# SCHOOL OF ENGINEERING

## SRI SATYA SAI UNIVERSITY OF TECHNOLOGY AND MEDICAL SCIENCES

**Syllabus of Examination - AICTE Pattern**

**Undergraduate Degree Courses in Engineering & Technology**

**Department of Chemical Engineering**

**CMA-701 Process Control**

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| **CMA-701** | **Process Control** | **3L:0T:0P** | **3 credits** | **3Hrs/Week** |

**Course Preambles:**

Objective is to introduce the fundamentals of process control with applications using P, PI, and PID controllers. The course will teach the students about mathematical models based on transfer function approach for single loop systems, how to obtain dynamic response of open loop and closed loop systems, stability analysis in transient and frequency domains, and controller tuning methods. The course would end with more advanced concepts like feed-forward control, ratio control, model-predictive control, ratio control, dead-time compensation, etc.

**Course Outcomes:**

Students will be able to

- Understand the importance of process dynamics (unsteady state operation)
- Tune a controller to reject disturbances or manage operating point transitions

**Unit-I: Introductory Concepts (10 Hours):** Need for control and automation, control logic, servo and regulatory control, block diagrams, control structures (feedback vs. feedforward), process and instrumentation diagrams.

**Unit-II: Laplace transforms (10 Hours):** Laplace transforms solution of ODEs using Laplace transform, Transfer function approach, response of first order systems: step, impulse and sinusoidal response, first order systems in series.

**Unit-III: Second order systems (12 Hours):** Second order systems, higher order systems, transportation lag and dead time, Linear closed loop systems, development of block diagrams, classical feedback controllers, Final control element such as Proportional, Integral, PD, PID controllers (control valves), block diagram reduction techniques.

**Unit-IV: Closed loop response (12 Hours):** Closed loop response, servo and regulatory problems, Stability analysis, Routh stability criterion, Root locus diagrams (rule based), Introduction to frequency response, notion of stability.

**Unit-V: Bode diagrams (10 Hours):** Bode diagrams, Nyquist plots, Bode and Nyquist stability criterion, Controller tuning: Ziegler-Nichols method, Cohen-Coon method, Introduction to advanced controllers: cascade control, feed forward control, ratio control, Smith-predictor, IMC, MPC, dead-time compensation, Introduction to digital control.

## Text / References:

1. Coughanowr, D. R., LeBlanc, S. "Process Systems Analysis and Control", 3rd edition, McGraw-Hill (2008).
2. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, John Wiley (2003)
3. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984)

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| **CMA-701** | **Process Control** | **0L:0T:1P** | **1 credits** | **2Hrs/Week** |

## List of Experiment:

1. To study the characteristics of control valves (linear, quick opening, etc)
2. To study the dynamics of liquid level systems of non-interacting and interacting types.
3. To study the response of mercury in glass thermometer with and without a thermowell.
4. To study the characteristics of an electronic PID controller.
5. To study the characteristics of a current to pneumatic converter.
6. To study the effectiveness of computer control of a distillation column.
7. To study the effectiveness of a computer control of a heat exchanger.
8. To study to effectiveness of a computer control of a chemical reactor
9. To study to dynamics of a pressure tanks.
10. To calibrate an air purged liquid level indicator.

**CMA-702 Numerical Method in Chemical Engineering**

| CMA-702 | Numerical Method in Chemical Engineering | 3L:0T:0P | 3 credits | 3Hrs/Week |
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**Course Preambles:**

To introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming. Fundamentals of numerical methods/algorithms to solve systems of different mathematical equations (e.g. linear/ non-linear algebraic equations, ordinary /partial differential equations), will be introduced. The course would enable students to write their own computer programs using programming languages like C and commercial software like Matlab. Hands-on experience will be provided to apply these computer programs to solve problems in different areas of chemical engineering e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc. Practicals to involved solving actual chemical engineering problems through computer programming and coding.

**Course Outcomes:**

Students will be able to solve chemical engineering problems involving

- Linear and non-linear equations
- Ordinary and partial differential equations using programming languages like C and softwares like MATLAB.

**Unit-I: Introduction Error & Linear Algebraic Equations (12 Hours):** Introduction, Approximation and Concept of Error & Error Analysis, Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linear algebraic equations.

**Unit-II: Non-Linear Algebraic Equations (10 Hours):** Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non-linear equations.

**Unit-III: Interpolation (10 Hours):** Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression.

**Unit-IV: Numerical integration (10 Hours):** Numerical integration, Trapezoidal rule, Simpson’s rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration.

**Unit-V: Ordinary Differential Equations (15 Hours):** Ordinary Differential Equations, Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs, **Introduction to Partial Differential Equations:** Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method.

## Text / References:

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.
2. S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
3. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
4. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.
5. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

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| **CMA-702** | **Numerical Method in Chemical Engineering** | **0L:0T:1P** | **1 credits** | **2Hrs/Week** |

## List of Experiment:

1. Introduction to use of computers for numerical calculations (1 practical turn)
2. Solution of linear algebraic equations using Gauss elimination, Gauss-Siedel etc. (2 practical turns)
3. Solution of a non-linear equations using bracketing and Newton-Raphson method (2 practical turns)
4. Interpolation and Approximation(2 practical turns)
5. Numerical integration(2 practical turns)
6. Euler method (1 practical turn)
7. Runge-Kutta methods for ODEs (2 practical turns)
8. Solution of system of ODEs using simple methods (1 practical turn)
9. Solution of simple PDEs (2 practical turns)

# SCHOOL OF ENGINEERING

## SRI SATYA SAI UNIVERSITY OF TECHNOLOGY AND MEDICAL SCIENCES

**Syllabus of Examination - AICTE Pattern**

**Undergraduate Degree Courses in Engineering & Technology**

**Department of Chemical Engineering**

### CMA-703 (A) Polymer Technology

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| **CMA-703 (A)** | **Polymer Technology** | **3L:0T:0P** | **4 credits** | **3Hrs/Week** |

**Course Preambles:**

- To study industrial manufacturing process advantages disadvantages, process parameters of the thermoplastics like PVC Cellulosics Speciality polymers etc
- To give understanding of properties like physical mechanical thermal rheological etc and structure properties and relationship
- To make aware of practical applications of thermoplastics.
- To study basic processing methods coating applications related to of the thermoplastics

**Course Outcomes:**

- Explain central concepts within the fields of polymer physics and polymer technology
- Describe phenomena in terms of properties of polymer systems at molecular level
- Describe the relationship between microscopic and macroscopic levels for polymer systems
- Solve simple polymer-related problems arising in industrial contexts

**Unit-I: Polymerization Chemistry (10 Hours):** Chain, step and miscellaneous polymerization reactions and polymerization technique. Polymerization kinetics: Free radical, cationic and anionic polymerization, poly-condensation and polymerization.

**Unit-II: Polymerization Processes (10 Hours):** Bulk solution, emulsion and suspension polymerization, thermoplastic composites, fiber reinforcement fillers, surface treatment reinforced thermo-set composites resins, fillers, additives.

**Unit-III: Polymer Reactions (12 Hours):** Hydrolysis, acidolysis, aminolysis, hydrogenation, addition and substitution reactions, reactions of various specific groups, cyclyzation and cross linking reactions, reactions leading to graft and block copolymer

**Unit-IV: Manufacturing Processes of Polymers (12 Hours):** Manufacturing processes of important polymers: Plastics- polyethylene, polypropylene polyvinyl chloride & copolymer, polystyrene; Phenol-formaldehyde, epoxides, urethane, Teflon, elastomers, robbers, polymeric oils - silicon fibers - cellulosic (Rayon), polyamides (6:6 Nylon), Polyesters (Dacron). Acrylic-olefin.

**Unit-V: Composite Materials (12 Hours):** Composite materials - Ceramic and other fiber reinforced plastics, Polymer degradation - Thermal, Mechanical, Ultrasonic, Photo, High energy radiation, Ecology and environmental aspects of polymer industries. Rheological Sciences Equations, Uni-coelastic models - Maxwell.

## Text / References:

1. Rodringuez; Principles of polymer systems; TMH
2. Billmayer Jr, Fred W.; Textbook of polymer science; Wiley tappon
3. David J Williams; Polymer science & engineering; PHI
4. Mc. Keley, JH; Polymer processing; John Wiley

# SCHOOL OF ENGINEERING

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**Syllabus of Examination - AICTE Pattern**

**Undergraduate Degree Courses in Engineering & Technology**

**Department of Chemical Engineering**

**CMA-703 (B) Multi-Phase Flow**

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| **CMA-703 (B)** | **Multi-Phase Flow** | **3L:0T:0P** | **4 credits** | **3Hrs/Week** |

**Course Preambles:**

- The fallout of the multiphase flows is focused on: oil and gas industry, nuclear components and subsystems, chemical and petrochemical industry.
- Multiphase flow is important in many areas of chemical and process engineering. The behaviour of the material will depend on the properties of the components, the flow rates, and the geometry of the system.

**Course Outcomes:**

- Develops as the flow rate is increased whilst vapor flow is maintained at a low amount.
- Two phase flows are commonly found in ordinary life and in industrial processes.
- Gas-liquid flow also occurs in boiling and condensation operations.

**Unit-I: Introduction (10 Hours):** Introduction to the flow of multiphase mixtures: gas or vapor liquid, liquid-liquid, liquid-solid, gas-solid, solid-liquid-gas and gases carrying solids (pneumatic transport) stratification and dispersion, Flow regimes and flow patterns.

**Unit-II: Gas (Vapor) and Liquid Flows (10 Hours):** Horizontal flow, Vertical flow, pressure, momentum and energy relations, methods of evaluating pressure drop, Lockhard - Martinell, Chisholm correlations, critical flow, non-Newtonian flow.

**Unit-III: Physical-Chemical Properties (12 Hours): P**hysical, chemical properties, rheology, corrosive nature, viscosity, Solid particle size, distribution phase, and density i.e. their factors effecting behavior in a fluid, Concentration of particles and the flow rates of both solids and liquid.

**Unit-IV: Solid-Gas Flow (12 Hours):** Horizontal flow, Suspension mechanism, determination of voids, energy requirements for conveying, pressure drop and solid velocities in dilute phase flow, dense phase conveying, vertical transport.

**Unit-V: Bubble and Drop Formation (10 Hours):** Phase holdups, Interfacial areas, mixing and pressure drops, multiphase (gas liquid solid) operations.

**Text / References:**


1. The flow of complex mixtures in pipe Govier, G.W. and Aziz, K
2. Chemical engineering, Vol I, Coulson JM and Richardson J.F
3. Multiphase Flow Handbook Crowe, C.T.
4. Fundamentals of Multiphase Flow Brennen, C.E

### CMA-704 (A) Food Technology

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| **CMA-704 (A)** | **Food Technology** | **3L:0T:0P** | **4 credits** | **3Hrs/Week** |

**Course Preambles:**

- Knowledge and understanding of food properties, processing and preparation and their interrelationship to produce quality food
- Knowledge and understanding of nutrition and food consumption, and the consequences of food choices on health.

**Course Outcomes:**

- Demonstrates hygienic and safe practices in the selection, handling and storage of food.
- Recognises the relationship between food properties, preparation and processing.
- Recognises the nutritional value of food items, recognises the impact of food habits and choices on health.

**Unit-I: Introduction (06 Hours):** Current status of the Indian a) agriculture b) Food Industry c) Food processing industry.

**Unit-II: Basic Food Biochemistry and Microbiology (12 Hours):** Food Constituents, Water activity enzymes, Ambient Temperature Processing: Raw material preparation, Size reduction of solid fibrous foods and in liquid foods, Emulsification and Homogenization, Theory and equipment, Mixing and Forming, Extraction and expression,

**Unit-III: Membrane Concentration Fermentation (10 Hours):** Membrane concentration Fermentation: Theory, Types, Equipment Effect on foods.

**Unit-IV: Heat Processing using Heat or Water (10 Hours):** Theory, Equipment, Effect on foods, blanching, extrusion, pasteurization, Heat Sterilization, In-container Ultra high temperature (UHT)/aseptic processes. Heat processing using Hot air: Theory, Equipment, Effect on foods, Dehydration, Baking and Roasting; Heat Processing using hot oils: Theory, Equipment, Effect on foods Frying.

**Unit-V: Heat Processing by Direct & Radiated Energy: (12 Hours):** Heat Processing by direct & radiated energy: Theory, Equipment, Effect on foods Dielectric heating microwave. Processing by removal of heat, Food Preservation & Storage Food contamination Modified Atmosphere Storage (MAS) Hurdle Technology, Post Processing, Applications, and Packaging**.**

**Text / References:**

1. Vijaya khader, Preservation of Fruits and Vegetables.
2. Viyaya khader, Food Processing and Preservation.
3. Srilakshmi. B, Food science, (2nd edition) & Food science & Nutrition.
4. Swaminathan. M, Essentials of Food and Nutrition , Vol. I & II.

## CMA-704 (B) Optimization Methods

| CMA-704 (B) | Optimization Methods | 3L:0T:0P | 4 credits | 3Hrs/Week |
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**Course Preambles:**

- To understand the basics of optimization techniques, and problem formulation for optimization
- To understand the single variable and multivariable optimization techniques and their application
- To understand the linear programming application for optimization
- To understand the advance optimization technique like the genetic algorithm

**Course Outcomes:**

- The students will understand the necessary and sufficient condition for optimization and will be able to formulate the optimization problem.
- The students will be able to solve different optimization problem and their application to the case studies like heat exchanger, evaporator etc.

**Unit-I: Nature and Organization of Optimization Problems (10 Hours):** What optimization is all about, Why optimize, scope and hierarchy of optimization, examples of applications of optimization, the essential features of optimization problems, the general procedure for solving optimization problems, obstacles to optimization.

**Unit-II: Basic Concepts of Optimization (10 Hours):** Continuity of functions, unimodal versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function, interpretation of the objective function in terms of its quadratic approximation.

**Unit-III: Optimization of Unconstrained Functions (12 Hours):** One-dimensional search: Numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton's, Quasi-Newton's and Secant methods of uni-dimensional search, region elimination methods, polynomial approximation methods, how the one- dimensional search is applied in a multi-dimensional problem, evaluation of uni-dimensional search methods.

**Unit-IV: Unconstrained Multivariable Optimization (15 Hours):** Direct methods, random search, grid search, uni-variate search, simplex method, conjugate search directions, Powell's method, indirect methods- first order, gradient method, conjugate method, indirect method-second order: Newton's method forcing the Hessian matrix to be positive definite, movement in the search direction, termination, summary of Newton's method, relation between conjugate gradient methods and Quasi-Newton method.

**Unit-V: Linear Programming and Applications (12 Hours):** Basic concepts in linear programming, Degenerate LP's – graphical solution, natural occurrence of linear constraints, the simplex method of solving linear programming problems, Optimization of Unit operations, recovery of waste heat, shell & tube heat exchangers, evaporator design, liquid-liquid extraction process, optimal design of staged distillation column.

**Text / References:**

1. Edgar, T.F., D.M. Himmelblau, and L.S. Lasdon, Optimization of Chemical Processes, 2nd Edition, McGraw-Hill International Edition, Singapore, 2001.
2. Rao, S.S., Engineering Optimization Theory and Practice, 4th Edition, A Wiley Interscience Publication, Canada, 2009.
3. Reklaitis, G.V., A. Ravindran, and K.M. Ragsdell, Engineering Optimization: Methods and Applications, 2 nd Edition, John Wiley, New York, 2006.
4. Fletcher R., Practical method of optimization, 2 nd Edition, John Wiley, New York, 2000.
5. Chong E.K.P. and Zal S. H., An Introduction to optimization, 2 nd Edition, John Wiley, New York, 2001.
6. Nocedal J. and Wright S.J. Numerical Optimization, 2 nd Edition, Springer,2000.
7. G. Mitsuo and C. Runwei, Genetic Algorithms and Engineering Optimization, John Wiley, New York, 2000.

### CMA-705 Project Stage-I

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| **CMA-705** | **Project Stage-I (Minor)** | **0L:0T:10P** | **5 credits** | **20Hrs/Week** |

**Preambles:**

The following objective should be fulfilled in industrial training–II, and student must participate in any Chemical, Petrochemical, Pharmaceutical, Oil and Gas industry where they can learn to apply the Technical knowledge in real Industrial situations.

- Gain experience in writing Technical reports/projects.
- Expose students to the engineer’s responsibilities and ethics.
- Expose the students to future employers.
- Understand the social, economic and administrative considerations that influence the
- Working environment of industrial organizations.