Course Scheme for Undergraduate (Minor) Programme

In

Instrumentation & Control Engineering

Department of Electrical & Instrumentation

Engineering

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List of courses for B.E (Minor) Program in Instrumentation and Control Engineering

Semester- IV							
S No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Hrs**	**Credits**
1	MDIE-521	Transducers and Signal Conditioning	3	1	0	4	4
Semester-V							
S No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Hrs**	**Credits**
1	MDIE-611	Data Acquisition System	3	1	0	4	4
Semester-VI							
S No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Hrs**	**Credits**
1	MDIE-621	Control System	3	1	0	4	4
Semester-VII							
S No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Hrs**	**Credits**
1	MDIE-711	Industrial Measurements	3	1	0	4	4
Semester-VIII							
S No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Hrs**	**Credits**
1	MDIE-721	Industrial Automation	3	1	0	4	4

SYLLABUS

Bachelor (Minor)
of
Instrumentation and Control Engineering

Subject Code: **MDIE-521**
Title of the course: **Transducers and Signal Conditioning**

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students will be able to

CO1: illustrate the working of measurement systems using the model of input-output configuration.

CO2: summarize the various sensors and transducers by understanding their principle, construction, and accuracy.

CO3: compare resistive, capacitive, and inductive type transducers based on the various parameters, such as construction, power requirement, accuracy etc.

CO4: apply the knowledge of operational amplifiers to design the signal conditioning circuits for sensors.

CO5: explain the role of signal converters, like radiometric, logarithmic, voltage to current and frequency to voltage with sensors and transducers.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL4	BL3	BL2

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	**Programme Outcomes (POs)/ Program Specific Outcomes (PSO)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO2	3	2	2	1	-	2	2	1	1	1	2	2	2	1
CO3	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO4	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO5	3	1	2	-	1	2	2	2	2	1	2	3	2	-

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction**: Basic block diagram of generalized instrumentation system, general input- output configuration, definition of transducer, classification of transducers.	04
	Resistive transducers: Potentiometers, metal and semiconductor strain gauges, strain gauge applications, load and torque measurement, digital displacement sensors, Resistance Temperature Detectors (RTDs), Thermistors, Thermocouples	12
	Inductive and Capacitive Transducers: Measurement of self and mutual inductance, Linear Variable Differential Transformer (LVDT), Variable reluctance transducers, capacitive transducers: frequency response, advantages and disadvantages and uses of capacitive transducers Capacitance pick up, Condenser microphones, Differential capacitor pick up.	08
Unit-2	**Miscellaneous measurements**: Seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, magnetostrictive transducer, optic sensors, eddy current transducers, proximity sensors, tacho-generators and stroboscope.	08
	Introduction to signal conditioning: Concept of signal conditioning, Op-amp circuits used in instrumentation, summer, buffer, integrator, differentiator, instrumentation amplifiers, analogue-digital sampling, signal filtering, averaging	08
	Signal Converters: Radiometric converters, logarithmic converters, Voltage Controlled Oscilloscope (VCO), Phase Locked Loops (PLL), voltage to frequency	08

	converter, frequency to voltage converter, voltage to current converter, and current to voltage converter.	

Recommended Books-

1. A.K. Sawhney and Puneet Sawhney, "A course on electrical and electronic measurements and Instrumentation", Dhanpat Rai, 2012.
2. David A Bell, "Electronic Instrumentation and measurement", 3rd edition, Oxford University Press.
3. J.B Gupta, "A Course in Electronic and Electrical Measurements & Instrumentation", S K Kataria and Sons.
4. S.M Sze, "Semiconductors sensors", John Wiley & Sons Inc., 3rd Edition, 2006.
5. Patranabis, "Sensors and Transducers", Prentice Hall, 2nd Edition, 2003.
6. H. S. Kalsi, "Electronic Instrumentation", Tata McGraw Hill, 2006.
7. Joseph J Carr, "Elements of electronic instrumentation and measurement", Pearson Education, 2005.

Subject Code: **MDIE-611**
Title of the course: **Data Acquisition System**

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: analyze various data acquisition systems, their components, and applications.

CO2: learn methods of data transmission, transmission channels and different type of modulation.

CO3: describe construction and working principle of digital to analog and analog to digital converters.

CO4: acquire knowledge of block diagram, classification, working principle of different telemetry system.

CO5: know about the satellite and fiber optic telemetry system.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL4	BL3	BL2

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	3	2	2	3	3	3	3	3	1
CO2	3	2	2	2	2	3	2	2	3	3	2	2	3	1
CO3	3	2	2	3	3	3	2	1	2	2	2	2	3	2
CO4	3	1	2	2	3	2	2	2	1	3	2	1	3	2
CO5	3	2	2	2	2	2	3	2	2	3	2	1	3	2

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Data acquisition systems (DAS):** Block diagram of data acquisition system, analog and digital acquisition systems, single channel data acquisition, multi-channel DAS, computer-based DAS, data logger, applications of DAS.	04
	Data transmission system : : Methods of data transmission, transmission channels and media, analog modulation and demodulation, amplitude, frequency and phase modulation and their circuits, comparison between frequency & amplitude, introduction to ASK, FSK,PSK, pulse modulation (PAM, PDM, PPM, PCM), delta modulation, adaptive data modulation, frequency division and time division multiplexing, time division multiplexing using mechanical commutator and electronic , time division multiplexing system.	12
	Error Detection and Correction: digital data codes: half binary and full binary transmission, return to zero and non-return type, unipolar and bipolar type, error detecting codes and error correction codes, pulse code formats used in data transmission	08
	A/D and D/A converters: Digital to Analog(D/A) converters, R-2R and binary weighted type D/A and Analog to Digital (A/D) converters, flash type, successive approximation type, dual slope type and counting converter type A/D.	06
	Transmitters and Receivers: AM Transmitters-Low level and High level transmitters, AM Receivers, TRF receiver and super-hetrodyne receiver, FM Transmitters, FM Receivers, PCM transmitters and receiver	04

Unit-2	**Introduction to telemetry principles:** Definition, generalized block diagram of telemetry System, classification of telemetry system, working principle, salient features and applications of the following telemetry systems: dc voltage, current and position telemetry system, pulse telemetry system, force balance telemetry system	08
	Satellite telemetry system : Introduction**, t**ypes of transmission**,** DMA, CDMA, TDMA	03
	Fiber optic telemetry system: Introduction to fiber optics and signal transmission through optical fiber, WDM (wavelength division multiplexing),Coarse and dense WDM	03

Recommended Books-

1. A K Sawhney, "Electrical and Electronic Measurement and Instrumentation", Dhanpat Rai, 2016.
2. D Patranabis, "Telemetry Principles", Tata McGraw Hill., 1999.
3. E L Gruenberg, "Handbook of Telemetry & Remote Control", Tata McGraw Hill, digitized 2007.
4. H S Kalsi, "Electronic Instrumentation and Measurement",4th edition, Tata McGraw Hill, 2019.
5. F Carden, R Henry and R Jedlica, "Telemetry system Engineering", 2nd edition, Artech House, 2002.
6. R N Baral, "Telemetry and Data Transmission", S K Kataria and Sons, 2012

Subject Code: **MDIE-621**
Title of the course: **Control System**

L	T	P	Credits	Weekly Load
3	**1**	**0**	**4**	**4**

Course Outcomes:
After successful completion of course, the students should be able to
CO1: explain the working mathematical model of a system.
CO2: distinguish the time-domain and frequency-domain analyses of the system.
CO3: design the specifications of the control systems.
CO4: obtain the state space analysis of the system.
CO5: analyze the stability analysis of non-linear systems.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL6	BL3	BL2

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	**Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	2	3	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	1	2	-	-	1	-	2	1	1	2	2
CO5	2	2	3	1	3	-	1	1	2	2	3	2	3	2

Unit	**Main Topics and Course Outline**	**Hour(s)**
Unit-1	**Mathematical Modelling:** Mathematical modelling of electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula, linearity, time-invariance versus nonlinearity and time-variance.	08
	Time Response of dynamical systems: Obtaining solutions from mathematical models. Poles and zeros and their effects on solutions, test-input signals, Step response of first and second order systems, time- domain specifications and their formulae.	08
	Control Actions: Study of process characteristics; controller operating models, on-off, proportional, integral, derivative, proportional-integral, proportional-derivative, proportional integral-derivative, relative merits of the above control modes, suitability of various control actions for different application, controller tunning, performance criterion.	08
Unit -2	**Stability Analysis:** Definition of stability, Routh-Hurwitz test, construction of Root Loci, root-locus plots, positive feedback systems, conditionally stable systems, root loci for systems with transport lag.	10
	Frequency domain Analysis: Bode plot, gain and phase margins, introduction to compensator design.	06
	State variable Analysis: Concepts of state variables, state space model, diagonalization of state matrix, solution of state equations, eigen values and stability analysis, concept of controllability and observability.	08

Recommended Books –

1. N.S. Nise, "Nise's Control System Engineering", Wiley India Ed, 2018.
2. B C Kuo, “Automatic Control System”, 9th edition, Wiley, 2014.
3. J J Distefano, A R Stuberud and I J Williams, “Schaum’s Outlines of Theory and Problems of Feedback and Control Systems”, 2nd edition, Tata McGraw Hill, 2007.
4. I J Nagrath and M Gopal, “Control System Engineering”, 6th edition, New Age International Publishers, 2017.
5. K Ogata, “Modern Control Engineering”, 5th edition, Pearson Education India, 2015.
6. R C Dorf and RH Bishop, “Modern Control System”, 12th edition, Pearson Education India, 2013.

Subject Code: **MDIE-711**
Title of the course: **Industrial Measurements**

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: describe the method of measurement of various parameters like temperature, level etc. that has scope in industries.

CO2: identify the different instruments for measurement of temperature, level, pressure etc. and their application in industries.

CO3: illustrate the construction and working of various measuring instruments used in industries.

CO4: summarize the calibration of various industrial instruments and use of instruments for other parameter measurements like force, torque, viscosity, humidity etc.

CO5: conclude the importance of measuring instruments and their calibration in industries.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL3	BL2	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO2	3	2	2	1	2	3	1	2	2	-	2	3	1	1
CO3	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO4	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO5	3	2	2	1	-	2	-	2	1	1	1	2	2	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Temperature measurement:** Introduction to temperature measurements, principle of vapor, gas, liquid filled thermometers, bimetallic thermometer, pressure spring thermometer, Thermocouple, Resistance Temperature Detector, Thermistor, and its measuring circuits, Radiation pyrometers and digital thermometry.	08
	Level measurement: Introduction, Differential pressure level detectors, Capacitance level sensor, Ultrasonic level detectors, Gamma rays level measurement, level limit switches, level measurement of closed vessel.	08
	Force, torque, and shaft power: Basic methods of force measurement; characteristics of elastic force transducer-Bonded strain gauge, differential transformer, Piezo electric transducer, variable reluctance/FM-oscillator, digital systems. Loading effects; Torque measurement on rotating shafts, shaft power measurement, (dynamometers).	08
Unit- 2	**Pressure measurement:** Introduction, definition, and units, Mechanical, Electro-mechanical pressure measuring instruments. Low pressure measurement, Transmitter definition and types, I/P and P/I Converters.	10
	Flow measurement: Introduction, definition and units, classification of flow meters, differential pressure and variable area flow meters, Differential pressure meter(primary elements)- theory, construction and applications of orifice plate, venturi meter, flow nozzle, pitot tube Positive displacement flow meters, Electro Magnetic flow meters.	10

	Miscellaneous measurement: Measurement of Viscosity, pH, Density Humidity, Moisture, Specific gravity, and Conductivity.	04

Recommended Books-

1. Ernest. O. Doebelin and Dhanesh. N. Manik, Doebelin‟s Measurement Systems, McGraw Hill Education, 6th Edition, 2011.
2. B. G. Liptak, “Process Measurement and Analysis”, CRC Press, 4th Edition, 2003.
3. Patranabis D, “Principles of Industrial Instrumentation”, Tata McGraw Hill, 3rd Edition, 2010.
4. B. E. Noltingk, “Instrumentation Reference Book”, Butterworth Heinemann, 2nd Edition, 1995.
5. Douglas M. Considine, “Process / Industrial Instruments & Controls Handbook”, McGraw Hill, Singapore, 5th Edition, 1999.
6. Andrew W.G, “Applied Instrumentation in Process Industries – A survey”, Vol I &Vol II, Gulf Publishing Company, Houston, 2001
7. Spitzer D. W., “Industrial Flow measurement”, ISA press, 3rd Edition, 2005.
8. Tony R. Kuphaldt, “Lessons in Industrial Instrumentation”, Version 2.02, April 2014.

Subject Code: **MDIE-721**
Title of the course: **Industrial Automation**

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1**: omit** the knowledge of process automation techniques.
CO2: develop PLC ladder programming for simple process applications.
CO3: **compare** distributed control system and different communication protocols.
CO4: analyze SCADA system, its hardware and software interfacing and applications.
CO5: **design** cloud-based process applications.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL6	BL2	BL4	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	**Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	2	3	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	1	2	1	-	1	-	2	1	1	2	2
CO5	2	2	3	1	3	1	1	1	2	2	3	2	3	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Introduction and overview of Industrial automation, automation strategy, role of automation in industries, introduction to descriptive automation tools PLC, DCS, SCADA, Hybrid DCS/PLC, automation strategy evolution, control system audit, and performance criteria	06
	Hierarchical computer control system stand- alone and PC based data acquisition, analog and digital signal conditioning, data loggers, supervisory control, computer based, controllers, direct digital control.	05
	Programmable Logic Controller (PLC): Block diagram of PLC, different types of PLC, Type of input and output, Introduction to relay logic, Application of PLC.	08
	Introduction to Ladder logic programming: Basic instructions, Timer and Counter instruction- Arithmetic and logical instruction, communication instruction, I/O and Interrupt instructions - Case studies and examples for each instruction set.	05
Unit-2	**Distributed control systems (DCS):** Introduction to DCS, PLC versus DCS, Block diagram and function of each component, control room for DCS, the control console equipment, engineering station interface, communication requirements, programming, functions including database management, reporting, alarm management, communication, third party interface, control, display, enhanced functions viz. advance process control, batch application, historical data management, OPC supports, security and access control.	08
	DCS Applications: Power plant, Iron plant, Steel plant, Cement plant, Fertilizer plant and Food industries.	04

	Introduction to Supervisory Control and Data Acquisition (SCADA) system: Definition, elements: hardware and software, communication, applications of IoT based SCADA systems.	06
	Communication systems: MAP/TOP protocol, types of bus: Field Bus, Rack Bus, PROFIBUS, FIPBUS, Comparison of buses, HART protocol its frame structure, programming, real-time implementation, advantages and limitation.	06

Recommended Books-

1. Curtis D. Johnson, "Process Control Instrumentation Technology", Prentice Hall, New Delhi, 8th Edition, 2005.
2. John W. Webb and Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, 5th Edition, 2002.
3. Lukcas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
4. Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill, New York, 4th Edition, 2010.
5. Deshpande P.B and Ash R.H, "Elements of Process Control Applications", ISA Press, New York, 1995.
6. Krishna Kant, "Computer-based Industrial Control", Prentice Hall, New Delhi, 2nd Edition, 2011.
7. Gary, Dunning, "Introduction to PLCs", Tata McGraw Hill, 2005