Department of Mechanical Engineering

National Institute of Technology Raipur

(Institute of National Importance)

G. E. Road, Raipur-492010 (CG)

B.Tech. in Mechanical Engineering

Seventh Semester Scheme

Sl. No.	Course Title	Course Name	L	T	P	Credits
1.	Program Core (CXX71) ME107101ME	Production Management	3	1	0	4
2.	Program Elective (EXX4) ME10720XME		3	0	0	3
3.	Program Elective (EXX5) ME10721XME		3	0	0	3
4.	Open Elective (OXX3) ME10730XME		3	0	0	3
5.	Project work		0	0	8	4
6.	Laboratory	Mechanical Lab - 9	0	0	2	1
7.	Summer Internship II					2
			12	**1**	**10**	**20**

List of Program Electives (EXX4)		
Sl. No.	**Code**	**Course Name**
1.	ME107201ME	**Fluid Mechanics-II-Fluid Machinery**
2.	ME107202ME	**Solar Energy Utilization**
List of Program Electives (EXX5)		
1.	ME107211ME	**Energy Conversion System**
2.	ME107212ME	**Power Plant Engineering**
3.	ME107213ME	**Tribology**

List of Open Electives (OXX3)		
Sl. No.	**Code**	**Course Name**
1.	ME107301ME	**Air Pollution Control**
2.	ME107302ME	**Integrated Product Development**
3.	ME107303ME	**Optimization Techniques**

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Fluid Mechanics-II-Fluid Machinery**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Program Elective**
7.	Pre-requisites (course no./title)	Nil
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of the course, the student will be able to 1. Understand the concept of relative velocity and velocity diagrams of Jets and calculate the Vane angles, power transfer and efficiency. 2. Understand the concept of axial, tangential and radial flow in turbomachinery 3. Understand the concept of different type of Turbines. 4. Understand the concept of different type of Pumps	
10.	**Course Syllabus** **UNIT I** **IMPACT OF JETS**: Impulse momentum principle, force exerted by the jet on stationary and moving plate. Concept of relative velocity and velocity diagrams. Vane angles, power transfer and efficiency. **INTRODUCTION TO TURBO MACHINERY:** positive displacement and rotodynamic or turbomachines, types of turbomachines, axial, tangential and radial flow, impulse and reaction types, degree of reaction, velocity diagrams, Eulers equation. **UNIT II** **INTRODUCTION TO TURBINES:** Hydroelectric power plant, location, major components, surge tank, classification of turbines, specific speed, **PELTON TURBINE:** major components and their function, specific speed, nozzles, force, power, losses of power, different efficiencies, bar diagram. **UNIT III** **REACTION TURBINES**: Francis turbine, construction, major parts, working, work done, efficiency, cavitation, role of draft tube, advantages and disadvantages. Kaplan and propeller turbine working and comparison, model analysis. **UNIT IV** **CENTIFUGAL PUMP**: Construction, working, velocity diagram, work done, power, efficiency, pumps in series and parallel, cavitation, specific speed **RECIPROCATING PUMP**: classification and working, single acting and double acting,	

	slip, indicator diagram, work done and power, air vessel, use, cavitation.
11.	**Text Books-** 1. **Mechanics of fluid** – Massey B S – English Language Book Society (U K) 2. **Fluid Mechanics** –Yunus A . Cengel and John M Cimbala – McGraw Hill
12.	**Reference Books-** 1. **A Text book of fluid mechanics**—R K Rajput—S Chand and Co, Ltd 2. **Introduction to Fluid mechanics and machines** --- S K Som and G Biswas --- McGraw Hill

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Solar Energy Utilization**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Program Elective**
7.	Pre-requisites (course no./title)	Thermodynamics, Heat and Mass Transfer
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of the course, the student will be able to 1. Estimate the amount of solar radiation received by any surface, at any place, on any date over the globe. 2. Estimate, Evaluate and analyse the amount of distillation of potable water by various techniques based on solar energy. 3. Evaluate and analyse the use of various solar thermal applications that includes air heater, solar chimney, solar dryer for energy conservation as a benefit to the society and to mankind. 4. Estimate the economic feasibility of any proposed solar thermal application in the light of payback period and life cycle etc.	
10.	**Course Syllabus** **UNIT I** **Calculation of solar radiation received:** The sun, Solar Radiation: Terrestrial, Extraterrestrial, Sun Earth angles, Availability of solar radiation on inclined surface, on horizontal surface, Solar Time, Sun rising, and sun set time, day length, sunshine hours, Estimation of beam and diffused components of hourly, daily, monthly average, radiation on any surface on any day and at any place. **UNIT II** **Solar distillation:** Introduction, working principle, thermal efficiency, instantaneous efficiency, overall thermal efficiency, heat transfer, external heat transfer, top loss coefficient, bottom and side loss coefficient, internal heat transfer, radiative loss coefficient, convective loss coefficient, evaporative loss coefficient, determination of distillate output, passive solar stills, effect of various parameters, other designs, modified internal heat transfer. **UNIT III** **Solar thermal devices**, Description and classifications, conventional heaters, double exposure heaters, air heater with flow above and both side of the absorber, two pass solar air heater, heater with finned absorber, vee-corrugated absorber, reverse absorber heater, with porous absorber, testing of solar air collector, parametric studies, applications of air heater, comparison of performance of liquid and air collector.	

	Other Solar Thermal Devices: solar cooker, solar driers, solar chimney etc. **UNIT IV** **Economic analysis of solar equipment:** Introduction, cost analysis, Cash flow diagrams, cost comparison with equal and unequal duration, Payback time with and without interest, benefit cost analysis, Effect of depreciation, cost comparison after taxes.
11.	**Text Books-** 1. **Solar Energy Fundamentals, Design Modelling and Applications** By G.N.Tiwari, Narosa publication 2. **Solar distillation practice for water desalination systems**: By G.N.Tiwari and A.K.Tiwari, Anamaya Publishers. 3. **Solar Energy Principles of thermal collection and** storage By S P Sukhatme and J K Nayak
12.	**Reference Books-** 1. **Advance solar distillation systems** By G N Tiwari and Lovedeep Sahota 2. **Solar Engineering of Thermal Processes** by Duffie and Beckman

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Energy Conversion System**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Program Elective**
7.	Pre-requisites (course no./title)	Physics, MOS-1, Basic Mechanical Engineering
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of this course, the students will be able to 1. Explain the functioning of different types of high-pressure boilers. 2. Apply thermodynamics principle in closed and open system. 3. Differentiate various forms of non- conventional energy sources. 4. Apply the principle of momentum and thrust equation for jet propulsion systems.	
10.	**Course Syllabus** **UNIT I – Boilers** Classification of boilers, Boiler mountings & accessories, Draught & its classification, Chimney height & diameter calculation, Efficiency of a chimney, Draught losses. High pressure boilers – La-Mont, Benson, Velox and Super critical boiler, Fluidized bed boiler. **UNIT II – Steam Condensers** Function, Types of condensers, Efficiency and measurement. Analysis of condenser operation, Source of air leakage, Effect of air leakage, Air extraction, Thermodynamic analysis. **UNIT III – Direct Energy Conversions** Tidal energy conversion, OTEC, MHD power system, Geothermal energy, Conversion technique, Thermo-electric effects, Thermo-electric & thermionic converters. **UNIT IV – Jet Propulsion** **Aircraft Propulsion**: Types of jet engines, Principle and operation, Thermodynamics of turbo jet, Efficiency and performance, Turbo prop, Ram jet, Pulse jet, Comparison of various propulsive devices **Rocket Propulsion:** Types of rocket engines**,** Basic theory, Physics equations, Classifications, Liquid propellant rockets and its advantage, Efficiency and performance, Rocket projection and escape velocity.	
11.	**Text Books-** 1. **Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion –** S.M. Yahya – New Age International Publishers. 2. **Thermal Engineering –** Mahesh M. Rathore- McGraw Hill Education.	

	3. **Thermodynamics & Heat Engines** – R. Yadav – CPH. 4. **Non Conventional Energy Resources**- B. H. Khan- McGraw Hill Education
12.	**Reference Books-** 3. **Fundamental of Compressible Fluid Dynamics** – P. Balachandran – PHI. 4. **Gas Turbine Theory & Jet Propulsion** – J.K. Jain – Khanna Publishers. 5. **High Pressure Boilers**- Frederick M. Steingress, Harold J. Frost, Daryl R. Walker- American Technical Publishers. 6. **Thermal Engineering (engineering Thermodynamics & Energy Conversion Techniques)**- P. L. Ballaney- Khanna Publishers.

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Power Plant Engineering**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Program Elective**
7.	Pre-requisites (course no./title)	Strength of Materials, Fluid Mechanics, Machine Design, Engineering Mechanics, Material science and engineering mathematics
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of this course, the students will be able to 5. The steam power plant. 6. The Hydroelectric power plant. 7. The Nuclear power plant. 8. The Diesel power plant 9. Variable load problems and power station economics.	
10.	**Course Syllabus** **UNIT I** General Sources of power, Central Power Stations, Elements of electric power systems primary and secondary distribution substations (in brief). **Steam Power Plant:** Elements of modern steams power stations, brief layout and arrangement of elements and complements, Foundation. Heat Balance in steam cycles, Fuels and fuel handling System and Ash handling System, Air pre-heater, Feed water pre-heaters, Steam re-heaters, Dearators, Feed water treatment, Pumping and regulation water walls, Modern developments in steam boilers, Important instrumentation and piping of gas and water loop. Factors to be controlled from maximum efficiency and variable output. **UNIT II** **Hydro Electric power station** –Potential power with reference to rainfall and catchments **a**rea, Water storage, Equipment used in hydro electric power stations, Characteristics of hydraulic turbines, Comparison of the factors governing the cost of hydro steam and diesel power stations. **Diesel power station** –Application of Diesel in power field, Suitability of dieselengines for bulk power, Layout of Diesel Power Plant, Advantages and limitations of diesel, Power stations, Performance Characteristics. **UNIT III** **Nuclear Power Station -**Evolution of nuclear energy from atoms by fission and fusion, Chain reactions, Fission materials, Type of reactors, gas cooled, Boiling water	

	liquid,Metal cooled and fast reactor, Arrangements of various elements in a nuclear power station, Steam cycles and boilers coolant heat exchangers, Reactor control, Reactor shielding and safety methods. **UNIT IV** **Variable load problems:** Idealized and realized load curves, Effect of variable load on plant design and operation variable load operation. **Power station Economics:** Source of income, Cost of plant and production, Elements of cost, depreciation and replacement theory of rates.
11.	**Text Books-** 1. **Power Plant Engineering**, 2nd Edn. – P.K. Nag – Tata McGraw-Hill Pub. Com., New Delhi. 2. **Fundamental of Power Plant Engineering** -R. Yadav-Central Publishing House Allahabad,2011 3. **Plant Engineering** – G. R. Nagpal – Khanna Publishers.
12.	**Reference Books-** 1. **Power Plant Engineering** – F. T. Morse Affiliated East – West Press Pvt. Ltd., New Delhi. 2. **Power Plant Technology** – M. M. E1 – Wakil – McGraw Hill, International Edition 1984

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Tribology**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Program Elective**
7.	Pre-requisites (course no./title)	Strength of Materials, Fluid Mechanics, Machine Design, Engineering Mechanics, Material science and engineering mathematics
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of this course, the students will be able to 1. Differentiate different types of lubricants 2. Understand different laws of friction 3. Appreciate the various modes of wear: adhesive, delamination, fretting, abrasive, erosive, corrosive, oxidational (mild and severe). 4. Identify types of lubrication: boundary, solid-film, hydrodynamic, and hydrostatic lubrication. 5. Classify different types of bearings and select for different engineering applications	
10.	**Course Syllabus** **UNIT I** Tribology Introduction, Historical background, Practical Importance and subsequent use in the field. **Friction:** Origin, Friction Theories, measurement methods, friction of metals and non metals. **Wear:** Classification and Mechanisms of Wear, Delamination theory, Testing methods, approach to wear reduction **UNIT II** **Lubricants:** Types and specific field of applications. Requisite properties of lubricants. Viscosity, its measurement, effect of temperature and pressure on viscosity, standard grades of lubricants, selection of lubricants. Lubrication Types, Basic equation of lubrication. **Surface Roughness:** Standardization, measurement with contacting and non-contacting instruments, Statistical analysis of surface, characteristics of the surface. **Condition Monitoring:** Condition monitoring & monitoring techniques for tribological systems, Lubricant monitoring, Temperature monitoring, Corrosion monitoring, Surface roughness monitoring. **UNIT III**	

	Behaviour of Tribological components, Bearings, Classification, selection, effect of frictional torque, factors affecting performance, failure modes, bearing lubrication. **Hydrodynamic Bearings:** Mechanism of pressure development, classification, Idealized Journal Bearing, oil film thickness, pressure distribution, load carrying capacity. **Elastohydrodynamic Lubrication:** Theoretical considerations, line and point contacts, film thickness equations, different regimes in EHL contact. **UNIT IV** **Antifriction Bearings:** Ball and roller bearings, geometry of ball bearings, radial load distribution, stresses and deformations, lubrication of ball bearings. **Gears:** friction & stresses, wear, lubrication & failure. Failure Case Studies. **Green Tribology:** Basics and Applications **Nano Tribology:** Basics and Applications Case Studies in different areas of Engineering.
11.	**Text Books-** 1. **Engineering Tribology**– Prasanta Sahoo – Prentice Hall of India Pvt. Ltd., New Delhi, 2005. 2. **Fundamentals of Tribology –** S.K. Basu, S.N. Sengupta, B.B. Ahuja – PHI Learning Pvt. Ltd., 2010. 3. **Tribology in Industries** – S.K. Shrivastava – S. Chand & Company Ltd., New Delhi, 2001
12.	**Reference Books-** 1. **Engineering Tribology** – G.W. Stachowiak, A.W. Batchelor – Elsevier India Pvt. Ltd., New Delhi. 2. **Introduction to Tribology of Bearings** – B.C. Majumdar – S. Chand & Company Ltd., New Delhi. 3. **Rolling Bearing Analysis** – T.A. Harris – John Wiley & Sons, Inc., New York

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Air Pollution Control**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Open Elective**
7.	Pre-requisites (course no./title)	Nil
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of the course, the student will be able to 1. Identify sources of air pollution and its effect, relationship between pollutant concentrations, legislation & regulation. 2. Explain about emission from IC engine &major industries along with control measures. 3. Discuss meteorological aspects of air pollutant dispersion 4. Discuss air pollution sampling& measurements, pollution control method and control Equipment.	
10.	**Course Syllabus** **UNIT I** **Air Pollution: Introduction** Air Pollution, sources & classification of air pollutants, aerosols, Primary & secondary air pollutants, Photochemical Air pollution, Effect of air pollution on human health, vegetation and materials, Pollutant concentration, types, relationship between different concentration Air pollution indices, determination of index, Air pollution legislation & regulations (1981 & 1986). **UNIT II** **Air pollution: Transportation & Major Industries** Air pollution due to automobiles, types of emission from IC Engines, Effect of various operating variables on exhaust emission, control of emissions from IC Engines. Air pollution from major industries: Fe & Steel Industry, Thermal Power Plants Cement Industries. Smoke, measurement of smoke and its control. **UNIT III** **Meteorological Aspects of Air pollutant Dispersion** Temperature Lapse rates & stability, wind velocity and turbulence, Plume Behaviour, Dispersion of air pollutants, the Gaussian Plume Model. **Air Pollution Sampling & Measurement** Types of pollutant sampling techniques and measurement, Ambient Air Sampling, collection of gaseous air pollutants and particulate pollutants, stack sampling techniques, analysis of air pollutants.	

	UNIT IV **Air Pollution control methods & Equipment** Air pollution source correction methods: Process changes, equipment modification/ machinery replacement etc. Gases/ Odour control: Combustion, Absorption, Adsorption. Control equipment's: Objectives and choice of control equipment, Settling chamber, Inertial separators, Cyclones, filters, Electrostatic Precipitator, Scrubbers.
11.	**Text Books-** 1. **Air Pollution-** M.N. Rao, H.V.N. Rao, Tata McGraw Hill Company. 2. **Environmental Pollution Control Engineering** - C.S. Rao, New Age International Limited Publishers.
12.	**Reference Books-** 1. **Air Pollution control Theory**- Martin Crawford, Tata McGraw Hill Company.

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Integrated Product Development**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Open Elective**
7.	Pre-requisites (course no./title)	Nil
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of the course, the student will be able to 1. gain the knowledge of the product development process; from market analysis, product design and manufacturing to market introduction and sales and identify the various problems regarding the product development in the industries. 2. understand the integration of customer requirements in product design concept generation, selection and testing for development of product. 3. launch own ideas and the ideas of others, which enables you to manage your own company as well as to work with innovation and development in large companies. 4. analyze when and how to outsource activities to the greatest benefit of the company	
10.	**Course Syllabus** **UNIT I - Fundamentals of Product Development** **Global Trends Analysis and Product decision:** Types of various trends affecting product decision - Social Trends, Technical Trends, Economic Trends, Environmental Trends, political/Policy Trends; PESTLE Analysis. **Introduction to Product Development Methodologies and Management:** Overview of Products and Services; Types of Product Development (NPD/ Re-Engineering; Overview of Product Development methodologies; Product Life Cycle; Product Development Planning and Management. **UNIT II - Requirements and System Design** **Requirement Engineering:** Types of Requirements (Functional, Performance, Physical, Regulatory, Economical, Behavioral, Technical, Stakeholder, Environmental, Industry specific, Internal-Company Specific); Requirement Engineering (Gathering (VOC), Analysis (QFD), Design Specification); Traceability Matrix and Analysis; Requirement Management. **UNIT III - Design and Testing** **Conceptualization:** Industrial Design and User Interface Design; Introduction to Concept generation Techniques; Concept Screening & Evaluation. **Detailed Design:** Component Design and Verification; High Level Design/Low Level	

	Design of S/W Programs, S/W Testing; Hardware Schematic, Component design, Layout and Hardware Testing. **Testing, Certification and Documentation:** Introduction to Product verification processes and stages (DFMEA, FEA, CFD); Introduction to Product validation processes and stages - Industry specific (Sub-system Testing/ Integration Testing/ Functional Testing/ Performance Testing / Compliance Testing); Product Testing standards and Certification – Industry specific; Product Documentation (Compliance Documentation, Catalogue, Brochures, user manual, maintenance Manual, Spares Parts List, Warranty, Disposal Guide, IETMS, Web Tools). **UNIT IV - Business Dynamics – Engineering Services Industry** **The industry:** Engineering Services Industry – overview; Product development in Industry versus Academia. **The IPD Essentials:** Introduction to vertical specific product development processes; Product development Trade-offs; Intellectual Property Rights and Confidentiality; Security and configuration management.
11.	**Text Books-** 1. **Student handbook,** by NASSCOM and NIT Silchar
12.	**Reference Books-** 1. **Product Design and Development,** 4th edition, Karl T. Ulrich and Steven D. Eppinger, Irwin McGraw-Hill, 2008. 2. **Quality Function Deployment, Productivity Press**, Akao, Y., ed. (1990), Cambridge MA. Becker Associates Inc. 3. **The Mechanical Design Process,** Ullman, David G. Mc Graw-Hill, 4th edition, 2009 4. **Product design techniques in reverse engineering and new product development,** Kevin Otto, Kristin Wood, Pearson, India, 2001 5. **Designing engineering systems for sustainability,** Sandborn P, Myers J., In: Misra KB, editor. **Handbook of performability engineering**, London: Springer; 2008. p. 81–103.

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Semester-VII

1.	Department proposing the course	**Mechanical Engineering**
2.	Course Title	**Optimization Techniques**
3.	L-T-P Structure	**3-0-0**
4.	Credits / # of period	3
5.	Course Number (Code)	
6.	Status (Core/Elective)	**Open Elective**
7.	Pre-requisites (course no./title)	Nil
8.	Frequency of offer	Once per Academic Year
9.	**Course Objectives (CO):** At the end of the course, the student will be able to 1. Acquire knowledge and develop basic understanding of the concepts of optimization and mathematical modelling. 2. Acquire knowledge for basic modelling techniques to formulate the real-life practical problems into a mathematical model. 3. Use different direct and gradient based optimization method to solve single and multivariable un-constrained or constrained nonlinear function for minimization or maximization. 4. Use non-traditional optimization methods such as Genetic Algorithms, Simulated Annealing, Global Optimization 5. Application of software for optimization and develop the computer programs for different optimization algorithms 6. Get aware to Goal Programming, Advanced Optimization Techniques and Dynamic Programming	
10.	**Course Syllabus** **UNIT I** Introduction, Single Variable Optimization, Bracketing Methods (Exhaustive Search Method, Bounding Phase Method), Region Elimination Methods (Interval halving Method, Fibonacci Search Method, Golden Section Method), Point Estimation Methods, Gradient Based Methods (Newton-Raphson Method, Bisection Method, Secant Method, Cubic Search Method) **UNIT II** Multivariable Optimization Techniques, Unidirectional Search Methods, Direct Search Methods (Evolutionary Optimization Method, Simplex Search Method, Hooke-Jeeves Pattern Search Method, Powell's Conjugate Direction Method), Gradient Based Methods (Cauchy's Steepest Descent Method, Newton's Method, Marquardt's Method **UNIT III** Constrained Optimization Algorithms, Transformation Methods (Penalty Function Method, Method of Multipliers), Direct Search (Variable Elimination Method, Random	

	Search Method). **UNIT IV** Introduction to Non-Traditional optimization techniques (Genetic Algorithms, Simulated Annealing), Software related to Optimization, Introduction to Goal Programming, Introduction to Advanced Optimization Techniques.
11.	**Text Books-** 1. **Optimization: Theory and Applications**, S. S. Rao.
12.	**Reference Books-** 1. **Optimization for Engineering Design**, Kalyanmoy Deb, Mohan C Joshi & K. M. Moudgalya