

# GUJARAT TECHNOLOGICAL UNIVERSITY

## M.E. Mechanical (Industrial Engineering)

PROPOSED TEACHING SCHEME

(W.E.F July 2012)

### Semester I

Subject Code	SUBJECT	TEACHING SCHEME(HOURS)			CREDIT S
		THEOR Y	TUTORIA L	PRACTICA L	
710001	Communication and Research Skills	2	2	0	3
714601	Statistics for Engineers	4	0	0	4
714602	Work System Design and Human Factors Engineering	4	0	2	5
714603	Advance Operations Research	3	2	0	4
	Interdisciplinary Elective – I	3	2	0	4
	Major Elective - I	4	2	0	5
	<b>Total</b>				<b>25</b>

Subject Code	Major Elective - I
714605	Engineering Economics & Financial Management
714606	Reliability Engineering & Tero Technology

Subject Code	Interdisciplinary Elective – I
714604	Production Management Systems

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**M.E. Mechanical (Industrial Engineering)**  
Semester: I

**Subject: Statistics for Engineers**  
**Code:714601**

Sr. No.	Topic	Hours
<b>Probability Theory:</b>		
1	<b>Discrete Distributions:</b> Random variables, Standard probability distributions- Binomial, Poisson and Geometric distributions, Mean, Variance, Moment generating function of respective distributions. Two dimensional random variables.	4
2	<b>Continuous Distributions:</b> Special distributions- Normal, Uniform, Exponential, Gamma, Weibull and Beta distributions - Mean, Variance, Raw moments from moment generating functions of respective distributions.	6
3	<b>Sampling Distributions:</b> Random Sampling, Sampling distributions of mean and variance, T-test, F-test and Chi-square test	4
4	<b>Estimation Theory:</b> Estimation of Parameters, Maximum likelihood estimates, Confidence interval estimation of population parameters Method of moments	4
5	<b>Hypothesis Testing:</b> Large sample tests for mean and proportion, Non parametric tests, Goodness of fit tests, Analysis of variance - One way and two way classifications	10
6	<b>Design of Experiments:</b> Completely Randomized Design, Randomized Block design, Latin square design - 2 Factorial Design, Fundamental assumptions of analysis of variance, Single factor experiments – Fixed/random effects model – Model adequacy checking - Multiple comparisons - Design of experiments with several factors - Two factor factorial experiments, Taguchi Approach to Design of Experiments - The Loss Function – Orthogonal array – Signal-to- Noise ratio.	12
<b>Descriptive Statistics:</b>		
7	<b>Regression and Correlation:</b> Method of least squares, Linear Regression, Polynomial Regression and Multiple Regression, Karl Pearson's Coefficient of Correlation, Rank Correlation, Multiple and partial correlation	7
8	<b>Time Series Analysis:</b> Characteristics and Representation, Moving Averages, Exponential smoothening, Auto Regressive Processes.	5
		<b>52</b>

**Term Work:**

The term work shall be based on the topics mentioned above.

**Text Books:**

1. Probability and Statistics for Engineering, Freund John, E. And Miller, Irwin, 5th Edition, Prentice Hall, 1994.
2. Statistics for Management, Levin and Rubin, PHI, 2001.
3. Fundamentals of Mathematical Statistics, Gupta, S.C. and Kapoor, V.K. Sultan Chand and Sons.

**Reference Books**

1. Probability & Statistics for Engineers and Scientists, Ronald E. Walpole, Pearson Education Asia Edition.
2. Probability and Statistics for Engineering and Sciences, Jay, L. Devore, Brooks/Cole Publishing Company Monterey, California, 1982.
3. Probability and Statistics, SPIEGEL, MURRAY R., , Schaum's series.
4. Statistics, Schaum's Series. SPIEGEL, MURRAY R,
5. Probability and Statistics with Reliability and Queuing and Computer Science Applications , Trivedi K S., Prentice Hall Of India
6. Principles of Experimental Design and Analysis, Garcia-Diaz, A and Phillips, D. T., Chapman & Hall, New York, 1995.
7. Probability and Statistics in Engineering and Management Science, Hines, W. W, and Montgomery, D. C., John Wiley and Sons, New York, 1990.
8. Engineering Statistics, Bowker and Liberman, Prentice-Hall.
9. Forecasting and Time Series, Montgomery D.C and Johnson, L. A McGraw Hill.

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**M.E. Mechanical (Industrial Engineering)**  
Semester: I

**Subject: Work System Design and Human Factors Engineering**  
**Code:714602**

Sr. No.	Topic	Hours
1	<b>Introduction to Work Study:</b> Productivity, Scope of methods, motion and time study	02
2	<b>Work Methods Design:</b> Operation Process Chart, Flow Process Chart, Flow Diagram, String Diagram, Man and machine chart, Two handed process chart, Travel Chart, Micro motion and memo motion study.	08
3	<b>Work Measurement:</b> Tools and Techniques	08
4	<b>Work Sampling:</b> Determining time standards from standard data and formulas, Predetermined motion time standards, Work factor system, Methods time measurement, Analytical Estimation, Measuring work by physiological methods – heart rate measurement – measuring oxygen consumption– establishing time standards by physiology methods.	08
5	<b>Human Factors Engineering:</b> Introduction to ergonomics, Man/machine/environment systems concept, Human Anthropometry and its use in work place layout.	02
6	<b>Human Performance:</b> Information input and processing, factors affecting human performance, physical work load and energy expenditure, heat stress, manual lifting. Static and dynamic muscular load, human motor activity, metabolism, physical work load, repetitive and inspection work, measurement of physical work load, mental work load and its measurement, work duration and work pauses, principles of motion economy.	08
7	<b>Design of Work Space &amp; Equipment:</b> Work-space design for standing and seated workers, arrangement of components with in a physical space, Interpersonal aspect of work place design, Ergonomic Factors to be considered, design of displays and controls, design for maintainability.	08
8	<b>Design of Environment:</b> Illumination and its effect, Climate - Heat Humidity – Body heat balance, effective temperature scales, zones of discomfort, effect of heat on body and work performance, Vibrations - Response of body to low frequency vibrations, vibrations and discomfort, effect on health of worker, high frequency vibrations, effect of high frequency vibrations, methods of reducing vibrations, Noise - Physiological effects of noise, annoyance of noise, speed interference, hearing loss, temporary and permanent threshold shift, effect of noise on performance, reduction of noise, personal noise protection.	08
		52

**Term Work:**

The term work shall be based on the topics mentioned above.

**Practical / Viva:**

The candidate shall be examined on the basis of term-work.

**Text Books:**

- 1 Introduction to Work Study, I.L.O., 3rd Revised Edn.
- 2 Motion and Time Study – Design and Measurement of Work, Barnes, Raeph.m., John Wiley & sons, New York, 1990.
- 3 Human Factors in Engineering and Design, Macormick, E.J., Tata McGraw-Hill
- 4 A Guide to Ergonomics of Manufacturing, Martin Helander, TMH, 1996.
- 5 Human Factor Engineering, Sanders & McCormick, McGrawhill Publications.
- 6 Sound, Noise and Vibration Control, Lyle, F. Yerges, Van Nostrand, 1978

**References:**

- 1 Methods, Standards and Work Design, Benjamin W. Niebel and AndrisFreivalds, WCB McGraw Hill(1999)
- 2 Improving Productivity and Effectiveness, Mundel, Marvin, E., Prentice Hall, 1983.
- 3 Human Factors Engineering & Design, Sounders, M.S. and McCornic, E.J., McGraw Hill, 1983.
- 4 Motion and time study, Benjamin .W. Neibel,, Richard .D .Irwin Inc., Seventh Edition,1982.
- 5 Work design Stephen Konz., Publishing Horizon Inc.,Second Edition,1979.
- 6 Introduction to Ergonomics, Bridger R.S.,McGraw Hill,1995.
- 7 Applied Ergonomics, Hand Book: Brien Shakel (Edited) Butterworth Scientific, London 1988.
- 8 Work Study and Ergonomics, Shan, H.S, DhanpatRai& Sons, 1992

# GUJARAT TECHNOLOGICAL UNIVERSITY

## M.E. Mechanical (Industrial Engineering)

### Semester: I

**Subject: Advanced Operations Research**  
**Code:714603**

Sr. No.	Topic	Hours
1	<b>General concepts:</b> History, Definition, OR Models, OR Techniques and phases of implementing OR in practice	02
2	<b>Linear Programming Model:</b> Assumption, Limitations, Formulation of mathematical models, Solution of linear programming problems involving product mix, resource allocation, transportation and assignment by graphical, simplex and dual simplex methods, Duality theorem and applications and Sensitivity analysis	06
3	<b>Transportation Problems:</b> General Concepts, Formulation of TT problems and LP formulation of TT Problems, Solution Methods: North West Corner Method, Least Cost Method, Vogels Approximation Method, Optimality Tests: Stepping Stone Method and Modified Distribution method, Balanced/Unbalanced transportation problem, Degeneracy	04
4	<b>Assignment Problems:</b> General Concepts, Assumptions & Limitations, Formulation and solution of assignment problem, Special Issues: Restricted routes/Multiple Optimal Solutions.	03
5	<b>Network Analysis:</b> Introduction to Network, Minimum spanning tree algorithm, Shortest path problem, Maximal flow problem.	02
6	<b>Project Management:</b> Introduction, Definitions, Terminology, Assumptions, Limitations, Applications of Networks, Types of Networks: Critical Path Method and Programme Evaluation Review Technique, Estimation of Project completion time, Project Cost Analysis: Crashing, Project cost time trade-off, Resource allocation techniques	03
7	<b>Queuing Model</b> Queuing theory notation and assumptions, Poisson's queuing models.	03
8	<b>Games theory:</b> Introduction, Two-person zero-sum games, The Maximin -Minimax principle, Games without saddle points - Mixed Strategies, 2xn and mx2 Games -Dominance property, Algebraic solutions to rectangular games. Graphical solution.	03
9	<b>Integer programming:</b> Graphical representation. Gomory's cutting plane method, Branch-and-bound method, Travelling salesman problem, Cargo loading problem.	04
10	<b>Non linear programming: Single variable optimization</b> Introduction, Kuhn-Tucker conditions, Quadratic programming, Separable programming.	04

<b>11</b>	<b>Special topics:</b> Extreme Difference Method, Generalized Transportation Problem, Generalized Assignment Problem, Multi-objective Transportation Problem.	<b>05</b>
	<b>Total</b>	<b>39</b>

**Term Work:**

The term work shall be based on the topics mentioned above.

**Practical / Viva:**

The candidate shall be examined on the basis of term-work.

**Text Books:**

1. Wagner H. M., Principles of Operation Research with Applications to Managerial Decisions, 2<sup>nd</sup> Ed., PHI, 2010.
2. Taha H. A., Operation Research, 7<sup>th</sup> Ed., *Prentice Hall of India*, New Delhi, 2002.
3. Vohra N.D, Quantitative Techniques in Management, Tata McGraw Hill, 1995.

**Reference Books:**

1. Sharma J. K., Operation Research Theory and Applications, 2<sup>nd</sup> Ed., Macmillan, 2003.
2. Hira D. S. &Gupt P. K., Operations Research, S. Chand & Co. 1995.
3. Kasana H. S., Kumar K. D., Introductory Operations Research Theory and Applications, Springer, 2003.
4. Wilkes F. M., Elements of Operational Research, McGraw Hill Co.
5. Levin R. et.al, Quantitative approaches to mgmt, McGraw Hill Co.
6. Hiller & Lieberman, Introduction to Operations Research
7. Richard Broson, Govindasamy&Naachimuthu, Schaum's Outline of Theory and Problems of Operations Research, II Edition, Tata McGraw Hill , 2004.
8. Sen R. P., Operations Research Algorithm and Applications, PHI, New Delhi.
9. Shah N. H., Gor R. M., Soni H., Operations Research, PHI, New Delhi, 2007.

# GUJARAT TECHNOLOGICAL UNIVERSITY

## M.E. Mechanical (Industrial Engineering)

### Semester: I

**Subject: Engineering Economics and Financial Management (Dept. Elective – I)**  
**Code:714605**

Sr. No.	Topic	Hours
1	<b>Introduction to Engineering Economics:</b> Definitions, Concepts of Macro and Micro Economics, Types of goods, Concept of economic and non economic activities, Time Value of Money, Interest Calculations, Equivalence, Simple and Compound Interest, Cash Flows: Estimation and Diagramming.	04
2	<b>Introduction to Factors and Their Use:</b> Single Payment Factors (F/P and P/F), Uniform Series Present Worth Factor and Capital Recovery Factor (P/A and A/P), sinking Fund Factor and Uniform Series Compound Amount Factor (A/F and F/A), Standard Factor Notation and Use of Interest Tables, Present Worth, Future Worth and Equivalent Uniform annual Worth Calculations, Calculations of Unknown Interest Rates and Unknown Years.	04
3	<b>Present Worth and Capitalized Cost Evaluation:</b> Present Worth Comparison of Equal and Different Life Alternatives, Life Cycle Cost, Capitalized Cost Calculations	03
4	<b>Rate of Return:</b> Calculations Using PW and AW Equations	03
5	<b>Benefit/Cost Analysis:</b> Classification of Benefits, Costs and Disbenefits, Calculations for a Single Project, Alternative Selection by B/C Analysis	03
6	<b>Laws of Demand&amp; Supply:</b> Law of Demand, Demand Function, Types of Demand, Determinants of Demands, Demand Elasticities, Methods of Demand Forecasting, Law of Supply.	03
7	<b>Factors of Production:</b> Production Function, Factors of Production, Division of Labour, Localization of Industry, Capital and Capital formation, Scales of Production, Production Analysis – Long & Short Run,	03
8	<b>Laws of returns:</b> Laws of Returns, Utility, Law of Diminishing Marginal Utility.	03
9	<b>Market Structures:</b> Introduction to different market structures (perfect competition, monopoly, monopolistic competition, oligopoly)	03
10	<b>Introduction to Financial Management:</b> Forms of Business Organization, Introduction to financial management, Organization of the financial management functions, Business Environment, Tax Environment, and Financial Environment, Budgeting Fundamentals.	03
11	<b>Financial Statements:</b> Accounting Systems, Profit and Loss Accounts, Drawing of Balance Sheet and Ratio Analysis, Income statement, Trend	05



	analysis, Common size, and Index analysis. Flow of funds statement, Cash Flow Analysis.	
12	<b>Product Costing:</b> Costing based on fixed and variable costs, Break-Even Analysis, Profit –Volume Ratio, Costing based on direct and indirect costs, Overheads apportionment and absorption, Different Models of Depreciation.	08
13	<b>Working Capital:</b> Issues with working capital, Financing current assets, combining liability structure and current asset decisions. Capital budgeting.	03
14	<b>Financing:</b> Intermediate and long-term financing. Private placement, initial financing, signaling effects, secondary market, bonds and their features, long term debt instruments. Term loans and leases. Provision of loan agreements, equipment financing, Lease financing and its evaluation.	04
		52

#### **Term Work:**

The term work shall be based on the topics mentioned above.

#### **Practical / Viva:**

The candidate shall be examined on the basis of term-work.

#### **Text Books:**

- 1 Engineering Economy, Laland T. Blank and Anthony J. Tarquin, McGraw Hill International Editions – Industrial Engineering Series.
- 2 Modern Economic Theory, Dewett and Verma, S. Chand & Sons
- 3 Managerial Economics, G S Gupta, Tata McGraw-Hill, New Delhi
- 4 Fundamentals of Financial Management, Van Horne, J C and Wachowicz, J M, Pearson Education Asia(2002).
- 5 Financial Management -Theory and practice, PrasannaChandra, TMH, Vth edition, 2001.
- 6 Financial Management – Theory and practice, I.M.pandey, VikasPublishing Hina 2002.

#### **References:**

1. Managerial Economics, Petersen, C & Lewis, W.C.:, PHI
2. Managerial Economics, Hailstones, Thomas J. and Rathwell, John C., Prentice Hall International,
3. Engineering Economics, Perk, Contemporary 3rd Ed, PHI
4. Engineering Economics, Panneerselvam, PHI
5. Financial Management and Policy, Van Horne, 12/e, PHI, (2002).
6. Principles of Corporate Finance, Breally and Myers, 7/e, TMH, (2002).
7. Fundamentals of Corporate Finance, Ross, Westerfield and Jordan, 6/e, TMH, (2002).
8. Corporate Finance, Damodaran, John Wiley & Sons, (2002).

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**M.E. Mechanical (Industrial Engineering)**

## Semester: I

**Subject: Reliability Engineering and Tero Technology (Dept. Elective – I)**  
**Code:714606**

Sr. No.	Topic	Hours
1	<b>Reliability Concept:</b> Reliability function - failure rate - Mean time between failures (MTBF) - Mean time to failure (MTTF) - a priori and a posteriori concept - mortality curve - useful life availability - maintainability - system effectiveness.	05
2	<b>Reliability Data Analysis:</b> Time to failure distributions - Exponential, normal, Gamma, Weibull, ranking of data - probability plotting techniques - Hazard plotting.	05
3	<b>Reliability Mathematics:</b> Introduction to probability distributions, Concept of Bathtub Hazard Rate curve, Reliability evaluation of two-state device networks-series, parallel, k-out-of-m systems; Standby redundant systems, Reliability evaluation of three-state device networks-series and parallel.	05
4	<b>Reliability Determination Methods:</b> Network reduction technique, Path tracing technique, Decomposition technique, Delta-Star method. <b>Advanced Reliability Evaluation Concepts:</b> Supplementary variables technique, Interference theory, Human reliability, Common cause failures, Fault trees, Failure mode and effect analysis.	08
5	<b>Reliability Prediction Models:</b> Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis - FTA - Limitations. <b>Reliability Management:</b> Reliability testing - Reliability growth monitoring - Non parametric methods - Reliability and life cycle costs - Reliability allocation - Replacement model.	08
6	<b>Risk Assessment:</b> Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.	02
7	<b>Maintenances systems and economics of reliability:</b> Maintainability and availability concepts, MTBF, MTTR, MTBM& MDT repair hozard rate, maintainability and availability functions and their mathematical expressions.	07
8	<b>Maintenance and spares management:</b> Preventive replacement-individual breakdown replacement policy - individual preventive replacement policy - preventive group replacement. <b>Condition based maintenance</b> - advantages and disadvantages - vibration monitoring - vibration parameters - vibration instruments.	07
9	<b>Total Productivity Maintenance (TPM):</b> Distinctive features of TPM, Basic philosophy of zero defects (ZD), ZD and TPM, Maximizing	05

	equipment effectiveness, Six major losses, TPM development activities, Steps of TPM development, Autonomous maintenance, Planned maintenance, Measuring TPM effectiveness.	
		52

**Term Work:**

The term work shall be based on the topics mentioned above.

**Practical / Viva:**

The candidate shall be examined on the basis of term-work.

**Text Books:**

- 7 Reliability Engineering, Srinath.L.S., Affiliated East West Press Pvt. Ltd., 2011
- 8 Reliability Engineering, Balagurusamy. E., Tata Mcgraw Hill Publishing Company, New Delhi, 1984.
- 9 Reliability Engineering & Terotechnology, A K Gupta, Macmillian India Ltd.

**References:**

1. Reliability and Risk analysis, Modarres, Mara Dekker Inc., 1993.
2. The Reliability of Mechanical system, John Davidson, published by the Institution of Mechanical Engineers, London, 1988.
3. Introduction to Reliability in Design, Smith C.O., McGraw Hill, London, 1976.
4. Reliability Analysis and Prediction Engineering, K B Mishra, Elsevier Science Publishers, 1992
5. Reliability Engineering in System Design and Operation, Balbir S. Dhillon. Von Nostrand Reinhold Company, New York, 1983.
6. Introduction to TPM, Nakajima Seiichi, Productivity Press India, Madras, 1997.
7. Introduction to Reliability Engineering, Lewis, E. E. John Wiley & Sons, New York, 1987.
8. Practical Reliability Engineering, O'Connor Patric D.T. 3/e revised, John Wiley & Sons, 1995.

## Semester: I

**Subject: Production Management Systems (Institute Elective - I)**

**Code:714604**

Sr. No.	Topic	Hours
1	<b>Introduction:</b> Manufacturing systems - Job shop production, Batch production, Mass production – Characteristics	04
2	<b>Production Planning and Control:</b> Functions and objectives of PPC, phases of PPC, Aggregate Planning and Master Production Scheduling	06
3	<b>Introduction to MRP and MRP II:</b> MRP Concept, Product Structure and Bill of Material, Lot sizing in MRP systems – Minimum cost per period method, Period order quantity method, Least unit cost method, Part period balancing method, Evolution from MRP to MRP II – Closed loop concept.	08
4	<b>Just In Time (JIT):</b> Introduction to JIT Manufacturing, Working of Kanban System, Push and Pull Manufacturing Comparison	03
5	<b>Introduction to Work Study:</b> Concept and scope of Method and Time Study, Operation Process Chart, Flow Process Chart, Flow Diagram, Man and machine chart, Two handed process chart, Principles of Motion Economy, Different tools and techniques of work measurement.	08
6	<b>Production Scheduling:</b> Single machine scheduling [Conditions/Assumptions of single machine scheduling, Definitions of Processing time, Ready Time, Due date, Completion time, Flow time, Lateness, Tardiness, Mean flow time, Mean tardiness, Shortest Processing Time (SPT) Rule to minimize mean flow rate, Weighted Mean flow rate, Earliest Due Date (EDD) Rule to minimize maximum lateness], Flow Shop Scheduling [Conditions/Assumptions of flow-shop scheduling, Johnson's Algorithm for 2 machines n jobs problems], Job Shop Scheduling [ Introduction, Graphical solution of 2 jobs and M machines],	08
7	<b>Introduction to Value Engineering:</b> Concept and Objectives of Value Engineering, Understanding the terms Value, Cost, Worth, Function, Types of Value, Cost-Function Relationship, Introduction of Value Analysis Techniques, Difference Between Value Engg. and Value Analysis, Advantages and Applications.	02
		<b>39</b>

### Term Work:

The term work shall be based on the topics mentioned above.

### Practical / Oral:

The candidate shall be examined on the basis of term-work.

### Text Books:

- 1 Production and Operations Management by R. Panneerselvam, Prentice –Hall of India Private Limited, New Delhi.

- 2 Introduction to Work Study, I.L.O., 3rd Revised Edn.
- 3 Production and Operations Management by K C Arora, Laxmi Publications (P) Ltd., New Delhi.
- 4 Industrial Engineering and Management by M Mahajan, Dhanpat Rai Publications, New Delhi.

**Reference Books:**

- 7 PPC and Industrial Management by K C Jain & L N Agrawal.
- 8 Modern Production Management by Buffa.
- 9 Production System, Planning, Analysis and Control by J L Riggs.
- 10 Industrial Engineering and Operations Management by S K Sharma, Savita Sharma and Tushar Sharma, S K Kataria & Sons, New Delhi.