

Potential IIT Bombay CEP courses for TEQIP III colleges

Sr. No.	Intended for	Course Name and Duration of Programme	Faculty & Department	About Course
1.	<i>All Branches</i>	Laboratory and Ergonomic Safety for Engineers <i>5 days</i>	<i>Prof. A. Kunwar</i> <i>Bioscience and BioEngineering</i>	<i>This short term course is intended to create awareness of the potential hazards and risks involved among faculty as well as laboratory staff members of Engineering colleges who are involved in laboratory activities. Course Contents include; Chemical Safety, Bio Safety, Fire Safety, Laser Safety, Radiation Safety, Gas Cylinder Safety, Electrical Safety, Machine safety, Cryogenic safety and Ergonomic Safety.</i>
2	<i>All Branches</i>	Analysis of Research Problems through Design of Experiments <i>3 - 5 days</i>	<i>Prof. Suhas Joshi</i> <i>MechanicalEngg.</i>	<i>The course will provide a step-by-step learning of classical as well as modern designs for experimentation using Taguchi Methods followed by analysis of the results. Design of experiments, if adopted efficiently, would aid in performing experiments to the desired level of resolution thereby avoiding unnecessary investment in resources.</i>
3	<i>All Branches</i>	Innovation Entrepreneurship and Incubators <i>5 days</i>	<i>Prof. Milind Atrey</i> <i>Mechanical Engg.</i>	<i>The course on offer will share with the participants, in terms of teaching of Entrepreneurship, forming a venture around an idea, as well as creating an Incubation centre in the institute or university. The course will also expose the participants to the ecosystem or the enabling mechanisms on the IIT Bombay campus which motivate students to come out with innovative ideas</i>
4	<i>All Branches</i>	Academic Leadership Development <i>3 days</i>	<i>Prof. Pooja Purang</i> <i>Humanities & Social Sciences</i>	<i>This academic leadership programme will be a national level activity. The program shall focus on challenges faced by Indian institutions engaged in higher education with changing times. The main objective of the course is :To develop skills for effective leadership and Development of strategies and practices to overcome current and future challenges in higher education</i>
5	<i>All Branches</i>	Innovative Teaching Methodology <i>3 days</i>	<i>Prof. Kannan Moudgalya</i> <i>Chemical Engg.</i>	<i>The developments in Information and Communication Technologies (ICT) have revolutionized the way education is delivered. Industry free Research has shown that use of ICT in teaching enhances student learning. This course will give an overview of ICT based teaching methods, such as flipped method and clickers based live lectures. This workshop will also cover free and open source software, such as Moodle, Scilab, LaTeX, Open Modelica and R. Scilab provides a powerful numerical computing environment for engineering and scientific applications, and is an alternative to the expensive Matlab.</i>

6	All Branches	Free and Open source software in teaching and learning <i>2-3Days</i>	<i>Prof. Kannan Moudgalya</i> <i>Chemical Engg.</i>	The developments in Information and Communication Technologies (ICT) have revolutionized the way education is delivered. Industry free Research has shown that use of ICT in teaching enhances student learning. The aim of this two-day workshop is to give hands-on training to the participants on using Free and Open Source Software (FOSS) such as Scilab, Open Modelica, LaTeX and R in teaching and learning. Scilab provides a powerful numerical computing environment for Engineering and Scientific applications, and is an alternative to the expensive Matlab.
7	All Branches	ICT Based Teaching Methods <i>3 days</i>	<i>Prof. Kannan Moudgalya</i> <i>Chemical Engg.</i>	Information and communication technologies can be used effectively in teaching and learning. These can help improve the quality of teaching. A large number of students can be trained effectively through ICT based training methods. Topics covered will be: New educational methodologies, Moodle, LaTeX, Scilab and Open Modelica
8	All Branches	Teaching through Moodle <i>5 days</i>	<i>Prof. P.Sunthar</i> <i>Chemical Engg.</i>	This course is for any teacher wishing to setup a course on moodle and use it as a supplement to the classroom lectures. Broad outline: course structure and capabilities, forums and discussions, assignments and online grading, automated evaluations and quizzes, workshops and peer evaluation
9	All Branches	Mathematics fundamentals for Engineering Teachers <i>5 days</i>	<i>Prof. Sachin Patwardhan</i> <i>Chemical Engg.</i>	Applied mathematics and computations have assumed a central position in Engineering research and design. In particular, it is important to teach applied mathematics with engineering flavour. As a consequence, applied mathematics has to be taught in a different approach The contents of this course are as follows: 1.Transformers & their Engineering Applications: A vector space view of functions and signals, geometric interpretations of signal processing operations and signal theoretic concepts, how one can explain several linear system theoretic ideas by taking recourse to geometric interpretations, eigen functions of linear systems, the Fourier Transform, interpreting the frequency and time domains and duality, generalization in the form of the Laplace transform, operating in time and frequency simultaneously, time-frequency methods, multiresolution analysis and the wavelet transform, engineering applications of these ideas.

				<p>2. <i>Matrix Computations: In this day and age, one is more or less completely dependent on computers for everything. As far as computing is concerned, however, not everything that the computer churns out may be exact. The existence of round-off errors and overflow/underflow errors are well known but the effects of these are quite often underestimated. It is therefore rather important to understand the extent of errors that actual computation can bring into a problem. These lectures are aimed at emphasizing this gap between actual theory of linear algebra and numerical linear algebra using some examples from matrix computations.</i></p> <p>3. <i>Mathematical Modelling based on Multivariate Regression: A large variety of grey-box and black-box mathematical models are used in all engineering disciplines for capturing static/dynamic behaviour or engineered systems</i></p>
10	All Branches	<p>End to End Innovation</p> <p>3/5 days</p>	<p><i>Prof. Sanjay Mahajani</i> Chemical Engg.</p>	<p><i>This is a course developed to help understand the challenges of designing and implementing technology solutions, using an end to end innovation approach. The 3-day course will be a unique combination of lectures, case studies, exercises and project experiences that highlights need identification, prototype building and eventually reaching the end product to the customer, in an interactive manner. With an additional lab component, this course can extend up to 5 days.</i></p>
11	All Branches	<p>Analysis of Modern Manufacturing Process.</p> <p>5 days</p>	<p><i>Prof. Prashant P. Date</i> Mechanical Engg.</p>	<p><i>Manufacturing is an intensely competitive activity. It is important to know of the recent developments and be able to consider several processing alternatives and choose the most economical one. Knowledge about the process is important for equipment selection & process capability assessments and for quality that can be expected from a process.</i></p>
12	All Branches	<p>Linear Algebra for Engineers</p> <p>5 days</p>	<p><i>Prof. INDER KUMAR RANA</i> Mathematics</p>	<p><i>The course will have two parts: Part one will cover important aspects of Linear Algebra as needed in Engineering branches. The second part will cover applications of linear algebra. We will also discuss how it can be made interesting for students.</i></p>

13	All Branches	Workshop on Outcome Based Education 2 days	Prof. Sridhar Iyer and Prof. Shahna Murthy Educational Technology	1. Outcome Based Technology The 2-day course aims to introduce college teachers to the why, what and how of outcome based education (OBE). The course includes sessions on : 1. writing valid learning objectives for modules/chapters in a course & mapping them to different cognitive levels of Revised Bloom's Taxonomy 2. hands-on sessions where teachers are guided to follow a structured way of writing measurable course outcomes from the learning objectives framed 3. hands-on sessions on writing assessment questions mapped to the course outcomes framed creating a blueprint of assessment questions along the three dimensions of course outcomes, Bloom's levels and type of questions 4. introduction to student centric teaching-learning techniques that enhance student learning 2. Course on pedagogy for effective student-centered teaching-learning with technology The 2-day course aims to introduce college teachers to the pedagogy of student-centered teaching-learning practices (active learning) with technology tools - tools that they commonly used as a teaching resource like videos, animations and simulations. It includes : 1. What, why and how of learning objectives 2. Why active learning is needed 3. What constitutes active learning 4. How to do effective student-centered integration of technology in teaching (includes introduction to example active learning techniques) 5. Hands-on sessions where teachers are guided to apply the techniques to design active learning activities with technology and implement them effectively in flipped classroom mode as well as in in-class teaching mode.
14	All Branches	Manufacturing Processes 5 days	Prof. Prashant P. Date Mechanical Engg.	The course will cover aspects on manufacturing processes like metal casting, forming, joining, PM and plastic injection moulding, plus a little exposure to machining if the participants so desire. A few lectures on Product design, TPM, TQM, FMEA, financial management are planned.

15	All Branches	Computational Techniques for Scientists and Engineers 5 Days	Prof. PSV Nataraj Systems & Control	1. Introduction to MATLAB 2. Cell & Structure Arrays 3. Functions and Files 4. Programming 5. Advanced Plotting 6. Model Building and Regression 7. Linear Algebraic Equations 8. Calculus & Differential Equations 9. Linear and Nonlinear Optimization 10. Simulation with Simulink 11. Code Vectorization 12. Parallel Computing with MATLAB - Multicore CPUs 13. Parallel Computing with MATLAB -GPUs 14. Connecting MATLAB and Simulink to Hardware The course is based heavily on solving problems via programming - It's a hands-on course. So, all participants must bring their own laptops loaded with MS-Windows Operating system. Other software required for the course will be provided to the college course coordinator, well in advance of the course. Participants must install these software and come to the course.
16	All Branches	Institution Building Program 3-5 days	Prof. Ashish Pandey School Of Management	This offering is based on whole system approach. We engage all the stakeholders of the institution or university for conversations based on possibilities and not on the constraints. This program has two components: 1. Appreciative Inquiry 2. Structured Inputs from Experts Appreciative Inquiry (AI) is based on the tenet that institution building is not the bundle of problems to be solved but a miracle to be embraced and cherished. AI by its very nature is application oriented, collaborative and provocative method of organization development

17	All Branches	Educational Leadership Program 3-5 days	Prof. Ashish Pandey School Of Management	<p><i>Educational leadership is the process of engaging, inspiring, guiding and channelizing the talents and energies of teachers, pupils and external stakeholders and partners toward achieving common educational goals.</i></p> <p><i>The Education Leadership Development Process (ELDP) equips institutions with a pipeline of highly engaged and inspired educators from within the existing talent-pool who can add value through teaching, consulting and research. It is a holistic perspective that looks at the Leadership Development process through the philosophy of Appreciative Inquiry.</i></p>
18	All Branches	Expo creative Design Methods 3 days	Prof. Ravi Poovaiah Industrial Design Centre	<p><i>The course will inform the participants about the complete aspects of Design Process including Need Finding, Design Analysis, Problem Space Visualisation, Visual Affinity Mappings, Concept Diagrams, Prototyping Tools, User Testing and Feedback, Iterative Creative Concept Generation, Scenarios and Presentation Techniques. The workshop will also delve upon Design and Innovation, Information Visualisation, Product Form and Visual Elements, Designing for Products and Interactions, etc.</i></p>
19	All Branches	Expo 'Designing for Computer Interactions' 3 days	Prof. Ravi Poovaiah Industrial Design Centre	<p><i>Methodology and process of designing interactive products, services and events with focus on physical, cognitive and social interactions. It includes design of tangible, gestural and expressive interfaces, products that enrich user experience encompassing design of integrated systems, products for future use, products for social interactions and devices used in public spaces.</i></p> <p><i>In addition, the course will cover user studies, affinity mappings, information theory, ordering of information, methods for structuring and visualization of Information, as well as introduction to Information Architecture.</i></p>

20	All Branches	Introduction to Cognitive Ergonomics/ Cognitive Systems Engineering <i>2 days</i>	<i>Prof. Vivek Kant</i> IDC School of Design	The aim of this course is to introduce the basics of Cognitive Ergonomics/ Cognitive Systems Engineering (CE/CSE). CE/CSE finds widespread application in the analysis and design of a variety of industrial applications. This course will introduce the basics of theory, methods and applications of these areas in a variety of technical artifacts and safety-critical systems. The course will cover the following topics: Human psychological systems (capabilities and limitations); Cognitive processes (perception, memory, attention, thinking and problem solving); Human factors methods (analysis methods, design guidance methods, evaluation methods); Applications in various sectors.
21	All Branches	Fluid-Structure Interaction <i>5 days</i>	<i>Prof. Rajneesh Bhardwaj</i> Mechanical Engg.	This course addresses fundamentals of Fluid-Structure Interaction (FSI), with applications in several disciplines such as Mechanical, Aerospace, Civil, Chemical, Bioengineering etc. The following key concepts in FSI will be explained: Added fluid Stiffness, Added Mass, Added Damping, Memory Effect, Sloshing, Aero-elasticity approximation, Flow induced static instability, coupled mode flutter, Flow-induced Coriolis damping, Vortex-induced Vibrations (VIV), Lock-in, Characteristics etc. Different Computational techniques used for FSI solvers will be discussed and compared. Finally, development of immersed boundary method will be covered in this course. The proposed topics are important from fundamental as well as applications point of view.
22	All Branches	Computational Fluid Dynamics: Development Application and Analysis <i>5 days</i>	<i>1.Prof. Atul Sharma,</i> <i>2.Prof. Sandip Kumar Saha,</i> <i>3.Prof. Shyamprasad Karagadde</i> Mechanical Engg.	Computational Fluid Dynamics (CFD) is a methodology for computer simulation of fluid mechanics and heat transfer problems. The present course is structured for a module-by-module code- development of the two-dimensional numerical formulation; the codes are given for 2D heat conduction, advection and convection. The present subject involves learning to develop and effectively use a product -a CFD software.

23	All Branches	Design of Mechatronic systems 5 days	<i>Prof. Prasanna Gandhi</i> Mechanical Engg.	Because of increasing demand on quality and productivity of products and services, the industrial dynamics is changing rapidly on several fronts including economics, research, technical knowledge and so on. To match these demands of increased quality at lower cost, automation is inevitable. Toward this goal, our engineers need to acquire the knowledge in the field of automation and mechatronics. With this motivation, the proposed course is designed to offer fundamental, theoretical and practical knowledge base in automation and mechatronics. The course will run for five days. It will comprise of lectures and hands on sessions. The participants will get unique hands-on and experimental exposure in the laboratory sessions. Topics covered in the course include: Importance of automation, Elements of mechatronic systems: sensors, actuators, and controller. Mathematical modeling/ representation of physical systems, real world examples. Use of Laplace transforms, transfer function and state space representations. Basic types of controllers P, PD, PID. Concept of stability, stability analysis, Linear domain tools for control analysis and synthesis: Use and application of Root locus method, frequency domain analysis, Bode plot. Introduction to Digital control systems. Fundamentals of microprocessors: architecture, memory, and interfacing peripherals. Concept of sampling, Implementation of digital control: using computer and microprocessor. Introduction to signal processing, filters, their importance. Introduction to PLCs: Ladder logic diagram, ARM based systems. Mechatronic systems design philosophy and approaches for various problems. Advanced control topics: nonlinear control fundamentals, handling nonlinearities inevitable in mechatronic systems such as friction, Control of robotic systems and general rigid body systems.
24	All Branches & Applied Science	Solar Photovoltaics : Fundamentals, Technologies and Applications 3 days	<i>Prof. Chetan S. Solanki</i> Energy Science & Engg.	This course with the title "Solar Photovoltaics: Fundamentals, Technologies and Applications" is designed to provide introduction to various aspects of solar PV technologies. The course is designed in a manner that any Engineering and Science graduate without background in solar photovoltaic can attend and understand it.

25	Aerospace Engg.	Incompressible Fluid Mechanics - A Refresher Course 5 days	Prof. Aniruddha Sinha Aerospace Engineering	The subject is fundamental to Mechanical, Aerospace, Civil and Chemical Engineering. The course will serve to deepen understanding of the essential concepts, with suitable mathematical rigour of the derivations, along with an exposition of the underlying physics. Topics covered: Classification of flows, Hydrostatics, Governing equations in differential and integral form, Dimensional analysis, Potential flow theory, Exact flow solutions, Boundary layer theory, Introduction to turbulence
26	Aerospace Engg.	Acoustics and aero acoustics 3-5 days	Prof. Aniruddha Sinha Aerospace Engineering	Most acoustics problems are essentially linearized fluid dynamics. We will take this perspective in this course to rigorously describe the fundamentals of acoustics. This will be a 3-day course. Depending on audience interest, a 5-day course may also be conducted to include Aero acoustics -- the study of sound generate by flow, in the absence or presence of solid walls. This will also include a discussion of computational aero acoustics (CAA).
27	Bioscience and BioEngineering	Biology for Engineers 5 days	Prof. A. Kunwar Bioscience and BioEngineering	The first part of the course will be molecular biology which will bring forth the components building a cell. The second part of the course will be Physical Biology/Biophysics which shall illustrate how one can use Physics and Mathematics to understand various biological systems/phenomena. The last part shall use a few notable examples to illustrate the Engineering perspective with an emphasis on applications.
28	Bioscience and BioEngineering	Modern Biophysical Techniques 5 days	Prof. A. Kunwar Bioscience and BioEngineering	The horizon of modern biosciences and bioengineering are rapidly expanding due development of various new biophysical manipulation and measurement techniques. The course is intended for faculty members of Engineering colleges, engaged in teaching biology courses, who seek an introduction to modern biophysical experimental techniques. Due to the interdisciplinary nature of the course, basic knowledge of physics and mathematics is expected, but strong attempts will be made to give an intuitive understanding of the mathematics and physics involved. The topics covered in this course include fluorescence microscopy, confocal microscopy, NMR spectroscopy, Fluorescence Resonance Energy Transfer (FRET), Fluorescence-activated cell sorting (FACS), optical tweezers and bio-AFM

29	Bioscience and BioEngineering	Computer Simulation of Complex Biological Systems 5 days	Prof. A. Kunwar Bioscience and BioEngineering	This short term course is intended to train the faculty members of Engineering colleges for molecular dynamics and Monte-carlo simulations. The course content assumes that faculty members have an exposure to Physics and Mathematics at 10+2 level. This short term course aims to cover basics of Molecular Dynamics and Monte-Carlo Simulations along with several examples of its applications.
30	Chemical, Systems & control Engg.	Advances in Control System 3 days	Prof. Ravindra Gudi Chemical Engg.	The course is planned to provide academicians and practicing Engineers with the principles and techniques for better understanding of issues related to advances in control of process and manufacturing systems.
31	Chemical Engg, Instrumentation Engg.	Data Analytics for Process Monitoring, Soft Sensing Controller Performance Assessment 3 days	Prof. Ravindra Gudi Chemical Engg.	The course is oriented towards Data Analytics for Process Monitoring, Quality Prediction and Performance Assessment. This workshop will aim on introduction to the tools. These tools will be very useful in overall plant optimization. These methods promote operation excellence in the batch and continuous process industry through their ability to benchmark process operations with respect to performance limits and play an important role in detecting aberrant operation and initiating remedial measures so as to align the plant back along prior established superior benchmarks.
32	Chemical Engg, Instrumentation Engg.	Optimization for Engineering System Design and Operations 3 days	Prof. Ravindra Gudi Chemical Engg.	This course will provide a tutorial introduction to the optimization based modelling tools and solution methods .It will also involve hands-on sessions on representative software platforms that showcase the technology advances in problem representation and solution methods and to provide practicing engineers with the principles and techniques for better understanding of issues related to process monitoring, performance assessment, soft sensing and control.
33	Chemical, Instrumentation , Control System Engg.	Digital Control from Scratch 3 days	Prof. Kannan Moudgalya Chemical Engg.	Control of systems is getting extremely important for reasons of safety, and competitiveness in industry. It has a great role to play in home automation. All controllers implemented in modern times are digital. This is because digital devices are rugged, inexpensive, easy to use and noise tolerant. Most digital control courses assume a good knowledge of analog control. These courses mostly discretise the analog controllers to arrive at a digital form. At IIT Bombay, we have been teaching digital control more or less from scratch.

34	Chemical, Instrumentation & Control System Engg.	Advanced Multivariable Control <i>3-5 days</i>	<i>Prof. Sachin Patwardhan</i> <i>Chemical Engg.</i>	<p>This course introduces fundamentals of control relevant model development and adaptive predictive control of multi-variable systems, introduction to Digital Control systems- sampling, model discretization, and open loop stability. Development of Predictive Control Relevant Linear Time Series Models using System Identification- Output Error models, introduction to stochastic processes, development of ARX, ARMAX and Box-Jenkins models, model structure selection and issues in model development, state space realizations.</p> <p>Recursive on-line parameter estimation using RLS and extended least squares approaches Adaptive and Model Predictive Control: Model based future prediction, constrained optimization based MPC formulation, quadratic programming and linear programming based reformulation, adaptive predictive control formulations with on-line recursive parameter estimation, simulation studies using quadruple tank system and experimental studies using single board heater system.</p>
35	Civil Engg.	Soft Computing Techniques at Basin Level Water Resources Assessment and Management <i>5 days</i>	<i>Prof. Jothiprakash</i> <i>Civil Engg.</i>	<p>The short-term course aims to include the following themes with particular emphasis to water resources:</p> <ol style="list-style-type: none"> 1. Artificial Neural Networks 2. Genetic Algorithms 3. Optimization Techniques 4. Remote Sensing Techniques 5. Geographic Information Systems 6. Advanced numerical methods 7. Hydro informatics
36	Electrical, Electronics & Telecommunicatio n Engg.	Digital Signal Processing <i>3 -5 days</i>	<i>Prof. V M Gadre</i> <i>Electrical Engg.</i>	<p>The aim of this course is to introduce the basic principles and developments that have taken place in this rich and evergreen subject while providing some expertise in DSP system design.</p> <p>Main Objectives of the course(s):</p> <ol style="list-style-type: none"> 1. To understand the requirements for, and implications of, working with a discretized independent variable: sampling theorems; correlating the analog and discrete domain. 2. To build up the elements of discrete system theory. 3. To learn to specify requirements for discrete time systems and to design them. 4. To translate these systems into realizations in hardware and software. 5. To explore practical applications of DSP. 6. To gain some awareness in advanced DSP concepts with an exposure to current developments. 7. To deal with specific advanced topics in detail.

37	<i>Electrical & Electronics Engg.</i>	Principles of Electromagnetics and Finite Element Method 3-5 days	<i>Prof. S.V.Kulkarni</i> <i>Electrical Engg.</i>	Electromagnetic Fields is one of the foundation courses in both Electrical and Electronics Engineering Curricula. It is generally perceived to be a difficult-to-understand subject by the students and a difficult-to-teach subject by teachers. This course is aimed at providing a thorough understanding of important concepts. Use of Virtual Electromagnetics Laboratory being developed at EE Dept. of IIT Bombay will also be made to supplement discussions during the course. The second part of the course covers principles and applications of Finite Element Method (FEM) to Electrical and Electronics Engineering. The method has emerged as one of the most powerful numerical techniques for analysis of low- and high-frequency electromagnetic devices. It is widely used in academia and industries for research and development. Exposure to free FEM software and procedures to develop FEM codes will also be given during the course.
38	<i>Electrical & Electronics & Communication Engg.</i>	Computational Electromagnetics 3-5 days	<i>Prof. S.V.Kulkarni</i> <i>Electrical Engg.</i>	Understanding and computation of electromagnetics are essential pre-requisites for development, analysis and optimization of low-frequency devices (transformers, rotating machines...) and high-frequency devices (waveguides, antennas...). This course will cover basics of electromagnetics relevant to numerical computation of fields. The theory and applications of the following numerical techniques will then be elaborated: Finite Difference Method, Finite Difference Time Domain Method, Finite Element Method, Boundary Element Method, and Method of Moments. A few advanced research topics such as Coupled Field Computations, Meshless Methods, Vector Finite Elements, etc., will be discussed at the end.
39	<i>Electrical & Electronics Engg.</i>	Use of simulation/app for teaching electronics 3-5 days	<i>Prof. Mahesh Patil</i> <i>Electrical Engg.</i>	This course is meant for faculty involved in teaching basic electronics. The course covers (a) problem solving in several areas commonly covered in an electronics course, (b) use of circuit simulation in teaching, (c) use of an app for "active learning". The last part of the course, i.e., use of an app in a classroom situation, is expected to enrich the learning experience of the students. The following topics will be covered: network theorems, diode circuits, common-emitter amplifier, op-amp linear circuits, Schmitt trigger, oscillator based on Schmitt trigger, asynchronous and synchronous counters.

40	Electrical & Electronics Engg.	RF and Microwave Design 4-5 days	<i>Prof. Girish Kumar</i> Electrical Engg.	This short term course will cover 1.Passive Microwave Circuits a. Transmission Lines, ABCD and S- parameters b. Characteristics of Microstrip Lines c. Microstrip Line Discontinuities d. Coupled Microstrip Lines e. Power Dividers and Couplers f. Filters g. Attenuators 2.Active Microwave Circuits a. Amplifiers b. Oscillators c. Switches, Phase Shifters and Mixers Microwave Systems
41	Electrical & Electronics Engg.	Microstrip Antennas 3-5 days	<i>Prof.Girish Kumar</i> Electrical Engg.	This short term course will cover fundamentals of antennas, microstrip antennas (broadband, compact, multi-band, linear and circular polarizations), and microstrip antenna arrays
42	Electrical, Mechanical, Chemical Engg.	Energy Efficiency and Management 3 days	<i>Prof.S.Bandyopadhyay</i> Energy Science & Engg.	Energy efficiency is the use of technology that requires less energy to perform the same function without compromise. The course will cover following topics: Overview of India's energy scenario; Fundamentals of energy engineering; Energy auditing; Energy economics; Energy management in thermal systems; Energy management in electrical systems.
43	Environmental Science and Engineering	Energy Recovery Options from Municipal Solid Waste 3-5 days	<i>Prof.Munish Chandel and Prof.Anurag Garg</i> Centre for Environmental Science and Engg.	The course will focus on the discussion of energy recovery opportunities from municipal solid waste (MSW). This course content includes the fundamentals and concepts of various biological and thermal treatment methods suggested for the generation of heat/ electricity from MSW. A brief background of waste characteristics and regulatory framework for MSW will be presented. Preparation methods for refuse derived fuel and its utilization as fuel in energy intensive industries will be discussed. Environmental pollution (air and liquid) from energy recovery processes and their control methods will also be discussed. An overview of life cycle analysis will be given. Some problems will be solved during the course duration and relevant case studies will be shared.

44	<i>Environmental Science and Engineering</i>	Introduction to Environmental Health & Safety 4 days	<i>Prof. Harish C. Phuleria</i> Center for Environmental Science & Engg.	This course will provide an overview of the current legislation, standards and practices related to environmental health and safety in the workplaces. This will include topics on occupational health and safety regulations, hazardous materials management, biological, physical and chemical hazards identification and risk assessment, use of personal protective equipment, and industrial toxicology. Environmental exposure standards, human exposure and dose assessment, environmental monitoring of air, water, food, soil and microorganisms, and personal monitoring will be additionally examined. The concepts will be further strengthened through case studies from construction, chemical and oil-gas industries.
45	<i>Environmental Science and Engineering</i>	Resource Recovery by Sustainable Sewage Sludge Management 3 days	<i>Prof. Anurag Garg</i> Center for Environmental Science & Engg.	The course will include the following: Overview of sewage characteristics and treatment; Sludge generation and processing strategies; Resource recovery by anaerobic process, composting and incineration.
46	<i>Environmental Science and Engineering</i>	Wastewater Reclamation Technologies 2-3 days	<i>Prof. Anurag Garg</i> Center for Environmental Science & Engg.	The focus of the proposed course is on the methods by which wastewater can be recycled for various beneficial purposes. The major topics will include: Overview of wastewater characteristics and treatment; advanced wastewater treatment processes; possible reclamation methods and case studies.
47	<i>Mechanical Engg.</i>	3D Printing: A Disruptive Technology 3 days	<i>Prof. K P Karunakaran</i> <i>Mechanical Engg.</i>	The goal in this course is to give an overview of the various RM technologies. After giving the necessary background in CAD modeling and Reverse Engineering, various popular RP processes will be discussed in detail. These will include Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereo-Lithography Apparatus (SLA), 3D Printing and Laminated Object Manufacturing (LOM).
48	<i>Mechanical Engg, Production Engg.</i>	E-Mobility and Innovations in Sheet Metal Forming 3- 5 days	<i>Prof. Prashant P. Date</i> <i>Mechanical Engg.</i>	Challenges of E-Mobility is demanding in terms of high power and energy density storage in batteries, fast charging, better management of heat generated and higher mileage per charge. Till a battery operated car reaches its peak development, and infrastructure necessary for that is developed, a hybrid engine concept is seen as an intermediate solution. Such a hybrid engine would have an IC engine as well as a battery drive. Hence it is absolutely essential to think of light weighting an IC Engine. This programme focusses on current and future battery technology and hybrid engine concepts.

49	Mechanical Engg, Production Engg.	Sheet Metal Technology 3-5 days	Prof. Prashant P. Date Mechanical Engg.	The course will cater to 7 areas namely, materials, product design, Process design, Tool design, Equipment selection, Materials testing and Troubleshooting.
50	Mechanical Engg, Production Engg.	Metal Forming 3 days	Prof. Prashant P. Date Mechanical Engg.	1. States of stress processes malts testing 2. Tensile testing and analysis of data 3. Flow forming 4. Forging 5. Deformation mechanism maps 6. Equipment selection & specification 7. Sheet metal formability concept 8. Formability evaluation 9. Deep drawing 10. Hot forming 11. Roll forming 12. Issues in sheet metal assembly
51	Mechanical Engg, Production Engg	Analysis of Sheet Metal Forming Process. 5 days	Prof. Prashant P. Date Mechanical Engg.	Sheet metal has traditionally been used in a number of sectors of the industry. Often, sheet metal forming is regarded by many, more as an art than any kind of science. Typical methods of manufacture involved the use of a die and a punch to shape the sheet into desired product shapes. Rule of thumb could be used to design the tools and expectations on the dimensional accuracy and dimensional tolerances were very limited (were not very high). Modern day manufacturing with sheet metal involves plenty of science. This was necessitated by the need for light weighting of sheet metal components, development of new materials, development of new processes, means to handle the spring back for which sheet metal parts are so notorious, development of new shaping and joining techniques, both at room temperature and at high temperature, and above all, a number of FEM soft wares which are capable of predicting the outcome of a forming process with a high degree of accuracy. These soft wares are based on the theory of plasticity, and it is important to understand not only the process but also the theory to be able to use the soft wares effectively. Measurements of parameters, process control also improved over the times so that the final outcome (the product) can be expected to be closed to the designed geometry, properties and performance. The proposed course attempts to bring to the participants the science involved in the development of several sheet metal technologies that we use. Industry delegates may bring along live cases which can be discussed during the brainstorming sessions during the course of the programme. Expression of interest to present a live problem should be made at the time of registration. One session of 15 minutes will be permitted per Company for presentation of the live case.

52	Mechanical Engg.	Fuels and Combustion 5 days	Prof. Neeraj Kumbhakarna Mechanical Engg.	The phenomenon of combustion is ubiquitous in power producing devices such as engines and turbines. It is also seen in various other engineering systems that accomplish useful tasks such as material processing in industries, waste disposal, space heating, etc. Hence it is essential for engineers to understand this phenomenon in detail. The knowledge of various aspects of combustion enables engineers to effectively control it and harness its potential to accomplish useful tasks. It also enables them in tackling various issues related to safety and pollutant emissions. This course introduces students to various aspects of the science of combustion from an engineering point of view while covering some necessary concepts of chemistry. It will also introduce the characterization of different fuels in terms of their composition and properties, both of which affect combustion. A few topics on fuel synthesis will help understand the reasons behind the heterogeneity in the composition of different liquid fuels.
53	Mechanical & Chemical Engg.	CFD using Open FOAM 5 days	Prof. P.Sunthar Chemical Engg.	This course will introduce teaching CFD as a full course or as a lab course to undergraduate/postgraduate students. Potential teachers: Mechanical, Chemical Engineering: Syllabus outline: Fluid flow, Turbulence, Heat Transfer, Reaction, Multiphase, non-Newtonian flows.
54	Mechanical Engg.	Fundamentals of Micro-electro-mechanical-Systems Technology 3-5 days	Prof. Pradeep Dixit Mechanical Engg.	Micro-electro-mechanical-Systems (MEMS) is an inter-disciplinary area, which is getting extremely popular due to the increasing usage of inertial sensors in daily life. Inertial sensors such as Accelerometers, Gyroscopes, Pressure sensors, tactile sensors, etc. are being used in air-bag deployment, Automatic screen rotation, and measuring pressure in various automobile applications. This three-to-five-day program aims at understanding the basic fundamentals of Micro-electro-mechanical-Systems (MEMS) technology, materials used in MEMS and various sensing/actuation principles (piezo resistive, piezoelectric, electrostatic, etc.). The program will specifically focus on the design and fabrication of smart sensors which are used currently in the industries. Various micro-fabrication techniques (Lithography, plasma etching, and thin film deposition) will be covered in this course, which will be helpful for researchers working in mechanical, electrical, Physics and material science domain.

55	Mechanical Engg.	Advance Heat Transfer 5 days	Prof. Sandip Kumar Saha Mechanical Engg.	Instantaneous and continuous, Superposition theorem. Duhamel's theorem and applications for time varying boundary conditions. Radiation heat transfer: Introduction- intensity, emissive power, Planck spectral emissive power for black body. Real surfaces: Emissivity, Absorptivity and Reflectivity. Shape factor calculations using shape factor algebra. Radiation calculation using radiosity approach for grey diffuse surface, Network modelling and Radiosity method Gas radiation, Well stirred furnace model. Convective heat transfer: Derivation of governing equation for convection. 2D laminar Couette flow and nondimensional numbers. Concept of Adiabatic wall temperature. Flow over a flat plate. Boundary Layer theory Scale analysis, Falkner Skan similarity solution for momentum and thermal boundary layers. Integral solution. Internal flow Scale Analysis, Concept of developed temperature profile and solutions for constant wall flux and constant wall temperature boundary conditions. Solution of entry length problem for constant wall condition (Graetz Problem). Natural convection solutions- Scale Analysis, Integral solutions, Similarity solution.
56	MechanicalEngg	Computational Fluid Dynamics 5 days	Prof. Sandip Kumar Saha Mechanical Engg.	Introduction to Computational Fluid Dynamics and Principles of Conservation: Continuity Equation, Navier Stokes Equation, Energy Equation and General Structure of Conservation Equations, classification of partial differential equations. Fundamentals of Discretization: Finite Difference, Finite Element and Finite Volume Method Finite Difference Method: Discretisation techniques using Taylor- Series, Consistency, Stability analysis and Convergence, Grid independence study Finite Element Method: Basics, discretization techniques for steady and unsteady problem. Finite Volume Method: Some Conceptual Basics and modelling of heat conduction, Boundary Condition Implementation. Discretization of Unsteady State Problems, convection-diffusion, and flow field using finite volume method (FVM), SIMPLE and SIMPLER algorithm Collocated Grid Unstructured Grid Formulation; Modelling of phase change problems; introduction to turbulence modelling

57	Mechanical Engg.	Fluid-Structure Interaction 5 days	Prof. Rajneesh Bhardwaj Mechanical Engg.	Computational techniques used for FSI solvers will be discussed and compared. Finally, development of immersed boundary method will be covered in this course. The proposed topics are important from fundamental as well as applications point of view.
58	Mechanical & Chemical Engg.	Basics of Combustion and Modelling 3 days	Prof. S Sreedhara Mechanical Engg.	The phenomenon of combustion plays a major role in power producing devices such as engines, turbines and furnaces. This course introduces students to various aspects of the science of combustion from an Engineering point of view while covering some necessary concepts of chemistry.
59	Mechanical Engg.	Realizing Science and Applications of Micro- and Nano-machining 3 - 5 days	Prof. Suhas Joshi Mechanical Engg.	<p>New products and technological developments in the area of strategic, automotive, aerospace, electronics, and bio-medical industries require complex and micro- and nano-sized features, significant miniaturization and high precision. In order to address these demands, micro- and nano-manufacturing has been continuously evolving in the recent years. It is envisioned that the research and development activities in this domain will not only facilitate the exponential growth in the global economy, but also aid in scientific understanding of materials processing at a fundamental level.</p> <p>This three-to-five-day program aims at understanding the role of micro- and nano-manufacturing in shaping the future needs in the context of Indian as well as global requirements. The program therefore will specifically focus on development of 'devices and processes' using micro- and nano-machining for automotive, aerospace, electronics and bio-medical domains. These aspects will be illustrated through lecture-cum- demonstration sessions. Concurrently, generating a new and in-depth understanding of mechanics pertaining micro- and nano-machining processes through numerical modelling and simulations has been the major topic of interest all over the world. The state of the art on this front will be realized through expert lectures and follow up discussions. In general, the topics which could include - Multi-scale science of micro- and nano-machining processes, Innovative applications of laser-based Micro-machining, Micro- textured surfaces design and fabrication, Microfluidic-based devices & developments, Micro-electric-discharge and associated processes and so on.</p>
60	Metallurgy & Material Science	Surface Engineering - the need for better surface management 2 days	Prof. A. S. Khanna MEMS	Domain of Surface - Properties, deterioration mechanism, possible ways of modification, characterization, performance evaluation

61	Systems and Control Engg.	Linear Systems Control 5 days	Prof. S. Srikant Systems and Control	The course will cover State Space Representation of dynamical systems, solutions, properties of solutions such as stability, controllability and observability, finally an overview of state feedback control, and Linear Quadratic Regulator (LQR) control design will be expounded. Additionally some intermittent material on vector spaces will be introduced.
62	Systems and Control Engg.	Nonlinear Adaptive Control 5 days	Prof.S.Srikant Systems and control	We begin with fundamentals of nonlinear state space systems, nature of solutions, stability notions and Lyapunov stability theorems, control design based on Lyapunov functions will be introduced, ideas of Back-stepping based control design will be developed, further adaptive control will be introduced based on certainty equivalence and non-certainty equivalence based methods, stability proofs constructed and update laws designed. Additional norms and properties of the same along with Barbalat's Lemma will be studied.
63	Systems and Control Engg.	Advanced Analytical Dynamics 5 days	Prof. S. Srikant Systems and Control	The course covers modeling of mechanical systems - Newton's laws for collection of particles both translating and rotating, force momentum principles, vector representation in rotating and translating frames, Newton's laws for rigid bodies, Lagrange's equations of motion, conserved quantities, Hamilton's equations, Holonomic constraints in dynamical systems.
64	Systems and Control Engg.	Optimal Control and applications 4 days	Prof.Ravi Banavar Systems and Control	This course will be beneficial to students and teachers in mathematics and engineering interested in learning about optimal control and its many applications. Basic ideas and tools of optimal control (with mathematical rigour), frequently encountered in engineering problems, in particular, electrical, mechanical, chemical and aerospace engineering will be introduced. A large part of the course will emphasize the following topics: calculus of variations and first order necessary conditions for an extremum; second order necessary conditions; control systems and a variational approach to a fixed-time, free-endpoint problem; statement of the Maximum Principle and a sketch of the proof; time-optimal control and linear- quadratic control problems. The textbook followed will be: Calculus of Variations and Optimal Control Theory: A Concise Introduction; by Daniel Liberzon; Princeton University Press, 2012.
65	Systems and Control Engg.	Nonlinear Control Systems 4 days	Prof.Ravi Banavar Systems and Control	The course will expose an individual with a background in linear control systems to the essential ideas and tools of nonlinear systems, both analysis and design. In specific, the course will cover the following topics: phase portraits of second-order systems; ordinary differential equations (ODEs), the Lipschitz condition and existence and uniqueness of the solution; affine-in- the-control nonlinear systems;

				<p><i>linearization and the Jacobian; flows, stability and invariant sets; Lyapunov theorem and LaSalle's invariance theorem; operations on vector fields - the gradient, the Lie derivative and the Lie bracket; distributions, feedback linearization, zero dynamics and controller design examples. The textbooks to be followed would be: 1. H. K. Khalil, Nonlinear Systems, Prentice Hall, 2002 2. J. LaSalle and S. Lefschetz, Stability by Liapunov's Direct Method, Academic Press, 1961 3. A. Isidori, Nonlinear Control Systems , Springer, 1989.</i></p>
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