy sources", 5th edition, Khanna Publishers, 2014.
2. D P Kothari, K C Singal and RakeshRanjan , "Renewable Energy Sources and Emerging Technologies", 2nd edition, 2012.
3. C S Solanki , "Solar Photovoltaics – Fundamentals, Technologies and Applications", 2nd Edition, PHI Pvt., Ltd., 2011.
4. Gilbert M. Masters , "Introduction to Environmental Engineering and Science", 2nd Edition, Prentice Hall, 2003.

## ONE-CREDIT COURSES

### 19UF01 DISTRIBUTED CONTROL SYSTEM IN INDUSTRIES

**1 0 0 1**

**INTRODUCTION** : Evolution of process control system - DCS CS3000 System Architecture Configuration: PFCS,-FCS Hardware LFCS, KFCS, FFCS, FFCS-L. (3)

**HIS CONFIGURATION** : Application Capacity - Network Details - Address Setting. (3)

**CS3000 SYSTEM BUILDER CONFIGURATION** : Project Creation-Project Attribution Utility - Downloading-Introduction to CS3000 FCS Simulation S/W - User Login - IOM - Creation/ Signal Configuration. (3)

**CONTROL STRATEGIES** : Concept of Control Drawing - Concept of Function block Diagram - Configuration of Feed Back Control Functions: Creation of Open Loop, Creation of Closed Loop, and Creation of Cascade Loop - Introduction to Standard Display Windows: System Defined Windows, User Defined Windows - Operation of Instrument Faceplates. (3)

**CREATION OF WINDOWS** : Operation of Tuning Window - Control Group Window - Configuration of Trend Window - Graphics Window - Introduction to Switches/Interlocks. (3)

**Total L: 15**

**TEXT BOOKS:**

1. Michael P. Lukas , "Distributed Control Systems", Van Nostrand Reinhold Co., 1986.
2. Yokogawa India Private Limited , "CS 3000-Software Instruction Manual", , Bangalore, .

**REFERENCES:**

1. John Park, Steve Mackay, Edwin Wright , "Practical Data Communications for Instrumentation and Control Systems", Elsevier, 2003.
2. Bela G.Liptak , "Process Control and Optimization", 4<sup>th</sup> Edition, CRC Press, 2006.

### 19UF02 ADVANCED INDUSTRIAL AUTOMATION SYSTEMS

**1 0 0 1**

**PROGRAMMABLE AUTOMATION CONTROLLERS** : Multidisciplined Controllers-System Model-Backplane Communications - Different Form Factors - Networking Options - Operating System - Task Program and Routine as per IEC 61131-3 - Controller Data Features - Programming Software - Anatomy and Memory Structure - Operating System Priorities - Concept of Connections for Industrial Automation Systems - Understanding Controller Communication to the external World (4)

**HANDS ON PRACTICE** : Logix Controller programming Software with examples on Process Control and PID Tuning (3)

**INDUSTRIAL NETWORKING** : Evolution of Industrial Networking - Need for Industrial Networking - Network functions - Open Vs Proprietary Industrial Networking - Netlinx - Seamless Industrial Networking - CIP and Netlinx - Netlinx networks - Implementation and application paradigm of Device net, Control net and Ethernet/IP networks - Applications (2)

**DEMONSTRATION** : Hands on Practice on Device net/Control net/Ethernet/IP Networks. (3)

**HMI SYSTEMS AND VISUALIZATION SOLUTIONS** : Integrated Architecture and Factory Talk Manufacturing Information platform - One Architecture for Plant wide Control and Information - Role of Industrial Visualization - Visualization fit within an Automation Environment - View technology Cornerstones - View Technologies - Machine level and PC Based platforms (3)

**Total L: 15**

**REFERENCES:**

1. John W. Webb and Ronald A. Reis , "Programmable Logic Controllers: Principles and Applications", 5<sup>th</sup> Edition, Prentice Hall India publication, 2002.
2. Instruction Manual , "Control and Configuration software", Rockwell Automation, Bangalore, .
3. Frank D Petruzella , "Programmable Logic Controllers", 5<sup>th</sup> Edition, Mc Graw Hill publication, 2010.
4. John Park, Steve Mackay , "Practical Industrial Networking for Engineers and Technicians", IDC Technologies, 2011.

**19UF03 MARINE INSTRUMENTATION AND SYSTEMS**

**1 0 0 1**

**ELECTRICAL LAYOUT OF A SHIP** : Main generators - Main switchboard - Paralleling of Generators - Synchronizing and load sharing - Generator protection - Emergency supply system - Emergency generator - Emergency batteries Shore supply electronic control of protective relays (2)

**NAVIGATIONAL AIDS** : Radar - Gyro - Echo sounder - Log - Voyage data recorder (2)

**COMMUNICATION** : Internal communication - Intercom - Sound powered telephones - External communication - VHF - GMDSS - Electronic components (3)

**CONTROL SYSTEMS** : Main engine controls - Generator controls - Propulsion control - Steering control - Vessel management systems - Application of PLC (4)

**ELECTRICAL PROPULSION** : Evolution - Advantages of electrical propulsion - Problems faced in electrical propulsion application of electronics in propulsion (4)

**Total L: 15**

**TEXT BOOKS:**

1. Elstan A. Fernandez , "Marine Electrical Technology", , 2nd edition, Shroff publishers, 2007.
2. Akber Ayub , "Marine Engineering", ANE Books pvt ltd, New delhi, 2010.

**REFERENCES:**

1. Elstan A. Fernandez , "Marine Electrical Technology", , 2nd edition, Shroff publishers, 2007.
2. Basic Marine electricity learning resources , DNV India, 2005.
3. D A Taylor , "Introduction to Marine Engineering", , 2nd edition, Elsevier, Butterworth, 2005.
4. John C. Payne , "The Marine Electrical and Electronics Bible -A practical Handbook for Cruising sailors", , USA 2001, .

**19UF04 MEDICAL IMAGE ANALYSIS**

**1 0 0 1**

**MEDICAL IMAGE MODALITIES** : CT Basics, MRI Basics (T1/T2 weighted images), Physics of MRI. (2)

**FEATURE DETECTOR** : KLT, SIFT, Surf (2)

**MEDICAL IMAGE SEGMENTATION** : Active Shape, Active Contours, Graph Cuts (3)

**MEDICAL IMAGE REGISTRATION** : Rigid, Affine, Elastic Registration, Non-Rigid Registration- Introduction (BSplines), Mutual Information Metric (2)

**COMPRESSED SENSING** : CS and its application in MRI (2)

**PATTERN CLASSIFICATION** : Bayes Classifiers, Random Forests (2)

**DEMO/HANDS ON PRACTICE ON SEGMENTATION, REGISTRATION** : ITKSnap, c3d (Segmentation examples), Slicer3D, MevisLab, Elastix (Registration), Fiji (ImageAnalysis), Pythonxy. (2)



**Total L: 15**

**REFERENCES:**

1. Geoff Dougherty , "Digital Image Processing for Medical Applications", Cambridge University Press, 2009.
2. Isaac Bankman , "Handbook of Medical Imaging: Processing and Analysis", Academic Press, 2000.
3. Linda Shapiro, George C. Stockman , "Computer Vision", Prentice Hall, 2001.
4. J. R. Parker , "Algorithms for Image Processing and Computer Vision", 2<sup>nd</sup> Edition, 2011.

**19UF05 SYSTEM DESIGN AND IMPLEMENTATION**

**1 0 0 1**

**INTRODUCTION TO CONTROL SYSTEM DESIGN AND SIMULATION** : Developing a plant model, transfer function model, State space model - Overview of Control Design Toolkit-Control Design VIs, Model representation, Model forms - Constructing Transfer function models, state space models and zero pole gain models (3)

**MODEL CONVERSION AND INTERCONNECTION** : Converting Model Forms- Continuous to Discrete model conversion - Connecting Models in series, Connecting models in parallel - Placing models in closed loop configuration (3)

**TIME RESPONSE ANALYSIS** : Calculating the time domain specification - Case study: Spring mass damper system, RLC circuit - Analyzing the time response of a system for an applied step and impulse inputs, Analyzing initial response of a given system (3)

**FREQUENCY RESPONSE ANALYSIS** : Frequency domain specifications, Bode frequency analysis - Gain margin, Phase margin - Nichols frequency analysis, obtaining frequency response data (3)

**STABILITY ANALYSIS AND CLASSICAL CONTROLLER DESIGN** : Determining stability : Root locus method, Pole zero map - PID Controller design and prototyping - Implementation of auto tuning PID controller. Case study- Speed control of a DC motor, Level and Flow control (3)

**Total L: 15**

**REFERENCES:**

1. Dorf, Bishop , "Modern Control Systems", 11<sup>th</sup> Edition, Prentice Hall, 2017.
2. Ogata K , "Modern Control Engineering", Prentice-Hall of India Pvt Ltd., New Delhi, 1997.
3. Norman S Nise , "Control System Engineering", 4th Edition, John Wiley & sons, Inc, 2004.
4. Nagrath I J, Gopal M, "Control System Engineering", 3<sup>rd</sup> Edition, Wiley and Sons, 2004.

**19UF06 CALIBRATION TECHNIQUES**

**1 0 0 1**

**MEASUREMENT UNCERTAINTY** : Background — random and systematic errors - type A and type B uncertainty - sensitivity coefficients –uncertainty evaluation (3)

**CALIBRATION** : Introduction - meaning — objectives - necessity of calibration - basic calibration process – various components of a calibration system (3)

**STANDARDS AND STANDARDIZATION** : Working standards, check standards and international standards - levels of standard accuracies, accuracy ratio between levels of calibration pyramid - Requirements of traceability - metrology standardization documents (3)

**CALIBRATION TECHNIQUES** : Introduction — Calibration Curve Method, Standard Additions Method – Internal Standard Method, Comparative technique - choosing calibration method — determining calibration intervals (3)

**CALIBRATION SETUPS** : Electrical calibration - Temperature calibration - Pressure and Flow calibration — demonstrations (3)

**Total L: 15**

**REFERENCES:**

1. Stephanie Bell , "A Beginner`s Guide to Uncertainty of Measurement", National Physical Laboratory, UK, 1999.
2. Allan. S. Moris , "Measurement and Calibration for Quality Assurance", Prentice Hall, 1991.
3. Mike Cable , "Calibration: A Technicians Guide", ISA Publisher, 2005.
4. International Organization for Standardization , "International Vocabulary of basic and general terms in Metrology", 2008.

## 19UF07 MOTION CONTROL SYSTEMS

1 0 0 1

**INTRODUCTION** : Motion Control System, Micro and nano level motion systems. (2)

**MOTION SENSING TECHNOLOGIES** : Optical and magnetic encoders, magnetic and optical readers, resolvers, MEMS based accelerometers / gyros, multi-axis force/moment sensors, piezoresistive sensors, PSD sensors, tactile sensors, nanometrology. (3)

**ACTUATOR TECHNOLOGIES** : PMDC Motor, BLDC Motor, Induction Motor, Variable Reluctance motors, voice coil motors, piezoelectric actuators, magnetic actuators, shape memory alloys, linear actuation, electro-pneumatic and electro-hydraulic actuators. (2)

**POWER TRANSMISSION SYSTEMS AND LOADS** : Planetary gears, cycloid gears, harmonic drives, series elastic drives, cable drives, ball screws, and CVT. Loads and motor sizing. (2)

**CONTROL OF ACTUATORS** : Force/Torque, speed, position control loops, importance of stiffness, damping and inertia in various applications, auto-tuning, motion profiling and trajectory generation. (2)

**ADVANCED MOTION CONTROL STRATEGIES** : Multi-axis motion systems, master-slave bilateral operations (2)

**SAFETY IN MOTION SYSTEMS** : Application of brakes and clutches and international regulations. (2)

**Total L: 15**

### REFERENCES:

1. Urs Kafader, "Selection of High Precision Microdrives", Maxon Academic Series, 2010.
2. Kok Kiong Tan, Tong Heng Lee, "Precision Motion Control: Design and Implementation", Springer, 2010.
3. Asif Sabanovic, Kouhei Ohnishi, "Motion Control Systems", Wiley-IEEE Press, 2011.

## 19UF08 ELECTRICAL METROLOGY

1 0 0 1

**BASIC METROLOGY** : Understanding metrology Vocabulary, Measurement significance and application - Common metrology terminologies - Calibration: Objective and benefits of calibration (3)

**TRACEABILITY AND SI UNITS** : Traceability and its importance, International Metrology Structure – Calibration Hierarchy - Importance of SI Units and types of SI Units (3)

**STANDARDS USED IN ELECTRICAL CALIBRATION** : Absolute, Primary, secondary, working and census standards – measurement setup - Interpretation of specifications of various calibration standards and Device Under Calibration (DUCs) (3)

**CALIBRATION PROCEDURES FOR VARIOUS ELECTRICAL T & M INSTRUMENTS** : Methods of Calibration: Oscilloscopes, clamp meter, Panel meters - Calibration procedure of Voltmeter, Multimeter, DMM - Case studies (3)

**MEASUREMENT UNCERTAINTY** : Overview on Uncertainty, reason for uncertainty and its importance - Uncertainty evaluation - best practice - Uncertainty in practice and Case studies (3)

**Total L: 15**

### REFERENCES:

1. International Organization for Standardization, "Guide to expression of Uncertainty in measurement", Switzerland, 1995.
2. International Organization for Standardization, "International Vocabulary of basic and general terms in Metrology", Switzerland, 1993.
3. International Organization for Standardization, "International Standard ISO 3534-1, statistics-Vocabulary and Symbols-part-I: Probability and General Statistical Terms", Switzerland, 1993.
4. National Accreditation Board for Testing and Calibration Laboratories, "Guidelines for Estimation and Expression of Uncertainty in Measurement — NABL-141", NABL, 2016.

## 19UF09 STANDARD PRACTICES FOR POWER PLANT INSTRUMENTATION

1 0 0 1

**OVERVIEW OF POWER PLANT** : Role of Instrumentation engineers in large power & process plants. - Evolution of Instrumentation (Gauges to DCS and beyond) (2)

**STANDARDS AND CONTROL SCHEMES** : Communication standards of Instrumentation - Standards of Instrumentation (National/International), Instrument numbering system, KKS coding, Typical control schemes in power plants. (5)

**SAFETY** : Instrumentation in hazardous areas - Standards of Instrument enclosures. (3)

**INTERNATIONAL STANDARDS** : International certification for Instruments - Underwriters Laboratories/Canadian Standards Association/Verband der Elektrotechnik (UL/CSA/VDE), Instrument installation guidelines. (5)

**Total L: 15**

**REFERENCES:**

1. Alan. S. Morris , "Measurement and Instrumentation Principles", Butterworth-Heinemann, 2011.
2. Bouwens A. J , "Digital Instrumentation", Tata McGraw-Hill Education, 2001.
3. Bela. G. Liptak , "Instrument Engineers' Handbook - Process Measurement and Analysis", Vol 1, CRC Press, 2003.
4. Bela. G. Liptak , "Instrument Engineers' Handbook - Process Control and Optimization", Vol 2, CRC Press, 2005.
5. Bela. G. Liptak , "Instrument Engineers' Handbook - Process Software and Digital Networks", Vol 3, CRC Press, 2011.
6. Sam G. Dukelow , "The Control of Boilers", 2<sup>nd</sup> Edition, Instrument Society of America, 1991.

## 19UF10 AUTOMOTIVE INSTRUMENTATION AND CONTROL

**1 0 0 1**

**AUTOMOTIVE INSTRUMENTATION CLUSTER** : Measurement and display techniques of Vehicle Speed, Engine Speed and Odometer, Fuel Level, Oil Pressure, Engine Temperature, Battery Status, Gear Shift Indication, Seat Belt Indication, Door Open indication. (3)

**VEHICLE CONTROL FUNCTION** : Cruise Control (Simple and Adaptive), Speed Limiter, Vehicle Stability control. (3)

**ENGINE CONTROL FUNCTION** : Air system Control, Fuel System Control, Ignition Control, Exhaust Control, Water temperature control(Electric fan and pump), Engine speed control and Engine speed limitation. (3)

**BODY ELECTRONICS** : Immobilizer for vehicle security, Power Window control, Wiper speed control (with and without rain sensing) Head lamp intensity control based on Ambient light sensing. (3)

**AUTOMOTIVE COMMUNICATION PROTOCOLS** : Controller Area Network(CAN), Local Interconnect Network(LIN), FlexRay, Media Oriented Systems Transport(MOST). (3)

**Total L: 15**

**REFERENCES:**

1. Robert Bosch GmbH , "Automotive Handbook", 9<sup>th</sup> Edition, Bentley Publishers, 2014.
2. Konrad Reif , "Automotive Mechatronics: Automotive Networking, Driving Stability Systems, Electronics (Bosch Professional Automotive Information)", Springer Vieweg, 2015.

## 19UF11 AIRCRAFT INSTRUMENTATION

**1 0 0 1**

**OVERVIEW** : Introduction to aircraft instrumentation, Types of instruments, Location inside the cockpit. (2)

**INTRODUCTION TO FLIGHT INSTRUMENTATION AND BAROMETRIC INSTRUMENTS** : Pitot Static System, Air Speed Indicator(ASI), Altimeter, Rate of Climb Indicator(ROCI), Mach Meter. (3)

**INTRODUCTION TO POWER PLANT INSTRUMENTATION AND ENGINE PARAMETER MONITORING INSTRUMENT** : Auxiliary Engine Gas Temperature Indicator, Main Engine Rpm Gauge, Exhaust Gas Temperature Indicator(EGTI), Engine Oil Temperature Indicator, Engine Oil Pressure Indicator, Engine Vibration Measurer, Fuel Flow Meter, Fuel Quantity Gauge, Engine Regime Indicator, Hydraulic System Pressure/Temperature Indicator. (5)

**INTRODUCTION TO NAVIGATION INSTRUMENTS AND GYRO INSTRUMENTS** : Artificial Gyro Horizon, Combined Course Indicator(CCI), Flight Director Indicator(FDI), Null Indicator, Turn and Slip Indicator. (3)

**INDEPENDENT INSTRUMENTS** : Chronometer, Magnetic Compass, Bomb Bay Compartment Temperature Indicator, Cabin Temperature Indicator, Cabin Pressure Indicator. (2)

**Total L: 15**

**REFERENCES:**

1. S Nagabhushan. , "Aircraft Instrumentation and Systems", I. K. International Pvt Ltd, 2013.
2. EHJ Pallett. , "Aircraft Instruments", Longman Scientific & Technical, 1988.
3. Max F Henderson , "Aircraft Instrument and Avionics", Jeppesen Sanderson, 1993.
4. Dale Crane , "A Pilot Guide to Aircraft and Their Systems", Aviation Supplies & Academics, Incorporated, 2002.

## 19UF12 AUTOMATIC FLIGHT CONTROL SYSTEM

1 0 0 1

**INTRODUCTION** : Aircraft Stability, Directional Divergence, Spiral Divergence, Dutch Roll and Controllability. (2)

**NEED AND ROLE OF FLIGHT CONTROL SYSTEM** : Elements of flight control system. Functional diagram of a basic closed loop flight control system. Purpose of Altitude hold and airspeed hold (4)

**CLASSIFICATION OF FCS** : Single axis, two axis and three axis. Functional components of three axis FCS. (2)

**INTRODUCTION TO SENSORS/ERROR DETECTORS** : Gyros (Vertical, Directional, Displacement, Rate), Altitude Sensor, Air speed Sensor, Compass/Heading Sensor, Accelerometers (INS), Synchronos. (3)

**INTRODUCTION TO ACTUATORS** : Electro Pneumatic Servo Actuators, Electro Hydraulic Servo Actuators, Electro Mechanical Servo Actuators, Position Control Servomechanism, Speed Control Servomechanism. (2)

**SIGNAL PROCESSING** : Functions of signal processing elements in a FCS, Signal Processing channel and its elements, Limiting Synchronizing, Gain and Adaptive Control, Feedback in a FCS. (2)

**Total L: 15**

### REFERENCES:

1. E H J Pallett, S Coyle , "Automatic Flight Control", 4<sup>th</sup> Edition, Oxford : Blackwell Science, 2005.
2. E. H. J. Pallett , "Aircraft Instruments", Himalaya Publishing House, New Delhi, 1993.
3. John P fielding , "Introduction to Aircraft Design,", 4th Edition, Cambridge University Press, 1999.
4. L J Clancy , "Aerodynamics", Pitman Publishing, 1978.

## ENGLISH

### 19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION

1 0 0 1

**INTRA ORGANIZATIONAL COMMUNICATION** : Communication Networks in an Organization; Intra- organizational communication (2)

**INTER ORGANIZATIONAL COMMUNICATION** : Flow Nomenclature; Workplace diversity and intercultural aspects of communication (2)

**COMMUNICATION FUNCTIONS IN ORGANIZATIONS** : Teamwork and team dynamics; Conflict resolution strategies and styles; Leading and influencing others-facilitation skills (3)

**WRITTEN COMMUNICATION** : Email Writing, Professional Reports, and Memos (4)

**INTERPERSONAL SKILLS** : Nature and Dimensions of Interpersonal Communication; Personality and Communication styles; Active listening and intentional responding; Working with emotional intelligence (4)

**Total L: 15**

### REFERENCES:

1. Bagchi Subroto , "The Professional", Penguin Publications, UK, 2011.
2. PMBOK guide , "A Guide to the Project Management Body of Knowledge", Project Management Institute Inc, USA, 2013.

### 19GF02 HUMAN VALUES THROUGH LITERATURE

1 0 0 1

**PROSE** : Kalam's vision of college education in Wings of fire - Emerson's advocacy of independence of Human will in Self-reliance - Harmony in Education-views of Betrand Russel (4)

**POETRY** : Maintaining Human relations in Robert Frost's Mending Wall - Quest for identity and freedom in Kamala Das's An Introduction (2)

**DRAMA** : Statesmanship and friendship in Girish Karnad's Tughlaq (3)

**ONE-ACT PLAY** : The theme of love in Chekhov's The Bear (3)

**SHORT STORY** : Empathy in Somerset maugham's Mr. Know-all - Family bond in Anita Desai's Devoted son (3)

**Total L: 15**

**TEXT BOOKS:**

1. Faculty - Department of English , "Course materials", PSG College of Technology, Coimbatore, 2019.

**REFERENCES:**

1. Abrams M .H, Harpham , "A Glossary of Literary Terms", Cengage, Boston, 2015.
2. Scholes R, et.al. , "Elements of Literature", IV, Indian Rpt. OUP, New Delhi, 2013.

**HUMANITIES****19OFA1 EXPORT – IMPORT PRACTICES****1 0 0 1**

**INTRODUCTION** : Export – Import Business – Preliminaries for starting Export – Import Business Registration. (3)

**EXPORT PROCEDURES** : Obtaining an Export License – Export Credit Insurance – Procedures and Documentation (4)

**FOREIGN EXCHANGE** : Finance for Exports – Pricing - Understanding Foreign Exchange Rates. (3)

**IMPORT PROCEDURES** : Import Policy – License - Procedure and Documentation. (3)

**EXPORT INCENTIVES** : Incentives - Institutional support (2)

**Total L: 15****REFERENCES:**

1. Ramagopal C , "Export Import Procedures - Documentation and Logistics", New Age International, 2014.
2. Cherian and Parab , "Export Marketing", Himalaya Publishing House, New Delhi, 2008.
3. Parul Gupta , "Export Import Management", MC-Graw Hill, 2017.
4. Justin Paul, Rajiv Aserkar , "Export Import Management", Oxford, 2013.

**19OFA2 INSURANCE - CONCEPTS AND PRACTICES****1 0 0 1**

**INTRODUCTION TO INSURANCE AND RISK MANAGEMENT** : Origin, History, Nature and Scope of insurance – Meaning, types and significance of risk. (3)

**INSURANCE LAWS AND REGULATIONS** : Insurance Act, IRDA Act, Consumer Protection Act, Ombudsman Scheme. (2)

**INSURANCE UNDERWRITING AND RISK MANAGEMENT** : Meaning of underwriting and underwriter, guidelines and steps in the process of underwriting – characteristics, significance and principles of risk management. (4)

**FINANCIAL ASPECTS OF INSURANCE MANAGEMENT** : Role and functions of financial institutions, determination of premium for various insurance products. (3)

**SETTLEMENT OF INSURANCE CLAIMS** : Documents needed during various claims, Factors affecting insurance claims (3)

**Total L: 15****REFERENCES:**

1. Scott Harrington, Gregory Niehaus , "Risk Management and Insurance", McGraw Hill Education, 2017.
2. George E Rejda , "Principles of Risk Management & Insurance", Pearson Education, 2017.
3. John Hull , "Risk Management & Financial Institution", John Wiley and Sons, 2018.
4. Arjun Mittal, D D Chaturvedi , "Insurance and Risk Management", Scholar Tech Press, 2017.

**19OFA3 PUBLIC FINANCE****1 0 0 1**

**INTRODUCTION**: Nature and Scope of public finance – Principles of taxation. (2)

**PUBLIC REVENUE AND TAXATION**: Sources of Revenue – Tax and non-tax revenue – Classification of Taxes, GST. (4)

**PUBLIC EXPENDITURE**: Importance – Types – Causes of increase in public expenditure – Effects of public expenditure in India. (3)

**DEFICIT FINANCING AND BUDGET:** Sources of public debt – Debt redemption – Budget – Types – Preparation of Budget in India. (3)

**FEDERAL FINANCE:** Centre-State financial relations – Finance commissions. (3)

**TOTAL: 15**

**REFERENCE BOOKS:**

1. Richard A Musgrave and Peggy B Musgrave, "Public Finance in Theory and Practice" – Tata McGraw Hill Education, New Delhi, 2004.
2. Bhatia H.L, "Public Finance" – Vikas Publishing House, 29th Edition, New Delhi, 2012.
3. David N Hyman, "Public Finance: A contemporary application of theory and policy", Cengage Publication, 11th Edition, Noida, 2014.
4. Santhosh Dalvi and Krishnan Venkatasubramanian, "An introduction to Goods and Service Tax: The biggest tax reform in India", CCH Publisher, New Delhi, 2015.

**190FA4 SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT**

**1 0 0 1**

**INVESTMENT ENVIRONMENT :** Financial Markets - Classification - Financial Instruments – Security Trading. (2)

**TYPES OF SECURITIES :** Trading – Orders, Margin Trading – Clearing and Settlement Procedures. (5)

**SECURITY ANALYSIS I :** Industry Analysis –Estimation of Rates of Return. (2)

**SECURITY ANALYSIS II :** Company Analysis — Estimation of Rates of Return. (2)

**PORTFOLIO MANAGEMENT :** Measuring Risk and Returns and Treatment in Portfolio Management. (4)

**Total L: 15**

**REFERENCES:**

1. William F Sharpe, Gordon J. Alexander, Jeffery V Bailey , "Investments", Prentice Hall, 2012.
2. Prasanna Chandra , "Investment Analysis and Portfolio Management", TATA McGraw Hill Publishing, 2011.
3. Ranganathan , "Investment Analysis and Portfolio Management", Pearson, 2004.
4. Bhalla V K , "Investment Management", TATA McGraw Hill Publishing, 2011

**LANGUAGE ELECTIVES**

**19G001 COMMUNICATION SKILLS FOR ENGINEERS**

**0 0 4 2**

**COMMUNICATION CONCEPTS:**

Process of Communication  
Inter and Intrapersonal Communication  
Inter and Intrapersonal CommunicationActivities (9)

**FOCUS ON SOFT SKILLS:**

Etiquette — Work Place etiquette — Telephone etiquette  
Body Language  
Persuasive Communication  
Public Speaking  
Critical Reasoning and Conflict Management based on Case Studies  
Group Communication  
Meetings  
Interview Techniques (14)

**TECHNICAL WRITING :**

Technical Writing Principles  
Style and Mechanics  
Technical Definitions – Physical, Functional and Process Descriptions  
Technical Report Writing  
Preparing Instructions and Manuals  
Interpretation of Technical Data (15)

**BUSINESS CORRESPONDENCE :**

Writing Emails  
Preparing Resumes  
Memos

Technical and Business Proposals (7)

**TECHNICAL COMMUNICATION :**

Seminars  
Process Description and Group Discussions  
Use of Visual Aids (15)

**Total P: 60**

**TEXT BOOKS:**

1. Faculty Incharge "Course Material on "Communication Skills for Engineers"", PSG College of Technology., Coimbatore, 2019

**REFERENCES:**

1. Jeff Butterfield "Soft Skills for Everyone", Cengage Learning., New Delhi, 2013
2. Jean Naterop B and Rod Revell "Telephoning in English", Cambridge University Press., Cambridge, 2011
3. David A Mc Murrey and Joanne Buckley "Handbook for Technical Writing", Cengage Learning., New Delhi, 2011
4. Simon Sweeney "English for Business Communication", Cambridge University Press., New Delhi, 2012

**19G002 GERMAN- LEVEL A1.1**

**0 0 4 2**

**GUTEN TAG! :**

1. To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages
2. Vocabulary: related to the topic
3. Grammar: W — Questions, Verbs & Personal pronouns I. (10)

**FREUNDE, KOLLEGEN UND ICH :**

1. To speak about hobbies, jobs, learn numbers from 20; build dialogues and frame simple questions & answers
2. Vocabulary: related to the topic
3. Grammar: Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural (10)

**IN DER STADT :**

1. To know places, buildings, question, know transport systems, understand international words; build dialogues and write short sentences
2. Vocabulary: related to the topic
3. Grammar: Definite & indefinite articles, Negotiation, Imperative with Sien verbs (12)

**GUTEN APPETIT! :**

1. To speak about food, shop, converse; Vocabulary: related to the topic; build dialogues and write short sentences
2. Grammar: Sentence position, Accusative, Accusative with verbs, personal pronouns & prepositions, Past tense of haben & sein verbs (13)

**TAG FÜR TAG/ZEIT MIT FREUNDEN :**

1. To learn time related expressions, speak about family, about birthdays, understand & write invitations, converse in the restaurant; ask excuse, fix appointments on phone
2. Vocabulary: related to the topic
3. Grammar: Time related prepositions, Possessive articles, Modalverbs (15)

**Total P: 60**

**TEXT BOOKS:**

1. Dengler Stefanie "Netzwerk A1.1", Klett-Langenscheidt GmbH., München, 2013
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

**REFERENCES:**

1. Stefanie Dengler "Netzwerk A1", Klett-Langenscheidt GmbH., München, 2013
2. Hermann Funk, Christina Kuhn "Studio d A1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004
4. Christiane Lemcke und Lutz Rohrmann "Grammatik Intensivtrainer A 1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2012

**19G003 FRENCH LANGUAGE LEVEL 1**

**0 0 4 2**

**PARTS OF SPEECH :**

1. inviter et répondre à une invitation, Pronoms sujets
2. L'article définis, l'article indéfinis
3. Conjugation : présent, adjectifs possessifs

4. interrogation, décrire les personnes
5. La vie de quatre parisiens de professions différentes (12)

**ELEMENTS OF GRAMMAR :**

1. Exprimer l'ordre et l'obligation demander et commander
2. l'adjectif possessifs, l'article partitif, l'article démonstratif, négation ne
3. pas, l'article contracté
4. verbe pronominaux
5. prepositions (12)

**SENTENCE STRUCTURE :**

1. Raconter et reporter-donner son avis
2. Futur simple, pronom complètement d'objet direct, passé composé
3. plusieurs région de France, imparfait, pronom y/en, imparfait (12)

**TENSES AND NUMBERS :**

1. Demander l'autorisation-passé récent, futur proche
2. La vie administrative et régionale, Pluriel des noms, moyens de transport (12)

**DISCOURSE :**

1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d'un système éducation de France
3. parler de la technologie de l'information (12)

**Total P: 60**

**TEXT BOOKS:**

1. Christine Andant étal "À propos (livre de l'élève", LANGER., NEW DELHI, 2012
2. Myrna Bell Rochester "Easy French Step By Step", MCGrawhill Companies., USA, 2008

**REFERENCES:**

1. Michael D. Oates "Entre Amis: An Interactive Approach", Houghton Mifflin., 2005 , 5th
2. Bette Hirsch, Chantal Thompson "Moments Literaries : An Anthology for intermediate French", .,
3. Simone Renaud, Dominique van Hooff "En bonne forme", .,

**19G004 BASIC JAPANESE**

**0 0 4 2**

**JAPANESE PEOPLE AND CULTURE :**

1. Basic greetings and responses
2. Basic script— Method of writing hiragana and katakana — Combination sounds and simple words
3. Selfintroductions: "Hajimemashite"-Demonstratives "Kore", "Sore", "Are"— Demonstrative "Kono", "Sono", "Ano"
4. Possessive noun particle "no" — Japanese apartments: Greeting your neighbor (12)

**PARTICLE "NI (AT)" FOR TIME :**

1. kara (from) ~ made(until) — Particle "to (and)"
2. Time periods: Days of the week, months, time of day —Verbs (Present / future and pasttense)
3. Telephone enquiry: Asking for a phone no. And business hours- Destination particle "e". (12)

**LIKES AND DISLIKES :**

1. Potential verbs (wakarimasu and dekimasu) — "Kara ( ~ because)"
2. Adverbs — Asking some one out over the phone-Verbs denoting presence
3. Introduction to Adjectives (na and ii type) -Verb groups — I, II and III — Exercises to group verbs- Please do (te kudasai)
4. Present continuous tenses (te imasu) — Shall I? ( ~ mashou ka) — Describing a natural phenomenon (It is raining) (12)

**DIFFERENT USAGES OF ADJECTIVES :**

1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabeti desu)- Going for a certain purpose (mi -ni ikimasu)
2. Choosing from a menu-Adjectives ("i" and "na" type) — Adjectives (Positive and negative useage) (12)

**ROLE PLAYS IN JAPANESE :**

1. Framing simple questions & answers
2. Writing Short paragraphs & Dialogues
3. A demonstration on usage of chopsticks and Japanese tea party (12)

**Total P: 60**

**TEXT BOOKS:**

1. Minna no Nihongo, Honsatsu Roma "ji ban (Main Textbook Romanized Version)", . International publisher — 3A Corporation., Tokyo, 2012



**REFERENCES:**

1. Eri Banno et.al "Genki I: An Integrated Course in Elementary Japanese I -Workbook", .. 1999
2. Tae Kim "A Guide to Japanese Grammar: A Japanese Approach to Learning Japanese Grammar", .. 2014
3. Minna No Nihongo "Translation & Grammatical Notes In English Elementary"