Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Applied Electronics and Instrumentation Engineering (AEIE)

(Applicable from the academic session 2018-2019)

FOURTH YEAR 7TH SEMESTER SYLLABUS

Course Code: PE-EI 701	**Category: Professional Elective Courses-III**
Course Name: Mechatronics & Robotics	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Total Lectures: 30	
Pre-Requisites: To understand this course, the learner must have idea of Sensor and Transducer, Measurement, Control System	

Objectives: To acquaint the Mechatronics & Robotics with theory and working principles of different types of sensors and mechanical systems used in the manufacturing industry and their applications.

Module No.	Description of Topic	Contact Hrs.
1.	**General Concepts of Mechatronics** Introduction, Definition of Mechatronics, Mechanical Systems: Introduction to various systems of units, mathematical modeling of mechanical systems, Newton's laws, moment of inertia, forced response and natural response, rotational systems, spring mass system, free vibration, spring mass damper system, mechanical systems with dry friction, work energy and power, passive elements and active elements an energy method for deriving equations of motion, energy and power transformers.	5
2.	Fluid and Thermal systems: **Mathematical modeling of liquid level system**: Resistance and capacitance of liquid level systems with interaction**. Mathematical modeling of pneumatic systems:** Resistance and capacitance of pneumatic systems, mathematical modeling of a pneumatic systems, liberalization of non-linear systems. **Mathematical modeling ofhydraulic systems**: Hydraulic circuits, hydraulic servometer and mathematical model of hydraulic servo motor dashpots. **Mathematical modeling of thermal systems:** Thermal resistance and thermal capacitance mathematical modeling of thermal systems	5
3.	**General Concepts of Robotics** Introduction, Definition of robot, classification of robots according to coordinate system (Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration) and control method, Main components of robots – manipulator, sensors, controller etc, Robot characteristics –payload, reach, repeatability, accuracy, resolution.	6
4.	Robot End effecters & Actuators: Types, mechanical grippers, other types of grippers, Tools as end effecters. Characteristics of actuating systems, Actuating System – Hydraulic devices, pneumatic devices, electric motors, other special actuators.	6
5.	**Transmission** Kinematics of Robot: Homogenous coordinates, Homogeneous transformation matrices, Direct and Inverse Kinematics of robots, Trajectory Planning.	4
6.	**Application** Application of Robots: Handling, loading and unloading, Welding, Spray painting, Assembly, Machining, Inspection, Rescue robots, Underwater robots, Parallel robot, and Medical robot.	4

Course Outcomes (CO):

The students will be able to -

1. Understand the basic concept of Mechatronics system. Engineering for designing the mechatronics system.
2. Analyzethe different mathematical modelling of the liquid level, pneumatic systems, hydraulic systems and thermal systems for actuation of mechatronics systems.
3. Understand the working of robot design with coordinate system.
4. Apply the knowledge of different parts of robots for real time application and robot design.
5. Understand and applythe robot kinematics in real time problem.
6. Apply the knowledge in different application for mankind.

Learning Resources:

Text Books:

1. Bolton, W, Mechatronics. 3rd edn, Addison-Wesley.
2. Robotics: Control, Sensing, Vision and Intelligence by Fu, Gonzalez and Lee
3. Introduction to Robotics:Mechanics and Control (3rdEdition) by John J. Craig
4. Robot Dynamics and Control: by Spong and Vidyasagar
5. Introduction to Robotics, S K Saha, McGrew Hill

Reference Books:

1. Fuller, J, Robotics: Introduction, Programming and Projects, 2nd edn, Prentice-Hall.
2. Schuler, C, &McNammee, W, Industrial Electronics & Robotics, McGraw-Hill.
3. Karnopp DC, Margolis DL & Rosenberg RC, System Dynamics: Modeling and Simulation of Mechatronics Systems. 3rd edn. Wiley Interscience.
4. Control of Robot Manipulations: F.I.Lewis, C.T.Abdallah, D.M.Dawson
5. Kinematic Analysis of Robot Manipulators: Carl D. Crane and Joseph Duffy
6. Robotics for Engineers: Koren Y.
7. Robot Modelling: Control and Application with software: by P.G.Ranky and C.Y.Ho

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Course Code: PE-EI 702	**Category: Professional Elective Courses-III**
Course Name: Digital Control System	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Total Lectures: 40	
Pre-Requisites: Basic Electronics, Control System, Sensors & Transducers, Measurement	

Objectives: To apply the control strategy in digital domain. To build the system small and useful for our daily life.

Module No.	Description of Topic	Contact Hrs.
1	**Discrete Representation of Continuous Systems –** 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.	**6**
2	**Discrete System Analysis** 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.	**6**
3	**Stability of Discrete Time System** Stability analysis by Jury test. Stability analysis using bilinear transformation. Root locus method in z plane. Design of digital control system with dead beat response. Practical issues with dead beat response design	**4**
4	**State Space Approach for discrete time systems** 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	**10**
5	**Design of Digital Control System** 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. Digital Control Algorithms :- (a) Dead beat control (b) Dahlin's algorithm.	**8**
6	**Fuzzy logic control** Crisp Set, Fuzzy Set, Fuzzy Operators, Overview of FLC, Different Fuzzy models (MA/TS), Applications of Fuzzy rule based systems: Studies of some Fuzzy-neural, Neuro-fuzzy and Fuzzy-GA systems	**6**

Course Outcomes (CO):

The students will be able to -

1. Understand the discrete representation of continuous systems with mathematical modelling.
2. Analyze discrete system.
3. Analyze stability of discrete time system.
4. Analyze state space approach of discrete time system.
5. Design the controller for discrete time system.
6. Understand the Fuzzy logic control.

Learning Resources:

Text Books:

1. Digital Control and State Variable Methods– M. Gopal, McGraw Hill Education
2. Digital Control Systems - B. C. Kuo, Oxford University Press-New Delhi
3. Digital Control System, V.I.George and C.P.Kurien, Cengage Learning.
4. Digital Control Engineering Analysis and Design, M.SamiFadali, Antonio Visioli, Academic Press.
5. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication.
6. Introduction to Neural Networks using MATLAB 6.0 – S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH

Reference Books:

1. C.M. Houpis, G.B.Lamount, ' Digital Control Systems- Theory, Hardware, Software', International Student Edition, McGraw Hill Book Co.,
2. Kannan M.Moddgalya, Digital Control, Wiley India,
3. C.L. Philips and J.M.Pan, "Feedback Control System, Pearson
4. Klir.G, Yuan B.B. "Fuzzy sets and Fuzzy Logic Prentice Hall of India private limited
5. Laurance Fausett, "Fundamentals of Neural Networks", Prentice hall
6. Gen, M. and Cheng R. "Genetic Algorithm and Engineering Design", John Wiley

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Course Code: PE-EI 703	**Category: Professional Elective Courses-IV**
Course Name: Analytical Instrumentation	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Total Lecture: 34	
Pre-Requisites: Chemistry, Process Control, Sensors & Transducers, Measurement	

Objectives: To make acquainted with Instrumentation application in industry for analyzing the sensors used for measuring the physical sensor parameters (Example: gas, liquid, optical etc.)

Module No.	Description of Topic	Contact Hrs.
1.	**Introduction to Analytical Instrumentation**: Classification, types of Instrumental methods Measurement of Humidity: dry & wet psychrometer, hair hygrometer, electrical type, Electrolysis type hygrometer, dew point meter.	4
2.	**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.	6
3	**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.	4
4.	**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	6
5.	**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.	8
6.	**Chromatography**: Introduction, basic definitions, some relationships.	6

	Gas Chromatography: basic parts, columns, detectors, techniques. **LC : types, HPLC:** basic parts, sample injection system, column, detectors, Applications	

Course Outcomes (CO):

The students will be able to -

1. Understand why Analytical Instrumentation is useful for industrial application.
2. Analyse Moisture, Viscosity with different method of measurement.
3. Analyse Gas and Oxygen with various methods.
4. Analyse Liquid with various practical experiments.
5. Understand and analyse Spectroscopy is significantindetermining composition, temperature, density, motion etc.,
6. Understand and analyse how Chromatography used for separation of mixture.

Learning Resources:

Text Books:

1. Principles of Industrial Instrumentation- D.C. Patranabis, Publisher: Tata McGraw Hill
2. Principles of Instrumental Analysis- Skoog, Holler, Nieman, Publisher: Thomson Brooks/Cole
3. Introduction to Instrumental Analysis-Robert D. Braun, Publisher: Pharma Book Syndicate
4. Handbook of Analytical Instruments- R.S. Khandpur, Publisher: Tata McGraw Hill

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Course Code: PE-EI 704	**Category: Professional Elective Courses-IV**
Course Name: Non Destructive Testing	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Total Lecture: 30	
Pre-Requisites: Measurement, Sensors & Transducers,	

Module No.	Description of Topic	Contact Hrs.
1	Introduction and importance of NDT. General Principles and Basic Elements of NDT.	**4**
2	Surface feature inspection and testing: General, Visual, Chemical, and Mechanical Magnetic-magnetization, flux, and Electro potential, Electrical resistivity, Electromagnetic-eddy current techniques.	**10**
3	Ultrasonic waves, principle of propagation, Ultrasonic Test methods: Echo, Transit time, Resonance, Direct contact and immersion types	**8**
4	Ultrasonic methods of measuring thickness, depth, flow, level etc. Various parameters affecting ultrasonic testing and measurements, their remedy Ultrasonic in medical diagnosis and therapy.	**8**

Course Outcomes (CO):

The students will be able to -

1. Understand why Non Destructive Testing (NDT) is useful for industry or clinical process.
2. Understand and analyze different techniques of NDT General, Visual, Chemical and Mechanical system.
3. Understand and analyze Ultrasonic wave used in NDT.
4. Understand and analyze Ultrasonic method in Industry and Medical measurement techniques.

Reference Books:

1. Mclutive p (Ed) – NDT Handbook, American Society for NDT, 1989.
2. Hull B and John V – Non Destructive Testing, FI BS/McMillan.
3. Krantkramer - Ultrasonic Testing of materials, Springer 2005
4. Handbook of Nondestructive Testing, McGraw Hill, 1998
5. U. Schnars, W. Jeuptner - Digital Holograpy, Springer, 2005
6. W. J. Price – Nuclear radiation Detection, McGraw Hill, New York, 1958
7. Krauthsamer J and Krauthsamer H – Ultrasonic Testing of Materials, Springer Verlag, Berlin, New York.
8. Wells N T – Biomedical Ultrasonics, Academic Press,London 1977

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Syllabus for B. Tech in Applied Electronics and Instrumentation Engineering (AEIE)

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Course Code: OE-EI-701	**Category: Open Elective Courses - IV**
Course Name: Telemetry & Wireless Sensor Network	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Total Lecture: 40	
Pre-Requisites: Communication, Sensors, Basic Computer Knowledge.	

Module No.	Description of Topic	Contact Hrs.
1	Purpose of telemetry, basic scheme, voltage, current and frequency telemetry **Modulation Codes**: PAM, PFM, PTM, PCM Review of modulation and multiplexing: FM-AM, FM-FM, PAM-AM, PAM-FM, PCM-AM, etc. Quantization and error in quantization. Inter symbol interference, Bit error rate, noise.	**8**
2	FDM systems, IRIG standards in FDM systems. SCO's, Mux and Demux circuits, Detectors andDemodulators, Pulse averaging, Quadrature FM and PLL, Mixers. TDM systems (architecture)- TDM- PAM, PAM- PM, TDM- PCM systems, synchronization	**8**
3	Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks.	**5**
4	Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks (WSNs), Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks.	**4**
5	Routing Protocols, MAC Protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC Protocol, IEEE 802.15.4 Standard, ZigBee, Wifi. Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.	**10**
6	Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication.	**5**

Course Outcomes (CO):

The students will be able to -

1. Understand the basic concept of telemetry and communication modulation code
2. Understand Frequency-division multiplexing (FDM) and Time-division multiplexing (TDM) in practical field.
3. Understand and working of the sensor network and its application in Industry.
4. Understand and working of the Mobile Ad-hoc Networks and wireless sensor networks.
5. Understand and apply routing protocol in Industry.
6. Understand the WSNs Communication techniques.

Learning Resources:

Text Books:

1. D. Patranabis, Telemetry principles, TMH, New Delhi
2. E. L. Gruenberg, Handbook of Telemetry and Remote control, McGraw Hill
3. B. P. Lathi, Modern Digital and Analog Communication Systems, Oxford University Press
4. Swobada G – Telecontrol Method and Application of Telemetering and Remote Control, Von Nostrand.

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Course Code: OE-EI-702	**Category: Open Elective Courses - IV**
Course Name: Non-Conventional Energy System	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Total Lecture: 30	
Pre-Requisites:	

Module No.	Description of Topic	Contact Hrs.
1	Classification of Energy Sources Advantages of Non-Conventional Energy Sources over Conventional Sources Economics, Impact on Environment.	**4**
2	Thermal Energy Generation from Solar Energy: Solar radiation and its Characteristics. **Solar Collector:** flat Plate, evacuated tube, focusing, Solar Energy use for water heating, Solar thermal power generation. Principle of energy conversion in Solar Photovoltaic cells, Different types of PV Cells, Mono-poly crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems.	**6**
3	**Electricity Generation from Wind Energy:** Wind as energy source, Design of Wind turbine, Selection of site of Wind farm, characteristics of different types of wind generators used with wind turbines.	**4**
4	**Electricity Generation from Bio Energy:** Resources and conversion process: bio gas conversion, bio gas plant, bio mass gasifier, cogeneration. **Bio diesel:** Sources, usability and advantages over mineral product	**6**
5	**Electricity Generation from Tidal Energy**: Principle, selection of site, Economics and future prospect. **Electricity Generation from Wave Energy**: Principle, selection of site and future prospect Electricity **Generation from Geo Thermal Energy**: Principle , location , economics and prospect Introduction to Energy Conservation & Audit	**8**
6	Introduction to Energy Conservation & Audit	**2**

Course Outcomes (CO):

The students will be able to -

1. Understand the basic concept of Non-Conventional Energy source and application in real life.
2. Understand and explain Solar Energy generation and application.
3. Understand and apply Electricity Generation from Wind Energy
4. Understand and apply Electricity Generation from Bio Energy and Bio diesel techniques.
5. Understand and explain Electricity generation from Tidal, Wave and Thermal energy.
6. Understand the audit and energy conservation.

Learning Resources:

1. Bansal, Kleeman& Melisa - "Renewable Energy Sources & Conversion Technology" - TMH New Delhi.
2. S P Sukhatme - "Solar Energy"
3. Twidell& Weir - "Renewable Energy Resources"; ELBS
4. Non Conventional Energy Sources – G. D. Rai
5. Non-Conventional Energy Resources – Chandra & Chandra, Khanna Publishing House
6. Energy Technology, O.P. Gupta, Khanna Publishing House

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Course Code: ES-CS 701	**Category: Engineering Science Courses**
Course Name: Computer Networks	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Total Lecture: 30	
Pre-Requisites: Communication Engineering	

Module No.	Description of Topic	Contact Hrs.
1	**Data communication Components:** Representation of data and its flow Networks,Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN	**5**
2	**Techniques for Bandwidth utilization:** Multiplexing – Frequency division, Time division and Wave division, Concepts on spread spectrum.	**3**
3	Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols – Stopand Wait, Go back – NARQ, Selective Repeat ARQ, Sliding Window, Piggybacking. Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA,CSMA/CD,CDMA/CA	**8**
4	Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols	**4**
5	**Transport Layer:** Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.	**5**
6	Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography	**5**

Course Outcomes (CO):

The students will be able to -

1. Understand research problem formulation.
2. Analyse research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology but tomorrow's worldwill be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual property right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better product and in turn brings about, economic growth and social benefits.

Learning Resources:

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3. "An Integrated Approach to Computer Networks" by Bhavneet Sidhu, Khanna Publishing House
4. "Algorithm Design" by Kleinberg and Tardos.
5. "Design & Analysis of Algorithms", Gajendra Sharma, Khanna Publishing House, New Delhi