| Course code | Course Name | L-T-P-Credits | Year of Introduction |
|---|---|---|---|
| **CH465** | **PROCESS OPTIMIZATION** | **3-0-0-3** | **2016** |

**Prerequisite : Nil**

**Course Objectives**

- To identify and formulate different types of optimization problems
- To solve various multivariable optimization problems
- To apply different optimization techniques in process design.

**Syllabus**

Nature and essential features of optimization problems, formulation of optimization problems, convex and concave functions, numerical methods for one dimensional optimization problems, numerical methods for unconstrained multivariable optimization, nonlinear programming with constraints, application of optimization techniques in process design

**Expected Outcome**

The students completing this course will be able to:

i. analyze & solve practical chemical engineering optimization problems
ii. apply the knowledge of optimization to design problems

**Text Books**

1. Beightler C.S., Phillips D.T. & Wilde D.J., Foundations of Optimization, Prentice Hall of India
2. Beveridge G.S.G. & Schechter R.S., Optimiszation: Theory & Practice, McGraw Hill
3. Edgar T.F. & Himmelblau D.M., Optimization of Chemical Processes, McGraw Hill
4. Rao S.S., Optimization: Theory and Applications, Wiley Eastern

**Reference Books**

1. J. Nocedal and S. J. Wright, Numerical Optimization, Springer Verlag.
2. M.C. Joshi and K. M. Moudgalya, Optimization: Theory and Practice, Narosa Publishing.

**Course Plan**

| Module | Contents | Hours | Sem. exam marks |
|---|---|---|---|
| I | Nature and organisation of optimisation problems - scope and hierarchy of optimisation -typical applications of optimisation - essential features of optimisation problems – objective function - investment costs and operating costs in objective function - optimising profitability - constraints - internal and external constraints | 7 | 15% |
| II | Formulation of optimisation problems -typical examples - nature of functions and their representation - continuous functions - discrete functions - unimodal functions - convex and concave functions - necessary and sufficient conditions for optimum of unconstrained functions | 7 | 15% |

| FIRST INTERNAL EXAMINATION | | | |
|---|---|---|---|
| III | Numerical methods for unconstrained functions - one dimensional search - gradient-free search with fixed step size - gradient search with acceleration - Newton's method - Quasi-Newton method - dichotomous search -fibonacci search - golden-section method – quadratic interpolation | 8 | 20% |
| IV | Numerical methods for unconstrained multivariable optimisation – univariate search - Powell's method - method of steepest descent - Fletcher-Reeves conjugate - gradient method - Newton's method<br>Linear programming - basic concepts in linear programming - graphical interpretation -simplex method - apparent difficulties in the simplex method - two-phase simplex method | 8 | 20% |
| SECOND INTERNAL EXAMINATION | | | |
| V | Nonlinear programming with constraints - equality constraints - method of direct substitution<br>Lagrange multiplier method - use of lagrange multipliers for inequality constraints – Kuhntucker conditions for local optimality<br>Complex method, - Rosen's gradient projection method | 6 | 15% |
| VI | Optimising recovery of waste heat - optimisation of evaporator design - optimum diameter for pipe for transportation of fluid - optimisation of liquid - liquid extraction process - optimal design and operation of staged distillation columns - optimum residence time for isothermal batch reactor - linear programming to optimize reactor operations | 6 | 15% |
| END SEMESTER EXAMINATION | | | |

**Question Paper Pattern**

Maximum Marks: 100 Exam Duration: 3 Hours

**Part A**: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

**Part B**: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together. (2 x20= 40 Marks)

**Part C**: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)