GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: INDUSTRIAL ENGINEERING
(COURSE CODE: 3351904)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	5th Semester

1. RATIONALE

Prosperity of nation in general depends on the productivity of industries and quality of production. Technical managers, engineers, plant operators, machine operators, supervisors and workers working in industries have to compulsorily meet set standards of production in terms of quality, quantity and productivity so as to compete domestic and international market. This is possible for them only when they employ and exploit the principles of industrial engineering. Industrial engineering always aims to achieve higher productivity and better standards of quality through its constant endeavor in design, improvements and installation of integrated systems of human resource, machines and methods.

2. LIST OF COMPETENCY

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 competencies:

- **Improve productivity and quality by applying industrial engineering, quality control and cost reduction/saving techniques.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Improve productivity using work study and method study techniques.
ii. Analyze work content and calculate standard time in a given situation.
iii. Apply Statistical Quality Control tools in a given situation.
iv. Select material handling equipment.
v. Apply Ergonomics for human comfort at work place.
vi. Appreciate the emerging trends in industrial engineering.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment**.**

5. COURSE DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit-1 **Introduction to Industrial Engineering.**	1a. Appreciate importance of industrial engineering, productivity and work study. 1b. Describe ways to enhance productivity for given simple cases. 1c. Explain concept and importance of SQC	1.1 Industrial engineering-definition, objectives and techniques. 1.2 Scope, importance and applications of industrial engineering. 1.3 Methodology and approach of Industrial engineering. 1.4 Productivity – concept, definition, importance and ways to enhance it, numeric examples. 1.5 Introduction to work study. 1.6 Introduction to statistical quality control (SQC).
Unit-2 **Work Study.**	2a. Define work study, method study and work measurement. 2b. State the basic procedure of work study, method study and work measurement. 2c. Prepare in the standard formats the outline process chart, flow process chart, flow diagrams, man machine chart and process plan for given data. 2d. Modify given process plan and flow diagram for improvements. 2e. State principles of motion economy. 2f. Analyze work content and calculate standard time in a given situation.	2.1 Work study-Definition, techniques and role to enhance productivity. 2.2 Importance of human factors in application of work study techniques. 2.3 Basic procedure of method study. 2.4 Methods of recording data for method study using standard symbols, process charts and diagrams. 2.5 Preparation of operation (outline) process chart for given mechanical assembly having 6-8 components. 2.6 Process planning-concept, meaning, importance, functions, procedure and forms used. 2.7 Information required for process planning and information available from process planning. 2.8 Prepare process plan for given mechanical components, take 2-3 components. 2.9 Preparation of flow process chart and flow diagram for given mechanical components having at least 6-8 major operations. 2.10 Given the process plan, operation process chart and flow diagram, develop questioning techniques in analyzing data for method study. Also develop and improve the method, based on analysis of given data. 2.11 Principles of motion economy

		applied in (a) use of human body, (b) design of work place layout (c) design of tools and equipment. 2.12 Principles of micro motion study, Therbligs and SIMO chart. 2.13 Man and machine chart. 2.14 Basic procedure of work measurement. 2.15 Equipment used in time study. 2.16 Job elements and their types. 2.17 Methods of measuring time-cumulative and fly back timing. 2.18 Concept of rating and rating scale. 2.19 Allowances-types, normal values and applications. 2.20 Calculation of basic time, standard time and work content. 2.21 Concept of work sampling/ activity sampling.
Unit-3 **Quality Assurance.**	3a. Appreciate importance of quality. 3b. Define quality, quality control (QC), quality assurance (QA), statistical quality control (SQC) and reliability 3c. Differentiate between inspection and quality control. 3d. Calculate mean, mode, median and standard deviation for simple data. 3e. Prepare suitable frequency distribution chart for a given data. 3f. Determine central tendency and dispersion in a given situation. 3g. Calculate probabilities using normal distribution. 3h. Define binomial and Poisson distribution.	3.1 Definition of quality, quality control (QC), quality assurance (QA), statistical quality control (SQC) and reliability. 3.2 Importance of quality. 3.3 Difference between reliability and quality control. 3.4 Factors affecting and improving reliability. 3.5 QA tools. 3.6 Concept of total quality cycle, quality of design, quality of performance, quality of conformity and total quality. 3.7 Difference between inspection and quality control. 3.8 Fundamentals of statistics-types of variations, frequency, class boundary and midpoint, frequency distribution, frequency histogram, frequency bar chart and polygon chart. 3.9 Frequency distribution curve, central tendency, spread or dispersion and range, mode, median and mean, standard deviation and variance with numeric examples. 3.10 Concept of probability and normal distribution. 3.11 Area under normal distribution and examples on normal distribution. 3.12 Introduction to binomial and Poisson distribution.

Unit-4 **Statistical Quality Control (SQC).**	4a. Explain various tools of SQC. 4b. Compare variables and attributes 4c. Calculate control limits, range / mean and prepare control charts. 4d. Calculate number/ percentage of items falling in and outside specifications limits from mean and standard deviation using normal distribution curve. 4e. State and explain various methods of acceptance of incoming materials 4f. Prepare and operate single and double sampling plans on the basis of given lot size, AQL and inspection level. 4g. Describe process capability. 4h. Explain consumers and producers risk. 4i. State the importance of OC curve and interpret OC curves in a given situation.	4.1 Concept of variability. 4.2 SQC tools and statistical fundamentals. 4.3 Concept and differences between variables and attributes. 4.4 Control charts for variable quality-types, objectives, applications, calculations of control limits and range/mean, methods to plot and interpretations (X bar-R chart) and examples. 4.5 Control charts for attribute quality-types, objectives, applications, calculations of control limits and range/mean, methods to plot and interpretations (p, np, 100p and c chart) and examples. 4.6 Process capability – meaning, definition and method to calculate, numeric examples. 4.7 Acceptance sampling: i. Quality control of incoming raw material and components. ii. Concepts of random sampling. iii. Sampling plans: definition, terminology, types (Single, double and multiple), implementing plans based on given input. iv. OC curve-concept, need, types and importance, interpretation of given OC curve.
Unit-5 **Plant layout and material handling equipments.**	5a. Explain various types of plant layouts with their merits, demerits and their application. 5b. Describe importance and applications of material handling equipment. 5c. Select material handling equipments for given situation.	5.1 Plant layout: Definition and concept. 5.2 Types of plant layout, their applications, advantages and limitations. 5.3 Role of material handling systems in industries. 5.4 Material handling equipment-Classification, types, specifications, applications and selection criteria.
Unit - 6 **Recent trends in industrial engineering.**	6a. Explain ISO and its role in industries and business. 6b. Explain TQC and TQM and its applications. 6c. Explain six sigma and Kaizen with their	6.1 International Organization for standardization and its role, ISO standard series and quality managements system. 6.2 Total Quality Control (TQC) and Total Quality Management (TQM)-philosophical concepts.

	applications. 6d. Define and explain ergonomics. 6e. Explain types of workloads and show normal and maximum work area. 6f. Explain environmental requirements of workplace area and working conditions.	6.3 Concept of six sigma and its applications. 6.4 Concept and applications of Kaizen. 6.5 Definition, objectives and applications of ergonomics. 6.6 Normal and maximum work area. 6.7 Environmental requirements of work place.

6. 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 Marks
I	Introduction to Industrial Engineering.	4	4	0	2	6
II	Work study.	14	4	6	14	24
III	Quality assurance.	6	4	4	2	10
IV	Statistical Quality Control (SQC).	8	4	4	7	15
V	Plant layout and material handling equipment.	4	4	0	2	6
VI	Recent trends in industrial engineering.	6	7	2	0	9
	Total	**42**	**27**	**16**	**27**	**70**

Legends: R = Remember U = Understand; A = Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

General Notes:

a. If mid-semester test is part of continuous evaluation, unit numbers I, II (Up to 2.9 only), III and V are to be considered.
b. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(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 outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	**Practical Exercises** (outcomes in Psychomotor Domain**)**	Approx Hours. required
1.	I	**Preparatory Activity:** a. Prepare the table for values of surface finishes achieved in manufacturing processes. b. Give examples of enhancing productivity. c. Sketch drafting symbols. d. Given the readings, sketch how such can be shown using Vernier and micrometer.	02
2.	ALL	**Mini Project and presentation:** a. Sketch the parts taken in Design of Machine Elements (DME) under Mini project. The batch of DME is to be continued. b. Prepare process plans for each part. c. Prepare flow diagram for each part. Assume institute's workshop layout. d. Present the work including work distribution, photographs and movies of actual project work using power point presentation.	04
3.	II	**Operation process chart (OPC):** Given real mechanical assembly having 6-8 components, prepare operation process chart. (This has to be assigned by teacher). a. Sketch parts and assembly. b. Prepare OPC. c. Prepare process plans for all components. Use format given in Annexure-I.	06
4.	II	**Flow diagram(FD):** Given real mechanical component having minimum 6-8 mechanical operations, prepare FD. (This has to be assigned by teacher). a. Sketch component. b. Sketch institute workshop layout. c. Prepare FD.	02
5.	II	**Man and machine chart:** Prepare man and machine chart for given situation. Teacher will assign the real situation. This include: a. List objectives of preparing man and machine chart. b. Describe the situation assigned by the teacher. c. Prepare the man and machine chart. d. Interpret the chart and suggest if any further improvements can be made with respect to enhance productivity.	02
6.	II	**Performance rating:** Calculate co-efficient of co-relation for time study person	02

		using performance rating technique. Teacher will assign the situation. This include: a. Define performance rating. b. Describe the situation assigned by the teacher. c. List the steps followed to perform the exercise. d. Observe and record the observations. e. Plot, interpret and calculate the co-efficient of co-relation.	
7.	II	**Time study:** Calculate standard time for a given job using decimal minute stop watch techniques. Teacher will assign the situation/job/elements to be recorded. This include: a. Sketch the part undertaken for time study. b. List elements to be considered. c. Observe and record elements time. d. List and justify allowances to be taken with values. e. Calculate standard time.	02
8.	III	**Frequency distribution curve**: a. Take live problem (may be measured variable dimension, result analysis, etc. (Teacher has to assign the live problem) and summarize the data. b. Perform and prepare frequency table. c. Determine central tendency, spread or dispersion and range, mode, median and mean standard deviation and variance. d. Prepare frequency bar, frequency polygon and frequency curve. e. Plot the areas under normal curve. f. Given the data (Teacher will assign the data), determine numbers/probabilities of acceptance/ rejection using normal distribution table- 4 cases.	02
9.	IV	**Control charts for variables:** a. Define variable. Give five examples. b. For given live problem, determine subgroup size, measure the variable and record the observations. c. Perform necessary calculations and determine control limits. d. Plot $\overline{X}$ – R chart and interpret the same.	02
10.	IV	**Control charts for attributes:** a. Define attribute. Give five examples. b. Explain binomial and Poisson distributions. c. For given live problems (different for different charts), determine parameters, record the observations of attribute. d. Perform necessary calculations and determine control limits. e. Plot p and c charts and interpret the same.	02
11.	IV	**Acceptance sampling:** a. Show double sampling plan using block diagram. b. Prepare/ operate double sampling plans on the basis of given lot size, AQL, inspection level and other input for a given problems.	02

		c. Record the observations and conclude the outcome.	
12.	ALL	**Industrial Visit:** Visit at least two related industries. Prepare the report as guidelines provided in notes.	-
Total Hours			**28**

Notes:

a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.PA component of practical marks is dependent on continuous and timely evaluation of exercises.
b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. Mini project and presentation topic/area has to be assigned to the students in the beginning of the term by batch teacher.
d. Student activities are compulsory and are part of term work.
e. Term work content of industrial visit report should also include following.
    i. Brief details of industry visited.
    ii. Type, location, products, rough layout, human resource, etc of industry.
    iii. Details, description and broad specifications of machineries/ processes observed.
    iv. Safety norms and precautions observed.
    v. Student's own observation on industrial environment, productivity concepts, quality consciousness and quality standards, cost effectiveness, culture and attitude.
    vi. Any other details / observations asked by accompanying faculty.
f. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned the necessary data and should be given any one experience to perform.

8. SUGGESTED LIST OF STUDENT ACTIVITIES.

Sr. No.	ACTIVITY.
1	During Industrial visit for other subjects students should be made familiar with various types of material handling equipments used in the industry. They should be encouraged to write special reports on material handling equipments and type of plant layout in the industries they visited.

9. SPECIAL INSTRUCTIONAL STRATEGIES.

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction to Industrial Engineering.	Movies on productivity.
2	II	Work study.	Movies on work study, live explanation at workshop place, presentations.
3	III	Quality assurance.	Movies on QA, live cases during industrial visits, power point presentations, failure analysis with rejected live parts.
4	IV	Statistical quality control	Movies on SQC, performance, live cases

		(SQC).	during industrial visits, power point presentations.
5	V	Plant layout and material handling equipments.	Movies on material handling equipments, industrial visits, power point presentations.
6	VI	Recent trends in industrial engineering.	Movies on trends, presentations.

10. SUGGESTED LEARNING RESOURCES.

A) List of Books.

Sr.No.	Title of Book	Author	Publication
1.	Industrial Engineering (IE) and Management	C.Natha Muni Reddy	New age international Publishers.
2.	Handbook of IE: Technology and operations management.	Gavriel Salvendy	Institute of Industrial Engineers.
3.	Comprehensive Industrial Engineering.	M. J Manek	Laxmi Publications (P) Ltd., New Delhi.
4.	Introduction to Work-study. ISBN: 9221071081	George Kanawaty	International Labor Organisatioin, Geneva.
5.	Introduction to productivity	---	National Productivity Council (NPC).
6.	Method Study	---	NPC.
7.	Work Measurement	---	NPC.
8.	Introduction to Statistical quality control. 7th revised edition ISBN-13: 978-0078443541	Eugene Grant and Richard Leavenworth	McGraw-Hill Series in Industrial Engineering and Management

B) List of Major Equipment/ Instrument with Broad Specifications.

Sr.No.	Major equipment/ Instrument with Broad Specification.	
1	Decimal stopwatch (Non fly back type).	02 pcs.
2	Decimal stopwatch (Fly back type)	02 pcs.
3	Playing cards	2 sets.
4	M.S Pins 10mm dia X 15mm length with tolerance of ± 0.01mm.	100 pcs.
5	Buttons of 6 different colors.	100 of each color.
6	Sampling rack with 1000 washers	1 set.

C) List of Software/Learning Websites.

i. http://en.wikipedia.org/wiki/Industrial_engineering
ii. http://www.iiie-india.com/IIIE/industrial-engineering.php
iii. http://www.youtube.com/watch?v=3WmfSfNJr4w (How Receiver Operating Characteristic Curves Work ...)
iv. http://www.youtube.com/watch?v=J17SUDcrphw (How to construct an operating characteristic (OC) curve)

v. https://www.coursera.org/course/apstat (basics of statistics)
vi. http://www.youtube.com/view_play_list?p=299B5CC87110A6E7 (Lecture Series on Industrial engineering NPTEL)
vii. http://www.massey.ac.nz/~mbjones/Book/Chapter11.pdf (reading material on statistics)

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- R.R.MAHITCHA, Retired Lecturer in Mechanical Engineering, T.F.G Polytechnic, Adipur.
- P.V.JETHVA, Lecturer in Mechanical Engineering, L.E. College, Morbi.
- R.M. RAJYAGURU, Lecturer in Mechanical Engineering. GP,Porbandar.

Coordinator and Faculty Members from NITTTR Bhopal.

- **Prof. S.K.Pradhan,** Associate Professor, Mechanical Engg. NITTTR,Bhopal
- **Dr. A.K.Sarathe,** Associate Professor, Mechanical Engg. NITTTR,Bhopal

ANNEXURE-I

FORMAT FOR PROCESS PLANNING

NAME OF COMPONENT: MATERIAL AND RAW MATERIAL SIZE: QUANTITY / BATCH:

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OP.NO.	DETAILS OF OPERATION	MACHINE	CUTTING TOOLS , HOLDING TOOLS, MEASURING TOOLS USED	CUTTING PARAMETERS			SETTING TIME	OPERATION TIME
				CUTTING SPEED	FEED	DEPTH OF CUT		
				RPM / NO. OF STROKES	(mm / rev OR mm / min)	mm	Min	Min