

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
Course Curriculum

**PROCESS APPLICATION AND INSTRUMENTATION MAINTENANCE
MANAGEMENT**

(Code: 3331705)

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

1. RATIONALE

In the present industrial scenario, it is desired that diploma engineering students should be able to identify, classify, troubleshoot and maintain the different Process Instrumentation systems. They are required to implement the planned Plant Process Instrumentation maintenance schedules. Therefore, this course has been designed so that students may learn to maintain the different types of Process Instrumentation Systems of Process Application.

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:
Maintain the different types of Process Instrumentation Systems of Process Application

3. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Total Credits | Examination Scheme | | | | |
|-----------------|---|---|---------------|--------------------|-----|-----------------|----|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | Total Marks |
| | | | ESE | PA | ESE | PA | | |
| 3 | 0 | 2 | 5 | 70 | 30 | 20 | 30 | 150 |

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 Learning Outcomes (‘Course Outcomes’ in Cognitive Domain according to NBA terminology) | Topics and Sub-topics |
|--|--|---|
| Unit – I Process Applications using Instrumentation | 1a. Classify the various types of processes. 1b. Compare the specific need of Maintenance in batch process and continuous process of them | 1.1 Types of Processes based on: 1.1.1 Period of operation of the process viz. Batch process , Continuous process 1.1.2 Type of Process: Unit operation /Unit Process/ Composite / Hybrid Processes |
| | 1c. State Maintenance requirement for various process industries and state hazards (if not maintained) | 1.2.1 For Food and Beverages industries(bottle filling plant-batch process) 1.2.2.For Thermal Power Plant(material feeding in boiler to turbine-continuous process) |
| Unit– II Instrumentation Maintenance Engineering Techniques | 2a. Classify and define the types of maintenance | 2.1 Time based Maintenance: a)Preventive (shift wise, daily, weekly, monthly, quarterly half yearly, yearly) b) Shutdown c) Break down 2.2 Event based Maintenance- a)Run to Failure or Reactive b)Event driven c) <i>Calendar based or Pre-planned or Routine</i> d)Statistical based e)Condition based f)Predictive Maintenance g)Reliability Centered Maintenance h)Financially Optimized Maintenance |

| | | |
|--|---|---|
| | <p>2b. Define terminology Related to Maintenance in Process industries.</p> | <p>2.3 List of terminology</p> <p>2.3.1 Autonomous Maintenance,</p> <p>2.3.2 Bill of Materials (BOM),</p> <p>2.3.3 Computerized Maintenance Management System (CMMS),</p> <p>2.3.4 Corrective Maintenance,</p> <p>2.3.5 Failure Mode and Effects Analysis (FMEA), Frequency of Inspection,</p> <p>2.3.6 Key performance Indicator (KPI),</p> <p>2.3.7 Life Cycle Cost (LCC),</p> <p>2.3.8 Maintenance,</p> <p>2.3.9 Maintenance Engineering</p> <p>2.3.10 Maintenance Management,</p> <p>2.3.11 Mean Down Time (MDT),</p> <p>2.3.12 Mean Time Between Failures (MTBF),</p> <p>2.3.13 Mean Time To Repair (MTTR),</p> <p>2.3.14 Purchase Order (PO),</p> <p>2.3.15 Root Cause Failure Analysis (RCFA), Scheduling ,</p> <p>2.3.16 Uptime,</p> <p>2.3.17 Work Order,</p> <p>2.3.18 Work Request</p> |
| <p>Unit–III Field, Utility and Safety Instrumentation Components Maintenance</p> | <p>3a. Test each type of Instruments.</p> <p>3b. Describe the calibration procedure for each type Of instruments.</p> <p>3c. Describe the maintenance procedure for each type Of instruments.</p> | <p>Types of Instruments in the process plants:</p> <p>3.1. Indicating instruments:</p> <p>3.1.1. Analog Temp. indicator</p> <p>3.2. Recorders:</p> <p>3.2.1 Circular Chart,</p> <p>3.2.2 Strip Chart</p> <p>3.3. Transmitters :</p> |

| | | |
|---|--|---|
| | | <p>3.3.1 Electronic Differential Pressure Transmitter</p> <p>3.3.2 Pneumatic Differential Pressure Transmitter</p> <p>3.4 Switches:</p> <p>3.4.1. Pressure Limit Switch</p> <p>3.4.2 Level Limit Switch</p> <p>3.5. Valves:</p> <p>3.5.1 Globe valve</p> |
| <p>Unit– IV</p> <p>Instrumentation Maintenance Hardware and Software</p> | <p>4a. Describe the application of each tools used for Maintaining Instruments.</p> <p>4b. Describe the procedure to maintain and calibrate the tools used for Maintaining Instruments</p> | <p>4.1 List of tools:</p> <p>4.1.1 Dead weight Tester</p> <p>4.1.2 Temp. Controlled Bath,</p> <p>4.1.3 Temp. Controlled Oven</p> <p>4.1.4 Assorted Pneumatic and Hydraulic tubing/ piping tools</p> <p>4.1.5 Pnematic Calibrator,</p> <p>4.1.6 Electronic Calibrator,</p> <p>4.1.7 Thermo Couple Calibrator.</p> <p>4.1.8 Digital Multimeters with True RMS,</p> <p>4.1.9 Soldering / Desoldering Station,</p> <p>4.1.10 Universal Calibrator</p> |
| <p>Unit – V</p> <p>Instrumentation maintenance reporting and management</p> | <p>5a. List and give various Types of reporting Formats with sample data Used in instrumentation Maintenance management System.</p> | <p>5.1. Reports:</p> <p>Instrument bin card,</p> <p>instrument log book,</p> <p>maintenance indent book</p> <p>(physical, human resource) instrument complaint book</p> |

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

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|----------|--|----------------|------------------------------|-----------|-----------|-----------|
| | | | R Level | U Level | A Level | Total |
| I | Process Applications using Instrumentation | 6 | 3 | 3 | 2 | 8 |
| II | Instrumentation Maintenance Engineering Techniques | 6 | 6 | 6 | 0 | 12 |
| III | Field Utility and Safety Instrumentation Components, Maintenance | 12 | 5 | 5 | 10 | 20 |
| IV | Instrumentation Maintenance Hardware and Software | 11 | 5 | 5 | 10 | 20 |
| V | Instrumentation maintenance reporting and management | 7 | 2 | 5 | 3 | 10 |
| | Total | 42 | 21 | 24 | 25 | 70 |

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

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) | Approx Hours Required |
|--------|----------|--|-----------------------|
| 1. | I | Identify the continuous process from a textile industry. | 02 |
| 2. | I | Identify the batch process from a textile industry . | 02 |
| 3. | I | Prepare a daily maintenance schedule for a given process. | 02 |
| 4. | I | Prepare a weekly maintenance schedule for a given process. | 02 |
| 5. | I | Prepare a monthly maintenance schedule for a given process. | 02 |
| 6. | I | Prepare a half-yearly maintenance schedule for a given process. | 02 |
| 7. | I | Prepare a yearly shut down maintenance schedule for a given process. | 02 |
| 8. | I | Maintain the indicating instruments for a given process. | 02 |
| 9. | II | Maintain the controlling instruments for a given process. | 02 |
| 10. | II | Maintain the recording instruments for a given process. | 02 |

| | | | |
|-----|--------------|--|-----------|
| | | | |
| 11. | III | Maintain the final control elements/instruments for a given process. | 02 |
| 12. | IV | Test the performance of the final control elements/instruments for a given process | 02 |
| 13. | V | Log the maintenance activity carried out for a given process. | 02 |
| 14. | V | Carry out maintainance activity with Antivirus / Authorization/ Password for a given computerized maintenance management software. | 02 |
| | Total | | 28 |

7. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Students may be given exercises based on various instrumentation devices and components to maintain related to above topics.
- ii. Students may be asked to collect photographs using internet which is relevant to field application of various topics and have to prepare learning materials using it.
- iii. Teachers guided self learning activities, Course/library/internet/lab based mini projects, industrial visit etc.
- iv. Students activities like: course/ topic based seminars, Internet based assignments.

8 SUGGESTED LEARNING RESOURCES

A) List of Books

| S.No. | Author | Title of Books | Publication/Year |
|-------|--|---|------------------------------|
| 1 | Id Goettsche. | Maintenance of Instruments and Systems,. | ISA 2nd Edition Id Goettsche |
| 2 | Lindley R. Higgins, R. Keith Mobley, Darrin Wikoff | Maintenance Engineering Handbook, Seventh Edition | |
| 3 | W G Andrew | Applied Instrumentation to Process Industries | Gulf Publication Vol 1 to 4 |
| 4 | Jones E. B. | Instrument Technology, | Hollywell Vol - I, II |
| 5 | H. S Kalsi | Electronic Instrumentation | TMH New Delhi 2010 |

B. List of Major Equipment/ Instrument with Broad Specifications**1) Instrument Maintenance Shop Tools**

- a) Dead weight tester / Comparison Gauge,
- b) Temp. Controlled Bath ,
- c) Temp. Controlled Oven ,
- d) Assorted Pneumatic and Hydraulic tubing/ piping tools ,
- e) Pneumatic Calibrator , Electronic Calibrator ,
- f) Thermo Couple Calibrator, Indicator puller,
- g) Impulse line bending and flaring tools, Allenkey set,
- h) Open and Ring fix Spanner set,
- i) Adjustable pipe wrench and Spanner,
- j) Screw Driver set,
- k) Digital Multimeters with True RMS 4 1/2 Digit ,
- l) Clip on meters ,
- m) Assorted Electrical Insulated Tools set ,
- n) Soldering / Desoldering Station,
- o) Drilling M/c ,
- p) Mini Compressor,
- q) Mechanical Vice ,
- r) Megger / insulation tester,
- s) Fibre Optic assorted tools – Splicer , Alignment tool , cutter , Splitting Tools, All assorted
- t) Magnetic tools,
- u) All maintenance Consumables viz , Isopropyl Alcohol, Silicon Oil, Sprays , CTC , Thermic
- v) Fluids , Silicon Grease, Graphite based Grease, Clove Oil, Chart recorder Inks – Red/ Blue/
- w) Black

2) Standards Equipment Room Equipment

- a) High precision dead weight tester (customs design)
- b) High precision voltmeter
- c) General purpose oscilloscope
- d) Stabilized power supply (high precision-high and low voltage)
- e) High precision weighing balance
- f) Precision resistance thermometers
- g) One set of glass thermometers (-5 to +250°C)
- h) Precision variable resistance (decade box)
- i) Wheatstone bridge
- j) High precision barometer
- k) High precision dew point hygrometer
- l) Standard platinum resistance
- m) Precision current source
- n) Flat bed recorder
- o) Standard thermocouples

3) Pneumatic 'shop'

- a) Precision pressure regulator
- b) Pneumatic test rig for controllers (depending on manufacturer)
- c) Set of precision gages
- d) Low pressure/vacuum calibration system
- e) Pneumatic calibration unit
- f) Digital pressure calibrator (300 mbar)
- g) Digital pressure calibrator (1.6 bar)
- h) Digital pressure calibrator (10 bar)
- i) High pressure test kit (200 bar)
- j) Portable low pressure pump
- k) Portable calibrator
- l) Pneumatic calibrator- electro
- m) Pneumatic calibrator
- n) Absolute pressure unit

4) Electronic 'shop'

- a) Portable temperature indicator (6½ digits)
- b) Portable multivolt meter (6½ digits)
- c) Whetstone bridge
- d) Variable resistance (decade box)
- e) Analogic voltmeter multi-function
- f) Logic analyzer
- g) Electronic voltmeter
- h) Digital counter frequency meter
- i) Universal impedance measuring bridge
- j) Adjustable and portable power supply (high + low voltage)
- k) Function generator
- l) Programmable pulse generator
- m) General purpose oscillator
- n) Transistometer
- o) Stroboscopic tachometer
- p) Calibration set for vibration monitor
- q) Digital circuit tester
- r) Milli-ohm meter (in 0.001 ohm steps)
- s) High resistance meter (500 kohms)
- t) Pt 100 simulator
- u) Flat bed recorder (dual bed)
- v) Portable tachometer
- w) Xy recorder (dual bed)
- x) Set of standard resistors (10 000 to 1 000 ohm)

- y) Set of standard platinum resistances
 - z) Test oscilloscope microprocessor (to be kept in the control room, for integrated control systems)
 - aa) Digital oscilloscope with memory
 - bb) Low-voltage megger (50 volts)
 - cc) High-voltage megger (500 volts)
 - dd) Earth fault detector
 - ee) Specific 'manufacturers' calibrator
 - ff) Cold junction reference
 - gg) Computer peripherals.
- 5) **Special Test-Benches**
- a) Control valve
 - b) Hydraulic (portable type)
 - c) Temperature.
- 6) **Standard Test-Benches**
- a) Light Duty
 - b) Pneumatic
 - c) Electronic
 - d) Dcs And Plc
 - e) Analyzer (General Duty)
 - f) Analyzer (specific duty)
- 7) **Test equipment**
- a) Set Of Precision Pressure Gages
 - b) Low-Pressure Calibration Unit (Including Vacuum)
 - c) Set Of Digital Pressure Calibrators (300 Mb To 10 Bar)
 - d) Pneumatic Portable Calibration Unit (0.2 To 1 Bar)
 - e) Portable Temperature Indicator (Tc Simulator)
 - f) One Or Two Electronic Digital Accurate Voltmeters
 - g) Variable Resistance (Decade Box)
 - h) Portable Oscilloscope (General Purpose)
 - i) Pt 100 Simulator Calibrator
 - j) Portable Tachometer
 - k) Manufacturer's' Calibrator(S)
 - l) Portable Pulse And Function Generator
 - m) Portable Variable Power Supply (Amps/Volts).
 - i) b) Standard Voltage/frequency Sources
- 8) **List of Software/Learning Websites**
- a) Predictive Maintenance software module of DCS
 - b) Instrumentation Preventive Maintenance software.
 - c) www.mainpac.com/ Maintenance Software

- d) <http://confirm.pbbiblogs.com/2009/11/28/8-types-of-maintenance-a-comparison/>
- e) www.maintenancephoenix.com/.../8-steps-to-success-in-maintenance-
- f) www.reliabilityweb.com/.../Maintenance%20Scheduling%20101.pdf
- g) Maintenance Event Builder (MEB). Soft ware
- h) www.clicksoftware.com/service_schedule
- i) www.mainpac.com/ Maintenance Software
- j) <http://www.mainpac.com.au/> Preventive Maintenance Software
- k) www.clicksoftware.com/service_schedule SOFTWARE

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Visits to Industries

Take small instrumentation components to the class when teaching

Internet based home assignments

Mini project

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnic

1. **Prof.R.R. Manchiganti**, HOD IC Engineering, G. P. Gandhinagar
2. **Prof. N.B.Mehta**, Lecturer IC Engineering, Government Polytechnic Ahmedabad
3. **Prof. H.P.Patel**, Lecturer IC Engineering, Government Polytechnic Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

1. **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.
2. **Dr. Shashikant Gupta**, Professor and Cordinator for State of Gujarat.