

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

INSTRUMENTATION DRAWING (Code: 3331706)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	3 rd semester

1. RATIONALE

For an Instrumentation and control diploma engineer, it is important to interpret relevant circuit diagrams with the symbols, draw circuit diagrams and identify the various components relevant to process and instrumentation. These drawings could be of process and instrumentation diagram, process flow sheets, instrument location plan and such others. Ability to document as per international codes and practices (ISA, IEEE, NEMA) is also an essential skill required by IC engineer. This course will therefore help the students to develop the skills to draw and interpret requisite process instrumentation loop diagrams (using knowledge of relevant symbols and standard conventions) and to document records properly.

2. COMPETENCY ('Programme Outcome' according to NBA Terminology)

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Draw requisite process instrumentation loop diagrams using standard symbols and conventions.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	100
0	0	4	4	0	0	40	60	

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

4. COURSE DETAILS

Unit	Major Practical Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Process Flow Sheet Symbol	1a Identify the symbols 1b Draw the symbols 1c Label the symbols	1.1 Process line symbols 1.2 Symbols of valves (gate , globe, needle, ball valve, vee, three way, four way, angle, plug, check, butterfly valve) 1.3 Symbols of actuator with and without positioner or other pilot. 1.4 Furnace and boiler symbols(“A” Frame, Box type, single coil Radiant type, Vertical, Boiler fired or waste heat) 1.5 Heat transfer symbols (Water cooled exchanger, Water cooled condenser, Shell and tube exchanger, Cooling tower, kettle – thermo siphon type Re-boiler , Super heater and re heater, Barometric condenser) 1.6 Pump and compressor(centrifugal, reciprocating, rotary, proportioning, lower or fan centrifugal) 1.7 Drivers(Motor, engine, turbine and steam piston) 1.8 Process pressure vessels (Horizontal, vertical, jacketed) 1.9 Dryers (Batch, Spray, Desiccant, rotary drum dryer or kiln) 1.10 Material handling equipments(Air lift, belt or shaker, Bucket or flight conveyor, screw conveyor, roller conveyor, feeder and hopper , rotary feeder) 1.11 Size reducing equipments(Ball mill, Grinder, Roller crusher, screener) 1.12 Process Equipment(Mixer, Settlers, autoclave, Kettle jacketed, rotary film dryer or floker, Jet mixer) 1.13 Separator (centrifuge, cyclone, electrical precipitator, drum settler, open settling tank, rotary vacuum filter, atmospheric tank, floating roof tank, pressure storage tank, cone bottom bin, open top-closed top bulk storage)
Unit – II Flow Sheet and Line Symbols	2a Identify the symbols 2b Draw the symbols 2c Label the symbols 2d Define letter identification	2.1 Flow sheet code letter service (letter A to letter V) 2.2 Symbol for Lines (Main process line, secondary process line, instrument air signal line, electrical leads, instrument capillary)

Unit	Major Practical Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
		<p>tubing, Battery limits, Existing lines, Vehicle or hand truck route , package unit by vendor, screwed cap, weld cap, blind flange, insulated line, hose connection , flexible hose connection , Removable pipe spool, steam trace line, steam jacketed line)</p> <p>2.3 Utility symbols(duct, swage, spectacle blind, hammer blind, expansion joint, open drain to sewer, damper, utility rack, safety shower 'S' and eye wash'E', sample funnel, drain to sewer, steam trap – intermittent, steam trap-continuous</p> <p>2.4 Drainer, strainer, filter, mixer, twin basket filter, spray nozzle, suction Tee, ejector-eductor-injector and exhaustor, Horn, Air cleaner, steam separator, bootleg, seal legs, Hose reel, gage hatch, man-hole, flame arrester, diffuser, car sealed open-car sealed close-locked open-locked close, steam exhaust head winter type drain</p> <p>2.5 Process and utility flow sheet for drives(centrifugal pump-electrical drive, centrifugal pump turbine drive, reciprocating pump steam drive, reciprocating pump-electric drive, rotary pump electric drive, rotary pump turbine drive, tandem pumps, compressor – single type engine drive, blower electric type, electric turbine drive</p>
Unit – III Instrument Symbol and Identification	<p>3a Identify the symbols</p> <p>3b Draw the symbols</p> <p>3c Label the symbols</p> <p>3d Define letter identification</p>	<p>3.1 Instrument identification or tag number (6 letter code)</p> <p>3.2 Identification of letter (A to Z)</p> <p>3.3 Instrument line symbols(Instrument supply, undefined signal, Pneumatic signal , electric signal, hydraulic signal, capillary tube, guided – unguided EM or SONIC signal, internal system link, mechanical link, pneumatic and electric binary signal)</p> <p>3.4 Symbols of function designations for relays</p> <p>3.5 Symbols for primary location, field mounted, auxiliary location for discrete instruments, shared display and control, computer function and PLC</p> <p>3.6 Symbols for self actuated regulators, valves</p>

Unit	Major Practical Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
		and other devices for: Flow, Level, Pressure, Temperature, Traps, Multiple way valves, Primary element symbols (A to Z), Function symbols (A to Z)
Unit – IV Logic Function , PLC and Distributed Control Display Symbols	4a Identify the symbols 4b Draw the symbols as per ISA, NEMA standard 4c Label the symbols 4d Define letter identification	4.1 Logical function symbols <ol style="list-style-type: none"> i. Gates (AND , OR, NOT, NOR, NAND, EX-OR, EX-NOR, transmission gate, Gate isolated, Gate non isolated) ii. Transmission and Switching symbols(Flip-flop, single shot flip flop, level /schmett trigger flip flop, Amplifier , switching amplifier, signal converter) iii. Timer (Signal time delay, adjustable time delay, Time delay ON, Time delay OFF, time delay energizing, time delay de energizing) 4.2 Switching symbols for PLC <ol style="list-style-type: none"> i. Push buttons (single circuit normally ON , single circuit normally OFF, double circuit , Double circuit with mushroom head) ii. Foot switch (Normally open/OFF, Normally close/ON) iii. Limit switch (Normally open/OFF, Normally close/ON) iv. Process parameter switch(liquid level Normally open/OFF, liquid level Normally close/ON , Vacuum-pressure Normally open/OFF, Vacuum-pressure Normally close/ON, Temperature switch Normally open/OFF, Temperature switch Normally close/ON, Air-Water-gas etc. Flow Normally open/OFF, Air-Water-gas etc. Flow Normally close/ON) v. Output device(coil, motor, lamp, solenoid, optocoupler) 4.3 Distributed control / shared display symbols(As per ISA) <ol style="list-style-type: none"> i. Normally accessible to operator ii. Not Normally accessible to operator iii. Auxiliary operator's interface device 4.4 Distributed control Computer symbols <ol style="list-style-type: none"> i. Normally accessible to operator ii. Not normally accessible to operator

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		4.5 Distributed control logic/sequential Control symbols <ul style="list-style-type: none"> i. Normally accessible to operator ii. Not normally accessible to operator 4.6 Miscellaneous symbols <ul style="list-style-type: none"> i. Computing/signal conditioning ii. software system link
Unit – V Piping and Fluid Power Symbols	5a Identify the symbols 5b Draw the symbols flanged, screwed, welded, soldered 5c Label the symbols 5d Define letter identification	5.1 Piping symbols for Bushing, Cap, reducing cross, straight size cross, Cross over, 45° Elbow, 90° Elbow, long radius double branch, reducing double branch, Connecting pipe joint, Expansion pipe joint, Lateral, reducing flange, bull plug, pipe plug, sleeve, reducing tee, straight size tee, output up tee, output down tee, union, 5.2 Flow Obstruction symbols(orifice flange, Check angle valve, Gate (elevation) angle valve, Gate(plan) angle Valve, By-pass automatic valve, Governor operated automatic valve, reducing automatic valve, cock, float valve, diaphragm valve, motor operated gate valve, hose valve, safety valve 5.3 Fluid power symbols <ul style="list-style-type: none"> i. Line technique(Main line conductor, Pilot line, Exhaust/drain line, enclosure outline, line crossing at 90° line joining) ii. Flow direction of pneumatic, hydraulic iii. Rotating coupling, vented reservoir, pressurized reservoir, reservoir with connecting line for above fluid level, reservoir with connecting line for below fluid level, vented manifold, Accumulator, Spring loaded accumulator Gas charged accumulator, Air/Gas receiver, fluid conditioners iv. Heater, Cooler, Temperature controller, filter-strainer, manual drain separator, automatic drain separator, manual drain filter-separator, automatic drain filter-separator, chemical dryer, lubricator with less drain, Lubricator with manual drain v. Hydraulic and pneumatic Cylinders (single acting, single end rod double acting, double

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		<p>end rod double acting, fixed/adjustable/ non cushion double acting)</p> <ul style="list-style-type: none"> vi. Pressure intensifier, servo positioner, discrete positioner vii. Actuator and control: <ul style="list-style-type: none"> a. Contact type(Spring , Manual operated push button, lever, Pedal, mechanical, detent, pressure compensated) b. Electrical / hydraulic, pneumatic Motors and pumps(Uni-bi directional) c. Instruments(pressure /temperature / flow indicator-recorder) d. Sensing(Venturi, orifice plate, pitot tube, nozzle) e. Valve (two way ON-OFF Valve, two way pilot- operated to open check valve, two way pilot- operated to close check valve, two position normally open two way valves, two position normally close two way valves, infinite position normally open two way valves, infinite position normally close two way valves, two position normally open three way valves, two position normally close three way valves, two position normal four way valves, two position actuated four way valves, three position normal four way valves , three position right actuated four way valves, three position left actuated four way valves f. Pressure control valves(pressure relief valve, sequence valve, pressure reducing valve, pressure reducing and relieving valve, air line pressure regulator g. Flow control valves (adjustable, Adjustable with bypass, Adjustable and pressure compensated with bypass, temperature and pressure compensated adjustable)

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Not Applicable

6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course Outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies (Programme Outcomes). Following is the list of practical exercises for guidance.

Note: Here only course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercise (‘Course Outcomes’ in Psychomotor Domain according to NBA terminology)	Apprx. Hrs. Required
1	I	Sketch the process line symbols	2
2	I	Sketch the different valve symbols	2
3	I	Sketch the different heat transfer equipment symbols	2
4	I	Sketch the different process equipment symbols	2
5	II	Sketch the different flow sheet code letter service	2
6	II	Sketch the different Symbol for Lines	2
7	II	Sketch the different Utility symbols	2
8	II	Sketch the different process and utility flow sheet for drives symbols	2
9	III	Sketch the different instrument identification or tag number (6 letter code) schemes	1
10	III	Sketch the different identification of letter (A to Z)	2
11	III	Sketch the different instrument line symbols	2
12	III	Sketch the different symbols of function designations for relays	2
13	III	Sketch the different symbols for primary location, field mounted, auxiliary location for discrete instruments	2
14	III	Sketch the different symbols for self actuated regulators, valves and other devices for flow , level, pressure, temperature	2
15	III	Sketch the different symbols for self actuated regulators, valves and other devices for traps, multiple way valves	2
16	III	Sketch the different symbols for self actuated regulators, valves and other devices for primary element symbols(A to Z)	4
17	III	Sketch the different symbols for self actuated regulators, valves and other devices for function symbols(A to Z)	4
18	IV	Sketch the different Logical function symbols for different gates, transmission - switching , timers	2
19	IV	Sketch the different push buttons, foot, limit switches	1
20	IV	Sketch the different process parameter switches used for PLC	2
21	IV	Sketch the different graphical symbols used for distributed control system	2
22	V	Sketch the different graphical symbols for piping and joints	2

S. No.	Unit No.	Practical/Exercise (‘Course Outcomes’ in Psychomotor Domain according to NBA terminology)	Apprx. Hrs. Required
23	V	Sketch the different graphical symbols for flow obstruction	2
24	V	Sketch the different graphical symbols for fluid power transmission and storage	1
25	V	Sketch the different graphical symbols for hydraulic and pneumatic cylinders	2
26	V	Sketch the different graphical symbols for different electric, hydraulic and pneumatic motor and pumps	2
27	V	Sketch the different graphical symbols for sensing elements and 2,3,4 way valves	2
28	V	Sketch the different graphical symbols for pressure and flow control valves	2
Total			56

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- i. Study P & I diagram of given chemical process.
- ii. Study P & I diagram of given textile process.
- iii. Study P & I diagram of given automobile manufacturing.
- iv. Prepare chart for different categories of symbols.
- v. Study colour code for different zone/electric/piping fluid.

8. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Demonstration using Power Point Presentation
- ii. CBT based self learning session
- iii. Display of Industrial Drawings for Interpretation
- iv. Visit to Industry and correlating drawing with the actual systems
- v. Practical exercises both manually and on computer using different drawing software.
- vi. Mini project

9. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Books	Author	Publication
1	Applied Instrumentation in the process industries vol.3	W.G. Andrew/ H.B. Williams	Gulf publishing co. Kuwait 2012
2	DOE Fundamental handbook engineering symbology, prints and drawing	Department of energy	Department of energy USA 2012
3	Instrumentation and control system documentation	Frederick A. Meier and Clifford A. Meier	ISA USA year 2004 awarded best selling ISA book
4	Process control principles and applications	Bhanot Surekha	Oxford University Press year 2011

- B) List of Major Equipment/Materials with Broad Specifications**
- i. High end computers (22 No) with enhanced graphic card & 20 inch Display
 - ii. Media Projector -3000 lumens
 - iii. Electrical CAD software
 - iv. AutoCAD software
 - v. Chemskech software
 - vi. Three colour plotter
 - vii. Instrumentation component stencil
 - viii. Drawing tools.
- C) List of Software/Learning Websites**
- i. www.isa.org
 - ii. www.nema.org
 - iii. www.ieee.org
 - iv. www.ourinstrumentationgroup.com
 - v. www.chemsketch.en.malavida.com

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Mr. R. R. Manchiganti**, Head of IC Engineering Department, GPGandhianagar
- **Mr. A. K. Bilakhia**, Lecturer, IC Engineering Department, GP Gandhinagar
- **Mr. M. B. Vanara**, Lecturer, IC Engineering Department, GP Gandhinagar
- **Mrs. M. M. Shah**, Lecturer IC Engineering Department, GP Palanpur

Faculty Members from NITTTR Bhopal

- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.
- **Dr. Shashikant Gupta**, Professor and Coordinator for State of Gujarat. .