S.Y B.Tech. Instrumentation and Control Semester-II										
Course Code	Course Title	Teaching Scheme Hours/Week			Examination Scheme				Marks	Credit
		Lecture	Tutorial	Practical	In semester	End semester	Oral	Practical		
IN2201	Sensors and Transducers II	3	1	0	50	50	0	0	100	4
IN2202	Electronic Instrumentation & System Design	3	1	0	50	50	0	0	100	4
IN2203	Analytical Instrumentation	3	0	0	50	50	0	0	100	3
IN2204	Control Systems I	3	1	0	50	50	0	0	100	4
HS2201	Principles of Economics and Finance	3	0	0	50	50	0	0	100	3
IN2205	Sensors and Transducers II lab	0	0	2	0	0	0	25	25	1
IN2206	Electronic Instrumentation & System Design lab	0	0	2	0	0	0	25	25	1
IN2208	Analytical Instrumentation	0	0	2	25	0	0	0	25	1
IN2209	*Lab Practice I	0	0	2	25	0	0	0	25	1
AC2201	Self-Expression	0	0	2	0	0	0	0	0	No Credits
Total		**15**	**3**	**10**	**300**	**250**	**0**	**50**	**600**	**22**
Grand Total		**28**			**600**				**600**	**22**

***IN2209 – Lab Practice I: Assignments / Practicals based on Circuit Theory and Applied Biology should be conducted.**

AC 2201 -- Audit Course : Self Expression

1. Art & Craft
2. Basic Photography
3. Contemporary Dance
4. Film Appreciation
5. English Communication
6. Theatre

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IN 2201: Sensors And Transducers II

Teaching Scheme
Lecture: 3 Hr/week
Tutorials: 1 Hr/week

Examination Scheme
In Semester: 50 marks
End Semester: 50 marks
Credit: 4

Course Objectives:
1. To study measurement of some physical parameters
2. To learn analog and digital signal conditioning schemes for sensors/transducers
3. To design and study instruments based on applications

Course Outcomes: The student will be able to
1. define and list performance characteristic of different sensors and transducers.
2. compare features of different sensors and transducers.
3. build various signal condoning circuit.
4. design signal conditioning circuit for sensors and transducers for different application.

Unit 1: Displacement Measurement **(06)**
Resistive: Potentiometer, Linear and rotary, Loading Effect types of strain gauges. Inductive: LVDT and Eddy current type Transducers. Capacitive: Capacitance pickups, Differential capacitive cells. Piezoelectric, Ultrasonic transducers and Hall effect transducers Optical transducers. Precision measuring instrument (gauges), Angular measurement.

Unit 2: Velocity and speed Measurement **(06)**
Standards ,working, principle, types, material ,design criteria:
Moving magnet and moving coil, Electromagnetic tachometer, photoelectric tachometer, Toothed rotor variable reluctance tachometer, magnetic pick-ups, encoder, Photoelectric pick up, shaft speed measurement. Applications of velocity measurement sensor

Unit 3: Vibration and Acceleration **(05)**
Standards working principle, types, material, design criteria: Eddy Current type, piezoelectric type, Seismic transducer.
Accelerometer: Potentiometric type, LVDT type, piezoelectric type. Application of Acceleration ion and vibration sensor

Unit 4: Force and Torque Measurement **(06)**
Basic methods of force measurement, elastic force traducers, strain gauge, load cells, shear web, piezoelectric force transducers, vibrating wire force transducers, Strain gauge torque meter, Inductive torque meter, Magneto-strictive transducers, torsion bar dynamometer

Unit 5: Principles of Analog and Digital Signal conditioning **(06)**
Introduction, signal level and bias changes, linearization, conversation faltering and impedance matching, concept of loading, divider circuits, bridge circuits, lead compensation, RC filters (low pass, high pass), Readout/ meter. Converters, Readout/display

Unit 6: Design of Signal conditioning circuit **(07)**
Thermocouple, RTD, Thermistor, load cell, potentiometric sensors, capacitive level sensor, LVDT, Optical Sensors (LDR, photodiode, photo transistor, photo cell).

Text Books:

1. Rangan, Sarma, Mani, 'Instrumentation Devices and Systems' Tata McGraw-Hill, Second Edition.
2. D.V.S. Murthi, "Instrumentation and Measurement Principles", PHI, New Delhi, Second ed. 2003.
3. B. C. Nakra and K. K. Choudhari, "Instrumentation Measurements and Analysis" by, Tata McGraw Hill Education, Second ed., 2004.
4. A.K. Sawhney, "Electrical & Electronic Instruments & Measurement", Dhanpat Rai and Sons,
5. Eleventh ed., 20005 D. Patranabis, 'Principles of Industrial Instrumentation', Tata McGraw-Hill-second edition 1999.
6. C. D. Johnson, 'Process Control Technology' PHI-Seventh Edition.
7. Art of electronic book for signal condoning by harwitz

Reference Books:

1. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, 'Mechanical Measurements',
2. International Student edition, Addison- Wesley- 5thEd.
3. D. Patranabis, 'Principles of Industrial Instrumentation', Tata McGraw-Hill- 1986.
4. B.G. Liptak, "Process Measurement & Analysis", Chilton Book Company, Third ed., 1995.
5. E.O. Doebelin, 'Measurement Systems Application and Design', McGraw Hill, 4th Edition, 1990.

List of Tutorials:

1. Construction and working of speedometer
2. Study of digital dial gauge & digital micrometer
3. Study of Anemometer
4. Study of 3 axis MEMS accelerometer
5. Spring balance as a overload alarm
6. Study of optical source detector
7. Measurement of temperature using LM35
8. Measurement of temperature using thermocouple

IN 2202: Electronic Instrumentation and System Design

Teaching Scheme
Lecture: 3 Hr/week
Tutorial: 1 Hr/week

Examination Scheme
In Semester: 50 marks
End Semester: 50 marks
Credit: 4

Prerequisite:
1. Concepts covered in Basic Instrumentation subject
2. Concepts covered in Linear Integrated Circuits subject

Course Objectives:
1. To provide an overview and understand the internal structure of various laboratory measuring Instruments and Signal Conversion techniques.
2. To teach the theory of different types ADCs and DACs.
3. To introduce the theory and applications of various special purpose ICs.
4. To teach the various grounding shielding techniques and ESD, EMI/EMC effects.
5. To introduce the concept of reliability.
6. To understand concepts related to PCBs – their types, design considerations, soldering techniques.

Course Outcome: The student will be able to
1. analyze the operation and describe working of different types of measuring instruments.
2. select suitable ADC and/or DAC for given application.
3. apply the knowledge of special purpose ICs for real time problems.
4. design own PCBs and solder the circuits

Unit 1: ADCs and DACs **(07)**
Sampling Theorem, Sample and Hold Circuit, ADC types like Flash, Counter, SAR and Dual-Slope, ADC Specifications, ADC Numerical, DAC types like Weighted-Resistor and R-2R ladder, DAC Specifications, DAC Numerical, Study of CD4051 and ICM7107

Unit 2: Measuring Instruments **(05)**
RMS concept and True RMS Meter, DVM and Automation in DVM – auto ranging, auto zeroing and auto polarity, Digital LCR-Q Meter, Concept of frequency measurement and Universal Counter and Its Mode like Frequency, Totalizing, Period, Time Interval, Ratio, Measurement Errors in counter.

Unit 3: Generators and Signal Analyzers **(05)**
Types of Frequency synthesis, Direct Digital Synthesis, Arbitrary Waveform Generator, Study of IC8038
Signal Analyzers - Distortion Analyzer, Spectrum Analyzers, FFT Analyzer

Unit 4: Guidelines for enclosure, components and accessories **(05)**
Grounding and shielding techniques, EMI and EMC, Source of EMI, Protection against EMI, EMI and EMC effects minimization methods, ESD, Protection against ESD

Unit 5: Special Application ICs **(08)**
Instrumentation amplifier AD620, Linear opto isolator IL300, V to I converters XTR110, Signal conditioners AD594/595, Phase Locked Loop CD4046, Programmable counter

ICM7217, Optoisolator MCT2E, Power drivers ULN2803

Unit 6: PCBs and Reliability **(06)**

Printed circuit board - Design rules for analog and digital circuit PCB's, Single, Double, Multi layer and SMD boards, Soldering materials and techniques, need of flux and its characteristics Reliability - Definition, Distinction between Quality and Reliability, Availability, Maintainability, (MTBF, MTTF, MTTR) Life Cycle and Bathtub curve

Text Books:

1. Modern Electronic Instrumentation and Measurement Techniques by Helfrick and Cooper, PHI
2. Digital Instrumentation by A. J. Bowen
3. Electronic Instrumentation Handbook by Coombs.
4. Electronic Instrumentation by Oliver Cage, McGraw Hill.
5. Electronic Instruments and Instrumentation Technology by Anand M. M. S., PHI
6. Electrostatic Discharge and Electronic Equipment, Warren Boxleitner IEEE press.
7. Printed Circuit Boards, Walter C. Bosshart, CEDT series, TMH.
8. Reliability Engineering,.E. Baiguruswamy.
9. Data manual for analog and digital ICs

References:

1. Electrical and Electronic Measurements and Instrumentation by David A. Bell, Prentice Hall of India.
2. Electrical and Electronics Measurement and Instrumentation by A.K. Sawhney, Dhanpat Rai & Co.
3. Electronic Instrumentation by J. J. Carr.
4. Electronic Instrumentation by H. S. Kalsi, McGraw Hill.
5. Noise Reduction Techniques, Ott.

List of tutorials:

1. Study of IC0809 in detail – pin details, internal schematic, working
2. Study of IC0808 in detail – pin details, internal schematic, working
3. Study of RMS meter – internal schematic, features
4. Study of Universal Counter - internal schematic, various modes
5. Study of IC8038 in detail – pin details, internal schematic, working
6. Study of Distortion meter – internal schematic, features
7. Study of MCT2E and ULN2803 – application for driving different types of loads
8. Study of IL300 – typical application circuit
9. Study of CD4046 as frequency multiplier
10. Study of XTR110 as 0A to 10A output voltage to current converter

IN 2203: Analytical Instrumentation

Teaching Scheme
Lecture: 3 Hr/week

Examination Scheme
In Semester: 50 marks
End Semester: 50 marks
Credit: 3

Prerequisite:
Basics of Optics and sensors

Course Objectives:
1. To understand laws of photometry
2. To interpret instrumentation required for all types of spectroscopy
3. To learn separation methods such as chromatography and mass spectroscopy
4. To apply various principles for analysing different samples using suitable analytical technique

Course Outcome: The student will be able to
1. familiarize with the working of different analyzers
2. justify the use of analytical instruments in various applications
3. explain working of all types of spectrometers which is based on law of photometry
4. summarize and classify capabilities and limitations of analytical instruments

Unit 1: Overview and Introduction **(06)**
Introduction to Analytical methods and its classification, electromagnetic spectrum
Basics of spectroscopy: Laws of Photometry, components of optical systems (source, wavelength selector, detectors, signal processor, readout device), single beam and double beam Instrument

Unit 2: Molecular Spectroscopy **(08)**
Electronic transition: UV-Visible spectroscopy, Fluorimeters and Phosphorimeters
Nuclear transition: Nuclear Magnetic Resonance (NMR) spectrometry
Vibratinal transition: IR spectroscopy

Unit 3: Atomic Spectroscopy **(06)**
Atomic absorption spectroscopy: Principle, Hollow cathode source, Types, working, Background correction methods
Atomic emission spectroscopy: Principle, Sources (AC & DC Arc Excitation, Plasma Excitation), Types, working and Flame photometer

Unit 4: Separative Methods **(06)**
Components of mass spectrometry, Mass analyser types, Quantitative analysis of mixtures
Chromatography: Fundamental of chromatographic separation, Gas chromatography, High Performance Liquid Chromatography

Unit 5: Gas analyzers **(05)**
Oxygen analyzer, carbon dioxide analyzer, Hydrocarbon Analyzers

Unit 6: Radio chemical Instrumentation **(05)**
X-ray spectrometry: X-ray Diffractometer, Bragg's law, Instrumentation for X-ray spectrometry
Radiation detectors: Ionisation chamber, Geiger-Muller counter, proportional counter, scintillation counters

Text Books:

1. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, CBS Publishers. & Distributors, New Delhi, 7th ed.
2. Skoog, Holler, Nieman, Thomson Principles of Instrumental Analysis, Books-cole Publications, 5th ed.

Reference Books:

1. Khandpur R. S., Handbook of Analytical Instruments, Tata McGraw–Hill Publications, 3rd ed.
2. Ewing Galen W., Instrumental Methods of Chemical Analysis, McGraw-Hill Book Company, 5th ed.
3. Braun Robert D., Introduction to Instrumental Analysis, McGraw-Hill Book Company.
4. Sherman R.E., Analytical Instrumentation, ISA Publication

IN 2204: Control Systems I

Teaching Scheme
Lecture: 3 Hr/week
Tutorials: 1 Hr/week

Examination Scheme
In Semester: 50 marks
End Semester: 50 marks
Credit: 4

Prerequisite:
Basics of Laplace transform Linear algebra and complex number

Course Objectives:
1. Understand the basic components of control system, types of control systems.
2. Learn the developing relationship between system input and output.
3. To learn to develop system's mathematical models.
4. To understand the basic mathematical tools for analysis of the control systems.

Course Outcome: The student will be able to
1. classify and represent the various physical systems using differential equations.
2. develop mathematical models of control systems.
3. analyze the system in time and frequency domain.
4. compare classical control system with modern control systems.

Unit 1: Introduction to Control Systems **(06)**
Introduction, brief classification of control systems: Representation of: Electrical, mechanical, electromechanical, thermal, pneumatic, hydraulic systems, with differential equations, Concept of transfer function and state space representation. Advantages of state space representation over classical representation, Terminology of state space (state, state variables, state equations, state space).

Unit 2: Transfer function, block diagram algebra and signal flow graph **(07)**
Representation of transfer function of electrical, mechanical with force to voltage and force to current analogies, Block diagram algebra, Signal flow graph.

Unit 3: Time domain analysis of control systems **(07)**
Standard test signals, dynamic error constants. First order, second order systems and their response, Time domain specifications of first order and second order control systems, static error constants (kp, kv, ka, ess).

Unit 4: Stability Analysis **(06)**
Concept of Stability in *s* domain, Classification of Stability (BIBO stability and asymptotic stability), stability analysis by Hurwitz criterion and Routh array, concept of relative stability and its analysis using Routh array.

Unit 5: Root locus **(06)**
Definition, Evan's conditions for magnitude and angle, construction rules, determination of system gain at any point on root locus (from magnitude condition and by graphical method), Root locus of systems with dead time: Concept, approximation of dead time and construction rules.

Unit 6: Frequency Domain Analysis and Introduction to state space representation **(07)**
Bode plot, with and without dead time, determination of transfer function from asymptotic Bode plot, Polar plot, Nyquist plot
Representation of state models: direct (companion I and II *i.e.* controllable canonical and

observable canonical forms), parallel and cascade decomposition.

Text Books:

1. I. J. Nagrath, M. Gopal, "Control System Engineering", 6th Edition, New Age International Publishers.
2. B. S. Manke, "Linear Control Systems", Khanna Publishers, New Delhi.
3. A. K. Jairath, "Problems and Solutions of Control Systems", CBS Publishes, New Delhi.

Reference Books:

1. K. Ogata, "Modern Control Engineering", PHI, New Delhi.
2. Norman S. Nise, "Control System Engineering", John Wiley and Sons.
3. B. C. Kuo, "Automatic Control Systems", PHI, New Delhi

List of Tutorials:

1. Introduction to computational software (MATLAB).
2. Introduction to Basic MATLAB commands and functions.
3. Introduction to Control system toolbox.
4. Study of standard test signals.
5. Analysis of time domain specifications using MATLAB.
6. Analysis of stability using root locus approach
7. Analysis of stability in frequency domain (Bode plot)
8. Analysis of stability in frequency domain (Nyquist plot)
9. Conversion of SS to TF and TF to SS.

IN 2205: Sensors and Transducer II Lab

Teaching Scheme
Practical: 2 Hr/week

Examination Scheme
Practical: 25 marks
Credit: 1

Course Outcomes: The student will be able to
1. Select instruments required for characterization of given sensors.
2. Setup an experiment to compute characteristics of sensors and transducers.
3. Design signal condoning circuit for different application.
4. Implement and test the designed signal condoning circuit.

List of Experiments:
1. Design and implementation of signal conditioning for RTD
2. Measurement of Displacement using L.V.D.T. and testing of its performance characteristics.
3. Measurement of Displacement using Linear and Rotary Encoders and compare their resolutions.
4. Measurement of unknown weight using load cell and computing its hysteresis.
5. Design and implementation of weighing machine using load cell.
6. Design and implementation of liquid level indicator using electromechanical system
7. Design and implementation of liquid level indicator using capacitive transducer.
8. Design and implementation of through beam / reflected beam type optical proximity switch.
9. Angular speed measurement using optical Encoder and plot its characteristics.
10. Motor Speed measurement using contact and non-contact type tachometers and calculate error.
11. To measure vibration of a platform using piezoelectric type Vibrometer and calculate maximum amplitude of vibration.
12. Measurement of acceleration using Piezoelectric accelerometer and study its response.

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IN 2206: Electronic Instrumentation and System Design Lab

Teaching Scheme
Practical: 2 Hr/week

Examination Scheme
Practical: 25 marks
Credit: 1

Course Outcomes: The student will be able to
1. design electronic circuits for given application.
2. use various electronic instruments for measurement and analysis.
3. design of given problem using suitable application ICs.
4. apply the knowledge of the various electronic instruments and application ICs to real time problem.

List of Experiments:
1. Implement ADC IC 0808 along with IC4051 and analyse its characteristics.
2. Implement DAC IC 0808 and analyse its characteristics.
3. Check the performance of True RMS meter and multi meter for various waveforms.
4. Study and verify different modes of Universal Counter.
5. Design and implement signal generator using IC8038.
6. Measure distortion of various signals using Distortion Meter
7. Implement optoisolator MCT2E and ULN2803 for driving different loads.
8. Verify output of optocoupler IL300 for unipolar and bipolar inputs.
9. Design and implement PLL CD4046 for given application.
10. Study of XTR110

IN 2208: Analytical Instrumentation Lab

Teaching Scheme
Practical: 2 Hr/week

Examination Scheme
In Semester: 25 marks
Credit: 1

Course Outcomes: The student will be able to
1. analyze working of different types of spectroscopic instruments.
2. co-relate various principles of spectroscopy with working of the analytical instruments.
3. identify, formulate and solve a real world problem based on different types of spectroscopy.
4. critique spectroscopy and perform simple analytical procedures on a given sample using colorimeter and UV-Visible spectrophotometer.

List of Experiments:
1. Analysis by using Photoelectric colorimeter
2. Analysis by using Densitometer
3. Study of Signal beam spectrometer
4. Analysis by using Double beam spectrometer
5. Analysis by using Flame photometer
6. Analysis by using Spectrofluorometer
7. Study of NMR Spectroscopy
8. Study of Atomic Absorption spectroscopy
9. Study of Gas Chromatography
10. Study of High Performance Liquid Chromatography

IN 2209: Lab practice I

Teaching Scheme
Practical: 2 Hr/Week

Examination Scheme
In Semester: 25 marks
Credit: 1

Course Outcomes: The student will be able to
1. apply Kirchhoff's Law and Node and Mesh Analysis to circuits.
2. apply Thevenin Theorem and Superposition Theorem to circuits to measure lectrical parameters.
3. record and analyze physiological parameters.
4. analyze the characteristics of power electronics components and Implement the speed control methods for Motors.

List of Experiments:
1. Circuit solving using Kirchhoff's law
2. Network Analysis using Mesh current and Node voltage Method
3. Network Analysis using Superposition Theorem
4. Network analysis using Thevenin Theorem.
5. Study of Homeostasis for Blood sugar level, Temperature and Water level.
6. Anatomy of heart and its functioning- Explain concept of heart rate, arrhythmia, tachycardia and
7. bradycardia.
8. Measurement of blood pressure using Sphygmomanometer.
9. Study the characteristics and applications of SCR and UJT
10. Speed and direction control of DC motor
11. Speed and direction control of stepper motor.
12. Application of ICM7217
13. Application of MM7107

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