Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)
Syllabus for B. Tech in Instrumentation and Control Engineering (ICE)
(Applicable from the academic session 2018-2019)

Semester-VII

PE-IC 701	**Control System Design**	**3L:0T:0P**	**3 credits**

Course Outcomes:

At the end of this course, students will demonstrate the ability to understand various design specifications.

- Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).
- Design controllers using the state-space approach.
- To learn the control design using the classical design principles
- To learn the controller and observer designs

Module 1: Design Specifications (6 hours)

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

Module 2: Design of Classical Control System in the time domain (8 hours)

Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

Module 3: Design of Classical Control System in frequency domain (8 hours)

Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

Module 4: Design of PID controllers (6 hours)

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

Module 5: Control System Design in state space (8 hours)

Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

Module 6: Nonlinearities and its effect on system performance (3 hours)

Various types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.

Text and Reference Books :

1. N. Nise, "Control system Engineering", John Wiley, 2000.

2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.

3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988. AICTE Model Curriculum for Undergraduate degree in Electrical Engineering (Engineering & Technology) 241 | Page

4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.

5. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.

6. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.

7. R.T. Stefani and G.H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.

8. Bernard Friedland, Control System Design: An Introduction to State-Space Methods (Dover Books on Electrical Engineering), Dover Publications Inc., 2005.

9. Gene F. Franklin, J. Da Powell, Abbas Emami-Naeini, Feedback Control of Dynamic Systems, Pearson Prentice Hall, 7th Edition, 2014.

10. Richard C Dorf, Robert H Bishop, Modern Control Systems, Pearson Education India, 12th Edition, 2013.

11. A. Ambikapathy, Control System, Khanna Publishing House, 2018

PE-IC 702	**Robotics and Automation**	**3L:0T:0P**	**3 credits**

Module-1

Robotics (8 Hours)

Definition of Robot, History of robotics, Robotics market and the future prospects, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration.Robot motions, Joints, Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeatability, End effectors – Tools and grippers.

Module-2 (8 Hours)

Controllers and Actuators

Basic Control System concepts and Models, Transfer functions, Block diagrams, characteristic equation, Types of Controllers: on-off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers. Control system and analysis.

Robot actuation and feedback components

Position sensors – Potentiometers, resolvers, encoders, velocity sensors. Actuators - Pneumatic and Hydraulic Actuators, Electric Motors, Stepper motors, Servomotors, Power Transmission systems.

Module-3 (8 Hours)

Robot Sensors and Machine vision system

Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics.Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems.

Module-4 (8 Hours)

Robots Technology of the future: Robot Intelligence, Advanced Sensor capabilities, Telepresence and related technologies, Mechanical design features, Mobility, locomotion and navigation, the universal hand, system integration and networking.

Artificial Intelligence: Goals of AI research, AI techniques – Knowledge representation, Problem representation and problem solving, LISP programming, AI and Robotics, LISP in the factory.

Module-5 (8 Hours)

Automation

History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies

Automated Manufacturing Systems: Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS.

Reference Books:

1. **Adrienne Mayor, Gods and Robots:** Myths, Machines, and Ancient Dreams of Technology
2. **Matt Timmons Brown-** Learn Robotics with Raspberry Pi: Build and Code Your Own Moving, Sensing, Thinking Robots
3. **Mikell Groover, Mitchell Weiss, Roger Nagel, Nicholas Odrey-** Industrial Robotics
4. **Khushdeep Goyal**- Industrial Automation & Robotics
5. **Kevin M. Lynch and Frank C. Park**: Modern Robotics: Mechanics, Planning, and Control, Kindle Edition

Course Outcome:

1. Be able to desing and program robotic systems.
2. Transducers, sensors, actuators and controllers employed commonly in robotics and industrial automation systems.
3. Get skills programming control components.
4. Learn how to design and program monitoring interfaces and automated control processes.
5. Acquire the basic knowledge of industrial communications.
6. Learn to develop and manage projects in robotics and industrial automation.

PE-IC703	**Analytical Instrumentation**	**3L:0T:0P**	**3 credits**

Introduction to Analytical Instrumentation: Difference between analytical and other instruments. Classification, types of Instrumental methods.

Measurement of Humidity: Dry & wet psychrometer, Hair hygrometer, electrical type, Electrolysis type hygrometer, Dew point meter.

Moisture: Electrical conductivity type, Capacitive method type, IR method, Microwave method, Crystal oscillator method.

Viscosity: Poiseuilles formula, Saybolt's viscometer, Rotameter type viscometer, Friction tube viscometer, Searle's rotating cylinder type.
Density: Pressure head type, Buoyancy effect type, Gow-Mac densitometer, Radioactive type, Photoelectric type, Displacer type.

Gas Analysis:
a) Thermal conductivity method.
b) Heat of Reaction method.

Oxygen Analysis:
a) Magneto Dynamic instrument(Pauling cell)
b) Thermomagnetic type or Hot wire type instrument.
c) Zirconia oxygen analyzer.
d) Mackerth type galvanic analyzer for dissolved oxygen analysis.

Liquid analysis:
a) Electrodes-Ion selective, Molecular selective types- their variations.
b) pH analysis: pH electrodes, circuit for pH measurement and applications.
c) Conductivity cells – standards, circuits.
d) Polarography- apparatus, circuits and techniques-pulse polarography, applications
e) Colorimetry

Spectroscopic Methods:
Introduction, Laws relating to absorption of radiation, Molecular Absorption Spectroscopy in UV & VIS ranges: sources, wavelength selectors, sample container, detectors, Spectrophotometers (Single beam & Dual beam arrangement). Atomic Absorption & Emission spectroscopy : Atomizers, sources, single & dual beam arrangement Plasma Spectroscopy : Sequential & Simultaneous multichannel Instruments. Atomic X Ray spectrometry: Absorption & diffraction phenomena, sources, detectors, techniques.
IR Spectroscopy: sources, monochromators, detectors.
IR Spectrometer, FT-IR spectrometers.

Chromatography: Introduction, basic definitions, some relationships. Gas chromatography: basic parts, columns, detectors, techniques. LC: types, HPLC : basic parts, sample injection system, column, detectors, Applications.

Text Books:

1. Principles of Industrial Instrumentation- D.C. Patranabis, Tata McGraw Hill.
2. Handbook of Analytical Instruments- R.S. Khandpur, Tata McGraw Hill
3. Principles of Instrumental Analysis- Skoog, Holler, Nieman, Thomson Brooks/Cole.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:
1. Understand the humidity, density, viscosity and pH measurement.
2. Understand the industry oriented gas and liquid analysis.
3. Understand spectroscopic and chromatography method used in industry.

PE-IC704	**Digital Control Systems**	**3L:0T:0P**	**3 credits**

At the end of this course, students will demonstrate the ability to
- Obtain discrete representation of LTI systems.
- Analyse stability of open loop and closed loop discrete-time systems.
- Design and analyse digital controllers.
- Design state feedback and output feedback controllers.

Module 1: Discrete Representation of Continuous Systems (6 hours)
Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Module 2: Discrete System Analysis (6 hours)
Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.

Module 3: Stability of Discrete Time System (4 hours)
Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

Module 4: State Space Approach for discrete time systems (10 hours)
State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Module 5: Design of Digital Control System(8 hours)
Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Module 6: Discrete output feedback control (6 hours)
Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text Books :
1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

OE-IC701	**Non-Convectional Energy System**	**3L:0T:0P**	**3 credits**

Module I (8 hours)

Energy Sources - Classification, Need and potential of NCES, Electricity generation from NCES:

Module II (8 hours)

Photovoltaics: Mono; poly - crystalline and amorphous Silicon solar cells, Efficiency and cost of PV systems.

Module III (8 hours)

Wind electricity - wind as an energy source, wind electricity generating system – basic components, wind electric generators, siting of wind forms.

Module IV (4 hours)

Energy from Biomass - gasifiers and bio-gas reactors;

Module V (12 hours)

Tidal energy; Wave energy and Geothermal energy; Environmental effects and Economics of NCES.

Reference Books:
1. O.P. Gupta, Energy Technology, Khanna Publishing House
2. Bansal, Kleeman and Melisa, Renewable Energy Sources and Conversion Technology, TMH, New Delhi.
3. S P Sukhatme, Solar Energy
4. Twidell and Weir, Renewable Energy Resources, ELBS.

5. B.H. Khan, Non Conventional Energy Resources.
6. Abbasi & Abbasi, Renewable Energy Sources & their environmental impact.
7. El. Wakil, Power Plant Technology.
8. Chandra & Chandra, Non-Conventional Energy Resources, Khanna Publishing House

Course Outcomes:
At the end of this course, students will demonstrate the ability to
 Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
 Understand the basic physics of wind and solar power generation.
 Understand the issues related to the grid-integration of solar energy systems.
 Understand the biomass, tidal, wave &geothermal energy systems & environmental effects.

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OE-IC702	**Non destructive testing**	**3L:0T:0P**	**3 credits**

COURSE OUTCOMES:

At the end of the course, a student will be able to:

1. Explain the principles of conventional NDT methods (visual inspection, magnetic methods, thermal methods, radiography, eddy current testing, and ultrasonic inspection).

2. Analyze the limitations and advantages of different NDT methods to select the appropriate techniques for inspections.

3. Understand the generation and propagation of ultrasonic waves.

4. Describe the types of ultrasonic waves for different techniques used in flaw detection.

5. Describe measurement procedure of various parameters (thickness, depth, flow and level).

6. Explain the capturing process of biomedical organs using ultrasound.

Module I (12 hours)

Introduction and importance of NDT. General Principles and Basic Elements of NDT. Surface feature inspection and testing: General, Visual, Chemical, and Mechanical. Magnetic-magnetization, flux, and Electro potential, Electrical resistivity, Electromagneticeddy current techniques.

Module II (12 hours)

Ultrasonic waves, principle and propagation of various waves, Characterization Ultrasonic transmission, reflection and transmission coefficients, intensity and attenuation of sound beam, power level, generation of ultrasonic waves, Magnetostrictive and Piezoelectric effect, search unit , types, construction, characteristics.

Module III (12 hours)

Ultrasonic Test methods: Echo, Transit time, Resonance, Direct contact and immersion types Ultrasonic methods of measuring thickness, depth, flow, level etc. Various parameters affecting ultrasonic testing and measurements, their remedy. Ultrasonic in medical diagnosis and therapy, Acoustical holography. 1

Text Books:

1. NDT Handbook, Mclutive p , American Society for NDT, 1989.

2. Non Destructive Testing, Hull B and John V , FI BS/McMillan. Syllabus for B.Tech(Instrumentation & Control Engineering) upto Fourth Year Revised Syllabus of B.Tech ICE (for the students who were admitted in Academic Session 2010-2011) 56

3. Ultrasonic Testing of materials, Krantkramer ,Springer 2005

4. Handbook of Nondestructive Testing, Mc Graw Hill, 1998

5. Digital Holograpy, U. Schnars, W. Jeuptner ,Springer, 2005

6. Nuclear radiation Detection, W. J. Price Mc Graw Hill, New York, 1958

7. Ultrasonic Testing of Materials, Krauthsamer J and Krauthsamer H ,Springer Verlag, Berlin, New York. 8. Biomedical Ultrasonic, Wells N T, Academic Press, London.

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ES-CS701	**Computer Networks**	**3L:0T:0P**	**3 credits**

Module I (10 hours)

Overview of Data Communication and Networking:
Introduction, Data communications: components, data representation (ASCII, ISO etc.),direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure(type of connection, topology), categories of network (LAN, MAN, WAN); Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study.
Physical Level:
Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit Switching: time division & space division switch, TDM bus; Telephone Network.

Module II (10 hours)

Data link Layer:
Types of errors, framing (character and bit stuffing), error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, Go-Back-N ARQ, Selective repeat ARQ, HDLC;]
Medium Access sub layer:
Point to Point Protocol, LCP, NCP, Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA Traditional Ethernet, fast Ethernet (in brief).

Module III (12 hours)

Network layer:
Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing: IP addressing, sub netting; outing : techniques, static vs. dynamic routing , Unicast Routing Protocols: RIP, OSPF, BGP; Other Procols: ARP, IP, ICMP, IPV6.
Transport layer:
Process to Process delivery; UDP; TCP; Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm,

Module IV (8 hours)

Application Layer:
Introduction to DNS, SMTP, SNMP, FTP, HTTP & WWW; Security: Cryptography (Public, Private Key based), Digital Signature, Firewalls.
Modern topics:
ISDN services & ATM, DSL technology, Cable Modem: Architecture and operation in brief. Wireless LAN: IEEE 802.11, Introduction to blue-tooth.

Text Books:
1. Data Communications and Networking (3rd Ed.), A. Forouzan , TMH
2. Computer Networks (4th Ed.), A. S. Tanenbaum, Pearson Education/PHI3. Data and Computer Communications (5th Ed.), W. Stallings, PHI/ Pearson Education
3. An Integrated Approach to Computer Networks, Bhavneet Sidhu, Khanna Publishing House, 2018.

Reference Books:
1. Computer Networking -A top down approach featuring the internet, Kurose and Rose Pearson Education
2. Communication Networks, Leon, Garica, Widjaja, TMH
3. Communication Networks, Walrand, TMH.
4. Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.), Comer, Pearson Education/PHI