M.Tech Thermal Engineering 2nd year (3rd semester)

Title of Course : Optimization Techniques & Design Of Experiments
Course Code: TE301
L-T-P Scheme: 3-1-0 Course Credits: 4

Introduction:

This course introduces students to concepts and techniques of Classical and Bayesian design - experimental units, randomization, treatments, blocking and restrictions to randomization, and utility of designs. We will cover optimal sample size determination for estimation and testing. Topics include simple A-B testing, factorial and fractional factorial designs, response surface methods, conjoint designs, sequential designs, bandit problems used in on-line advertising, design and modeling of complex computer experiments, and designs for multiple objectives. Computational algorithms for finding optimal designs will be covered in the context of various problems.

Course Objective:

1. Understanding the details of various design methods,
2. Being able to use one or more appropriate techniques to analyze experimental results

Course Outcomes:

CO 1. Understand the different philosophical approaches to experimental design (Bayesian and frequentists)
CO2. Build a solid foundation for the statistical theory for experimental design.
CO3. Build appropriate statistical models for designed experiments, perform data analysis using appropriate software, and communicate results without use of statistical jargon.
CO4. Construct appropriate experimental designs for given problems: sample size determination, choice of levels of variables, designs with restrictions on randomization, utility functions for measuring design objectives, use of simulation to characterize properties of designs

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					3
CO2		2			1	
CO3			3			
CO4			3			

3 – High; 2 – Medium; 1 – Low

Course Contents:

SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION: Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. Variable metric method.

GEOMETRIC PROGRAMMING: Polynomials – arithmetic – geometric inequality – unconstrained G.P – constrained G.P

DYNAMIC PROGRAMMING: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

LINEAR PROGRAMMING: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. Simulation: Introduction – Types – Steps – application – inventory – queuing – thermal system.
INTEGER PROGRAMMING: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

STOCHASTIC PROGRAMMING: Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution – stochastic linear, dynamic programming.

TEXT BOOKS:
1. Optimization theory & Applications S.S Rao New Age International
2. Introductory to operation research Kasan & Kumar Springer
3. Optimization Techniques theory and practice M.C Joshi, K.M Moudgalya Narosa Publications.
4. Operation Research H.A. Taha TMH
5. Optimization in operations research R.L Rardin

Title of Course : Theory and Design of Heat Exchangers
Course Code: TE302
L-T-P Scheme: 3-1-0 **Course Credits: 4**

Introduction:

The heat exchanger design equation can be used to calculate the required heat transfer surface area for a variety of specified fluids, inlet and outlet temperatures and types and configurations of heat exchangers, including counterflow or parallel flow. A value is needed for the overall heat transfer coefficient for the given heat exchanger, fluids, and temperatures. Heat exchanger calculations could be made for the required heat transfer area, or the rate of heat transfer for a heat exchanger of given area.

Course Objectives:

To learn the sizing of heat exchangers, thermal and mechanical stress analysis for
various heat exchange applications

Course Outcomes:

After learning the course, the students should be able to:
CO1. Learn how to design common types of heat exchangers; namely shell-and-tube, tube and tube.
CO2. Understand types of heat exchangers that will include shell-andtube, double pipe, finned tube, and plate-fin heat exchangers and apply LMTD and Effectiveness methods in the design of heat exchangers
CO3. Measure the performance degradation of heat exchangers subject to fouling.
CO4. Become aware of single and multiphase heat transfer and friction coefficient correlations, and they will know how to select the appropriate ones for the case in hand

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3		3	
CO2	3	3	3			3
CO3			2		3	
CO4			3			

3 – High; 2 – Medium; 1 – Low

Course Contents:

Different classification and basic design methodologies for heat exchanger:
Classification of heat exchanger, selection of heat exchanger, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, fouling, cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology

Design of double pipe heat exchangers:
Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop

Design of Shell & tube heat exchangers:
Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method.

Transfer Enhancement and Performance Evaluation:
Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique.
Introduction to pinch analysis

Design of compact heat exchangers
Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop

TEXT BOOKS:

1. T.Taborek, G.F.Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw-Hill Book Co.1980.
2. Walker, Industrial Heat Exchangers- A Basic Guide, Mc Graw Hill Book Co. 1980
3. Nicholas Cheremistoff, Cooling Tower, Ann Arbor Science Pub 1981
4. Arthur, P. Frass, Heat Exchanger Design, John Wiley and Sons, 1988
5. J.P. Gupta, Fundamentals of heat exchangers and pressure vessel technology, Hemisphere publishing corporation, Springer-Verlag (outside NA), 1986
6. Donald Q. Kern and Alban D. Kraus, “Extended surface hear transfer” Mc Graw Hill Book Co., 1972

Title of Course: SEMINAR-I
Course Code: TE391
L-T-P Scheme: 0-2-0 **Course Credits: 1**

In II year III semester, a seminar presentation of project proposal shall be done by Supervisor for 1 credit.
The Supervisor along with department's member will examine the Problem Definition, Objectives, Scope of Work and design of Project via presentation in seminar. A candidate shall secure a minimum of 40% to be declared successful in Seminar-I presentation. If candidate fails to fulfill minimum marks, he has to reappear during the supplementary examination.

Title of Course: Project-Part I
Course Code: TE392
L-T-P Scheme: 0-0-12 **Course Credits: 12**

In II year III semester, a project work review shall be done by Supervisor for 12 credit. The evaluation for the project reviews shall be done in 4 stages (not less than 4 weeks between two consecutive stages) including end semester evaluation.
The Supervisor and internal examiner along with department's member will examine the Problem Definition, Objectives, Scope of Work and design of Project via presentation in seminar. A candidate shall secure a minimum of 50% to be declared successful in Seminar-I presentation. If candidate fails to fulfill minimum marks, he has to reappear during the supplementary examination.