GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. Mechatronics

PROPOSED TEACHING SCHEME (W.E.F July 2012)

Semester I

Subject Code	SUBJECT	TEACHING SCHEME(HOURS)			CREDITS
		THEORY	TUTORIAL	PRACTICAL	
710001	Communication and Research Skills	2	2	0	3
714701	Concepts in Mechatronics Engineering.	4	0	2	5
714702	Advance Control Systems	4	0	2	5
714703	Sensor Technology	3	0	2	4
	Interdisciplinary Elective – I	3	0	2	4
	Major Elective - I	3	2	0	4
	Total				**25**

Subject Code	**Major Elective - I**
714705	Finite Element Procedures in Engineering (Elective – I)
714706	Engineering Metrology (Elective – I)
714707	Soft Computing Applications (Elective – I)

Subject Code	**Interdisciplinary Elective – I**
714704	Optimization Theory and Practice

GUJARAT TECHNOLOGICAL UNIVERSITY

Mechatronics Engineering

M.E. Semester: I

Subject Name: Concepts in Mechatronics Engineering
Subject Code: 714701

Sr. No.	Topics	Hours
1	**ELECTRICAL ACTUATION SYSTEM** Electrical systems, solid state switches, DC motors, AC motors, stepper motors, servo motors.	5
2	**POWER CIRCUITS** Construction, operating mechanism and characteristics of power MOSFET, IGBT, Thiristor devices – SCR, DIAC, TRIAC. Full wave and half wave phasecontrolled converters – single phase and 3 phase, choppers.	10
3	**ELECTRIC DRIVES** Controlled converter and chopper based DC drives, converter based 3 phase induction motor drives.	10
4	**MECHANISMS** Link, kinematic pair, mechanism, machines, DOF of mechanisms, inversion of mechanism, mechanisms with lower pair, pantograph, straight line mechanism, introduction of synthesis of mechanism.	7
5	**MOTION TRANSMISSION** Belt drives, chain drive, power screws, gear and gear trains, cam and followers.	6
6	**DESING OF MACHINE ELEMENTS** Material selection, stress strain relationship, factor of safety, types of stresses, principle stresses, consideration for fatigue failure.	10
7	**MECHANICAL VIBRATION FOR SINGLE DEGREE OF FREEDOM SYSTEM.** Introduction of vibrations : free vibration, damped vibration, forced vibration, torsional vibration	2

REFERENCES:

1. K.P. Ramchandran, G.K. Vijayaraghavan, M.S. Balasundaram
   Mechatronics – Integrated mechanical electronicsystems, Wiley IndP.Ltd.
2. Dr. B.M. Bimbhra
   Power Electronics, Khanna publishers
3. G.K. Dubey Fundamentals of Electric Drives, Narosa publication.

4. S SRatan, Theory of Machines, Tata McGraw Hill Publications.
5. V B Bhandari, Introduction to Machine Design, Tata McGraw Hill Publications
6. Joseph Edward Shigley, Charles R. Mischke,
   Mechanical Engineering Design, McGraw Hill International Edition.

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHATRONICS ENGINEERING

M.E. Semester: I

Subject Code: 714702
Subject Name:ADVANCE CONTROL SYSTEMS

Sr.No.	Content	Hours
1	**DESIGN AND ANALYSIS OF COMPENSATION TECHNIQUES** Performance specifications, design considerations in time and frequency domain, lead, lag and lead-lag compensation based on root locus and frequency response approaches.	10
2	**DISCRETE TIME SYSTEMS** Introduction to discrete time systems, analog and digital controllers, the z-transform, basic definition of z-transform, derivation of z-transform of standard functions, difference equation and its solution by the z-transform method, initial and final value theorem, inverse z-transform using infinite series and partial fraction methods, pulse transfer function, pulse transfer function of closed-loop system using signal flow graph technique, stability analysis in z-plane	12
3	**STATE-SPACE ANALYSIS OF CONTROL SYSTEMS** Limitations of conventional control theory, state-variables and state vectors, state-space representation of higher order systems with forcing functions, solution of homogeneous and non-homogeneous state equations in time-domain and frequency-domain, matrix exponential, state-transition matrix, transfer matrix.	10
4	**NONLINEAR SYSTEM ANALYSIS** Introduction to nonlinear systems, standard nonlinearities in control systems, Describing function analysis of nonlinear control systems, stability of sustained oscillations or limit cycle. Concepts of phase plane analysis, phase plane portraits, phase plane analysis of linear and nonlinear control system, Lyapunov stability theorems, Lyapunov functions for nonlinear systems.	12
5	**INTELLIGENT CONTROL SYSTEMS** Introduction, Feedback linearization, model reference adaptive control, Generalized predictive control, sliding mode control, fuzzy logic control.	8
		52

Reference Books:

1. M. Gopal, "Control Systems: Principles and Design" (3rd Edition), TMH.
2. M. Gopal, "Digital control and state-variable methods" (3rd Edition), TMH.
3. B. C. Kuo, "Automatic control systems", PHI.
4. Norman Nise, "Control System Engineering", Wiley India Edition.

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHATRONICS ENGINEERING

M.E. Semester-I

Subject Name: Sensor Technology

Subject Code:714703

Sr. No.	Content	Hours
1.	**Introduction** Sensor classification, Sensor characteristics: Transfer function, calibration, hysteresis, non linearity, repeatability, resolution, dynamic impedance, excitation, dynamic characteristics, reliability, etc.	5
2.	**Physical Principles of Sensing** Electric charges, fields and potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric effect; pyroelectric effect; Hall effects; seeback and Peltier effects; Sound waves; Temperature and thermal properties of materials; Heat transfer; Light.	12
3.	**Position, Displacement and Level Sensors** Potentiometric sensors; Capacitive sensors; Inductive and Magnetic sensors: LVDT, RVDT, Eddy current sensors, Hall effect, magnetostrictive, magnetoresistive sensors; Ultrasonic sensors.	10
4.	**Angle Measuring Sensors** Incremental and absolute encoders; Synchros and resolvers.	7
5.	**Force, strain and Tactile Sensors** Strain gauges, Tactile sensors and Piezoelectric force sensors	6
6.	**Sensor Materials and Surface Processing** Materials like Silicon, Plastic, Metals, Ceramics and Glasses; Surface processing like spin-casting, vacuum deposition, sputtering, chemical vapor deposition; Nanotechnology: photolithography, micro machining, etching, wafer bonding.	5
7.	**Applications of Sensors in manufacturing** Various proximity sensors like capacitive, inductive, laser, microwave, etc.; Fibre Optics in sensors.	4

Text Book

1. Handbook of Modern sensors: Physics, Designs and Applications, 3rd Edition, Jacob Fraden, Springer

Reference Book

1. Measurement, Instrumentation and Sensors Handbook, John G. Webster (Editor-in-Chief), CRC Press
2. Sensors and Control Systems in Manufacturing, SabrieSoloman, McGraw Hill Publisher
3. Sensors and Transducers, D. Patranabis, Wheeler Publishing

GUJARAT TECHNOLOGICAL UNIVERSITY

Mechatronics Engineering

M.E. Semester: I

Subject Code:714705

Subject Name: Finite Element Procedures in Engineering (Elective – I)

Sr. No	Content	Hours
1	**Finite Element Method:** Basics, history and application, Comparison with other methods, Variational approach, Galerkin's Methods.	3
2	**Element and Boundary Condition:** Element shapes, interpolation function. Virtual energy principle, Rayleigh- Ritz method, stiffness matrix and properties, Boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain displacement relations	6
3	**1-D structural problems** – axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape function. Analysis of Trusses – Plane Truss and Space Truss elements	5
4	**Analysis of beams** – Hermite shape functions – stiffness matrix – Load vector – Problems. **2-D problems** –CST, LST, force terms, Stiffness matrix, load vector, boundary conditions.	7
5	**Element types -** Isoparametric element – quadrilateral element, Shape functions – Numerical Integration – sub parametric and super parametric elements. **3-D problems** – Tetrahedral element – Jacobian matrix – Stiffness matrix.	6
6	**Dynamic Analysis -** Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen Vector, natural frequencies – mode shapes – modal analysis. Applications of numerical procedures to determine natural frequencies and mode shapes. Finite Element Method for dynamic analysis, Introduction to torsional problems	8
7	**Introduction to Non linearity**, Geometric Non-linearity, Material Non-linearity, Non linear dynamic problems, analytical problems	5

REFERENCE BOOKS:-

1. Introduction to finite elements in Engineering by Tirupathi K. Chandrupatla and Ashok D.Belegundu.
2. Finite Element Procedures in Engineering analysis by K.J Bathe.
3. An Introduction to Nonlinear Finite Element Analysis by J.N.Reddy, Oxford University Press.
4. The finite element methods in Engineering – S.S. Rao - Pergamon, New York.
5. An Introduction to Finite Element Methods – J. N. Reddy – McGraw Hill.
6. A Textbook of Finite Element Analysis by P. Seshu
7. The Finite Element Method in Engineering science – O.C. Zienkowicz, McGraw Hill.
8. Concepts and applications of finite element analysis – Robert Cook

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER-I

MECHATRONICS ENGINEERING

Subject Name: Engineering Metrology (Elective 1)

Subject Code:714706

Sr. No.	Content	Hours
1.	**Introduction** Accuracy of measurement, errors of measurement	2
2.	**Linear and Angular Measurement** Slip gauges, length bars, principle of alignments, magnification, alignment, accuracy and precision, various comparators, sine bar, measurement of taper gauges, autocollimator, squareness measurement	10
3.	**Limit and Limit Gauges** Selective assembly, system of limits and fits, design of limit gauges including gauge tolerance and wear allowance, Taylor's theory of gauging, taper limit gauges, gauging of large diameters, gauge materials and its requirements.	9
4.	**Machinetool Metrology** Alignment test for all conventional machinetools, straightness and flatness measurement, flatness of small surface area using principle of interferometry, roundness measurement, concepts of calibration.	9
5.	**Gear and Screw Thread Measurement** Gear tooth thickness measurement, measurements over rollers, thread measurement (major, minor and effective diameter), measurement of thread form, types of pitch errors.	5
6.	**Surface Texture** Method of measuring surface texture, Analysis of surface traces, interference microscope.	3
7.	**Coordinate Measuring Machine** Construction features, working and applications.	1

Text Book

1. Metrology for Engineers, J.F.W. Galyer and C.R. Shotbolt, ELBS.

Reference Book

4. Practical Engineering Metrology, K.W.B. Sharp
5. Principles of Engineering Production, A.J. Lissaman and S.J. Martin
6. Workshop Technology, Part-I,II,III, W.A.J. Chapman and S.J. Martin, Viva Publication.

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER-I

MECHATRONICS ENGINEERING

Subject Name: Soft Computing Applications (Elective 1)
Subject Code:714707

Sr.No.	Content	Hours
1.	**Introduction to Soft Computing** Introduction, Importance of Soft Computing, Main Components of Soft Computing, Fuzzy Logic, Artificial Neural Networks, Support Vector machine, Evolutionary Algorithms, Hybrid Intelligent Systems.	4
2.	**Fuzzy Logic Systems** Introduction to Fuzzy logic, classical sets *vs* fuzzy sets, Features of membership functions, Properties and operations on Fuzzy sets, Fuzzy relation, Operations of Fuzzy relation, Defuzzification, Fuzzy rule base and approximate reasoning, Design a fuzzy logic controller: Mamdani&Sugeno Architecture, Fuzzy logic control systems.	15
3.	**Neural Network Systems** Introduction to artificial neural network, Biological neurons *vs* artificial neural network, Neuron models, Network architectures, Learning in neural networks, Back propagation network, Hopfield network, Self organizing feature maps, Control systems with neural networks.	15
4.	**Applications of soft computing** Applications of Fuzzy logic and neural network systems in automation, robotics and machine vision.	6
	Total	**40**

Text Book

S. N. Sivanandam and S. N. Deepa, "Principles of Soft computing", Wiley India Edition.

Reference Book

1. K. L. Du and M.N.S. Swamy, "Neural Networks in a Softcomputing framework", Springer
2. Drinkov, "An introduction to fuzzy control", Narosa Publication.
3.

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHATRONICS ENGINEERING

M.E. Semester: I

Subject Code:714704

Subject Name: Optimization Theory and Practice (Interdisciplinary Elective – I)

Sr.No.	Content	Hours
1.	**Introduction to Optimization** Historical Development, Engineering applications of Optimization, Design vector and constraints, Constraint surface, Objective function, Classification of Optimization Problems	03
2.	**Classical Optimization Techniques** Single variable optimization, Constrained and unconstrained multi-variable optimization, Direct substitution method, Lagrange's method of multipliers, Karush-Kuhn-Tucker conditions	06
3.	**Linear Programming** Statement of an LP problem, Graphical Solution of an LP problem, Simplex method, Dual simplex method	05
4.	**Non-linear Programming: One-dimensional minimization method** Unimodal function, Unrestricted search, Exhaustive search, Dichotomous search, Interval halving method, Fibonacci method, Golden section method, Direct root methods	06
5.	**Non-linear Programming: Unconstrained Optimization Techniques** Direct Search Methods: Random search methods, Grid search method, Univariate method, Hookes and Jeeves' method, Powell's method Indirect Search Methods: Steepest descent method, Fletcher-Reeves method, Newton's method	08
6.	**Non-linear Programming: Constrained Optimization Techniques** Direct Methods: Random search method, Sequential linear programming Indirect methods: Transformation techniques, Exterior penalty function method, Interior penalty function method	08
7.	**Evolutionary Algorithms** An overview of evolutionary algorithms, Simulated annealing algorithm, Genetic algorithm, Particle swarm optimization	04

TEXT BOOK:

1. Engineering Optimization Theory and Practice, S.S.Rao, New Age International (P) Ltd, Publishers

REFERENCE BOOKS:

1. Kalyanmoy Deb
   Multi-objective optimization using evolutionary algorithms
   John Wiley Publications
2. Jasbir S. Arora
   Introduction to Optimum Design
   McGraw Hill Publication