Government of India
Ministry Of Human Resource Development

GLOBAL INITIATIVE ON ACADEMIC NETWORKS (GIAN)

Analysis of Nonlinear Problems by the Finite Element Method

19-29 December 2016

Venue

MNIT Jaipur

http://www.mnit.ac.in

About the Teaching Faculty:

Prof. R. C. Batra

Romesh C. Batra is the Clifton C. Garvin Professor of Engineering Science and Mechanics at Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, Virginia.

Prof. Batra has worked in several areas of applied mechanics such as adiabatic shear bands, composite structures, functionally graded materials/structures, nanostructures, smart materials/structures, micro-electro-mechanical systems, and computational mechanics including the finite element and meshless methods. He has authored more than 400 research papers published in reputed and refereed journals that have received 13,000 citations with an H-index of 59 on Google Scholar. He has also written one book entitled: Elements of Continuum Mechanics, published by American Institute of Aeronautics and Astronautics (i.e., AIAA).

He has been teaching courses on the Finite Element Method, Continuum Mechanics and Nonlinear Elasticity to U.G., P.G. and Ph.D. students since 1974. Many of his former Ph.D. students hold faculty positions in India, China, Chile, Taiwan, S. Korea, France, Canada and the USA, and many others hold leadership positions in civilian industries and research laboratories across the globe.

Dr Batra is an Honorary Member of the American Society of Mechanical Engineers (ASME), and a Fellow of the American Academy of Mechanics, ASME, American Society of Engineering Education, Society of Engineering Science, and the US Association of Computational Mechanics. He is a founder and editor of the journal: Mathematics and Mechanics of Solids.

He has many awards and honors to his credit- Hind Rattan Award in 2016 from the Non-Residents of India Welfare Society, Virginia Outstanding Faculty Award in 2010, Engineering Science Medal from the Society of Engineering Science in 2009, Honorary D.Sc. from Thapar University in 2006, and Alexander von Humboldt Award for Senior Scientists in 1992 to name a few.

Prof. Batra can be contacted via. email on rbatra@vt.edu.

About the Course Coordinators:

Dr. Dinesh Kumar

Dr. Dinesh Kumar, B.E. (Mech.Engg.), M.E. (Mech. Engg.), Ph.D (BITS Pilani) is presently working as an Assistant Professor in the Mechanical Engineering Department of Malaviya National Institute of Technology (MNIT) Jaipur. Prior to joining MNIT Jaipur in 2012, he worked for teaching and research in the Birla Institute of Technology & Science (BITS), Pilani India for over 7 years. His current teaching interests are in the areas of Solid Mechanics, Continuum Mechanics, Finite Element Analysis and Mechanics of Composites, and carrying out research in the areas of Failure and Strength Analysis of Composite Laminates and FGM using Finite Element Methods and Multi-scale and Molecular simulation. He has published nearly 25 research papers in National and International Journals and Conferences of high repute.

Dr. Shakti S. Gupta

Dr. Shakti S Gupta, obtained his BE in Mechanical Engineering from the then GCE&T Raipur (Now NIT Raipur). Later, in 1995 after completion of one year Fellowship Program at IAT, Pune (Now DIAT, Pune) he was absorbed as Scientist in DRDO. In 2001 Dr. Gupta obtained ME in Mechanical Engineering from IISc and in 2009 he obtained PhD in Engineering Mechanics from Virginia Tech. He moved to IIT Kanpur as Associate Professor in 2011. He teaches Continuum Mechanics, Finite Element Analysis, Vibration of Structures and Applied Dynamics at IIT Kanpur. His current research area is application of higher order continuum theories to understand mechanical behavior of carbon based nanomaterials. He has published nearly 50 research papers in National and International Journals and Conferences of high repute.

About MNIT Jaipur

Established in 1963, the Malaviya National Institute of Technology (MNIT) Jaipur, India is one of the 31 National Institutes of Technologies of India. Extending into an area of about 317 acres of lush greenery, the campus of the Institute accommodates a population of nearly 5600 including faculty members, staff and students. The campus provides all essential amenities for the community living into the campus like staff clubs, hospital, bank, post office, community centre, school, residences, gymnasium, playing fields, guest houses, 24 Hours internet connectivity, and canteen etc.

About Jaipur

Rajasthan's beautiful Pink City Jaipur, was the stronghold of a clan of rulers whose three hill forts and series of palaces in the city are important attractions. Known as the Pink City because of the colour of the stone used exclusively in the walled city, Jaipur's bazaars sell embroidered leather shoes, blue pottery, tie and dye scarves and other exotic wares. Western Rajasthan itself forms a convenient circuit, in the heart of the Thar desert which has shaped its history, lifestyles and architecture. Weather in Jaipur is generally cold (with temperature during night as low as 5 C) in the later-half of the month of December, but with pleasant sunny days. It is thus advised to get warm clothes along with your baggage.

Tourist Places in or near Jaipur

Most prominent places to visit are Hawa Mahal, Jantar Mantar, City Palace, Albert Hall Museum, Amber Fort – Heritage Palace, Nahargarh fort, Jaigarh fort, Jal Mahal, Kanak Varindavan garden, Govind Dev Ji temple and many more. You may also visit Agra for a day on Sunday to visit one of the wonders Taj Mahal and Fetehpur Sikari. Agra is very well connected to Jaipur via Train, you may leave in the morning at 6:00 AM and can come back by 9:00 PM in the evening.

How to Reach MNIT Jaipur

Jaipur is well connected by Air, Road and Rail with all the major cities and railway stations in India. It is about 280 Kms from New Delhi. It has direct flights from New Delhi (45 min), Mumbai (1.5 hrs) and Kolkata (2.2 hrs). The Institute is prominently located on JLN Marg and is 15 minutes from the Airport. It is 10 Kms from the main Railway Station and Bus Stand. You can easily hire taxis/autos (OLA, MYCAB, MERU, UBER, JUGNOO, and other local service providers) in Jaipur around the clock.

About GIAN (An Initiative of Government of India)

Govt. of India approved a new program titled Global Initiative of Academic Networks (GIAN) in Higher Education aimed at tapping the talent pool of scientists and entrepreneurs available internationally to encourage their engagement with the institutes of Higher Education in India so as to augment the country's existing academic resources, accelerate the pace of quality reform, and elevate India's scientific and technological capacity to global excellence.

GIAN is envisaged to achieve the following main objectives:

1. To increase the footfalls of reputed international faculty in the Indian academic institutes and to create avenue for possible collaborative research with them.
2. Provide opportunity to the faculty to learn and share knowledge and teaching skills in cutting edge areas.
3. To provide opportunity to the students to seek knowledge and experience from reputed International faculty, and to increase participation and presence of international students in the academic Institutes.
4. opportunity for the students of different Institutes/Universities to interact and learn subjects in niche areas through collaborative learning process.
5. Provide opportunity for technical persons from Indian Industry to improve understandings and update their knowledge in relevant areas.
6. Motivate the best international experts in the world to work on problems related to India.

Overview of the course

The current world economy and society's health and welfare in future require that materials be used as efficiently as possible and life-time cost of components be minimized. These considerations necessitate that the factor of safety used in designing structural parts be as close to 1.0 as possible to account for uncertainties in material characteristics and structural geometries. The latter are being minimized through advances in manufacturing using 3-D printing, and the former by using improved experimental techniques of high precision and resolution equal to the wavelength of light. These need to be coupled with analysis techniques that accurately consider nonlinearities introduced due to large deformations of structures and material behavior and provide trustworthy results.

The Finite Element Method (FEM) is a versatile numerical technique for studying the response of structures under different static and dynamic loads such as those induced by earthquakes, strong winds, waves in rough seas and improvised explosive devices. It provides a detailed numerical solution that can be used to ascertain where, when and why failure will ensue and enables one to use test data for simulating realistic material behavior, failure theories and effects of geometric nonlinearities. Most commercial FE software provide excellent answers for linear problems involving infinitesimal deformations. Unfortunately, the status of analysis of nonlinear problems is far from satisfactory. It is thus critical that current and future design engineers thoroughly understand the theory and numerical algorithms used to analyze non-linear problems, and be able to discriminate among solutions provided by different software.

Course Objectives

The primary objectives of this advanced course are to expose participants to:

1. Overview of different sources of non-linearities in structural problems.
2. Theoretical and numerical techniques for studying non-linear problems.
3. Techniques to verify that a commercial software correctly solves equations.
4. Incorporation of new material models in commercial software.
5. Analysis of failure, instabilities and post-buckling response of structures.

Benefits of Attending the Course

A person on successful completion of the course would be benefited by strengthening his/her background in the following areas:

- Formulation of nonlinear problems in engineering.
- Fundamentals of the finite element method for nonlinear problems.
- Concepts of stability and accuracy of the finite element solution of nonlinear problems.
- Fundamentals of Meshless/Meshfree methods for nonlinear problems.
- Concepts of adaptive mesh refinement for nonlinear problems.
- Application of FEM to various non-linear problems, such as Elastic/Plastic Nonlinear Problems, Contact and Convection-dominated Nonlinear Problems, Crack Initiation and Propagation in Nonlinear Problems, Buckling and Post-buckling Response, Analysis of Nonlinear Problems for Functionally Graded Materials.

Profile and Number of Participants

The course is aimed at the followings:

- Engineers and researchers from manufacturing, services and government organizations including R&D laboratories.
- Any practicing engineer/scientist from Mechanical, Civil and Aerospace Engineering, Applied Mathematics, Applied Mechanics, Structural Engineering, Ocean Engineering, Naval Architecture and Marine Engineering with an interest in Finite Element Methods and its applications to Non-linear Engineering Problems.
- Faculty from reputed academic institutions and technical institutions, research students at all levels (BTech/MSc/MTech/PhD) working in the areas of applications of FEM to various engineering problems.

The maximum number of participants for the course shall be limited to 50.

Evaluation and Grading

There will be evaluations on the understanding of the concepts by the participant during the course. Based on the evaluations finally a letter grade will be awarded to the participant. If required, any student participant can earn academic credits (TWO credits) for this course. The home/sponsoring University/Institute of the student participant will be mainly responsible for transferring academic credits. A completion certificate shall also be provided.

Module-wise Course Contents

Module 1: Formulation of Nonlinear Problems in Engineering

- Discussion of Material/Geometric Nonlinearities and Nonlinear Boundary Conditions.
- Mathematical Models of Nonlinear Problems.
- Hands on experience in developing mathematical models of nonlinear engineering problems of interest to participants

Module 2: Fundamentals of the Finite Element Method for Nonlinear Problems

- Derivation and Assembly of Elemental Equations.
- Integration of coupled nonlinear ordinary equations in time domain.
- Hands on experience in developing numerical algorithms for prototype problems

Module 3: Stability and Accuracy of the Finite Element Solution of Nonlinear Problems

- Consistent and lumped mass matrices, time step size, solution stability and convergence.
- Code/software Verification to ensure governing equations are correctly solved.
- Hands on experience in developing mass matrices, estimating time step size, computing errors in numerical solution, and verifying a software/code.

Module 4: Elastic/Plastic Nonlinear Problems

- Material Models for Nonlinear Elastic and Elastic/Plastic Materials.
- Implementation of Nonlinear Material Models in FE software.
- Hands on experience in solving 1-dimensional nonlinear elastic and elastic/plastic problems.

Module 5: Contact and Convection-dominated Nonlinear Problems

- Algorithms for Contact Problems, Non-interpenetration conditions, Friction.
- Software modification for convection dominated problems.
- Discussion of solution of contact problems available in the literature.

Module 6: Crack Initiation and Propagation in Nonlinear Problems

- Crack-tip field singularities, Singular elements.
- Extended Finite Element Method (XFEM), Cohesive Zone Models (CZMs).
- Discussion of solutions of crack problems.

Module 7: Meshless/Meshfree Methods for Nonlinear Problems

- Element Free Galerkin, Smooth-Particle Hydrodynamics, Meshless Local Petrov-Galerkin Methods.
- Comparison of Meshless and Finite Element Methods.
- Solution of 1-dimensional problem by meshless methods.

Module 8: Adaptive Mesh Refinement for Nonlinear Problems

- Mesh Refinement Strategies in the FEM.
- Refinement Strategies in Meshless Methods.
- Hands-on experience for mesh refinement in 2-Dimensional Problems.

Module 9: Buckling and Post-buckling Response

- Riks arc length Methods.
- Effect of Inertia Forces on Buckling and Post-buckling Response.
- Solution of 1-Dimensional Buckling and Post-buckling Problems.

Module 10: Analysis of Nonlinear Problems for Functionally Graded Materials

- Efficient Analysis of Static Functionally Graded Material Problems.
- Transient Problems for Functionally Graded Materials.
- Review and Assessment.

Important Dates

Last date for receiving applications:	15 November 2016
Intimation to participants:	20 November 2016
Course Dates:	19-29 December 2016

Registration

Step 1: One-Time Registration at GIAN Portal

In order to register for any course under GIAN, candidate will have to go for one-time registration at GIAN Portal of IIT Kharagpur using the following steps:

1. Create login and password at http://www.gian.iitkgp.ac.in/GREGN/index
2. Login and complete the Registration Form.
3. Select Courses.
4. Confirm your application and payment information.
5. Pay Rs. 500/- (one-time fee and non-refundable) through online payment gateway.
6. Download and print "pdf file" of your enrolment application form for your personal records and copy of the same to be sent to the Course Coordinator.

Step 2: Institute Registration

1. Institute registration process is an offline process. Interested candidates are requested to download the Registration Form (docx/pdf).
2. ***Course Fee (Non-refundable):***

The participation fee to attend the present course shall be:

Participants from abroad:

(a) Industry/Research Organizations:	US $1000 (All Modules)
(b) Academic Institutions faculty:	US $600 (All Modules)
(c) Academic Institutions student/research scholar:	US $300 (All Modules)

Participants from India:

(a) Industry/Research Organizations:	₹ 15000 (Any Two Modules)
&	₹ 30000 (All Modules)
(b) Academic Institutions- faculty:	₹ 8000 (All Modules)
(c) Academic Institutions- student/research scholar:	₹ 5000 (All Modules)

The above fee includes the registration kit with instructional materials, internet facility and snacks between the sessions.

3. The Registration fee has to be paid via Demand Draft in favour of "Registrar, MNIT Jaipur" payable at Jaipur OR through National Electronic Funds Transfer (NEFT) in the account of "Registrar, MNIT Jaipur" (Account No. : 676801700388) at ICICI Bank, Branch MNIT Jaipur, IFSC Code: ICIC0006768.

4. Scan copy of the filled "Registration Form" along with the scan copy of "Demand Draft/ Receipt of NEFT" and Application Form must be sent via E-mail to Course Coordinator at dkumar.mech@mnit.ac.in; vermadinesh2002@gmail.com, on or before November 15, 2016.

5. Hard copy of the above mentioned documents must reach to the Programme Coordinator, on or before November 20, 2016, at the address:

Dr. Dinesh Kumar

Assistant Professor

Department of Mechanical Engineering

Malaviya National Institute of Technology Jaipur,

J. L. N. Marg, Jaipur – 302017, Rajasthan, India

Accommodation

Limited accommodation in the Institute Hostels and Guest Houses would be available on payment basis on prior request, subject to the availability OR otherwise participants will have to make their own stay arrangement.

Malaviya National Institute of Technology Jaipur
Department of Mechanical Engineering

Analysis of Nonlinear Problems by the Finite Element Method

Under

Global Initiative of Academic Networks (GIAN)

Ministry of Human Resource Development

Govt. of India

REGISTRATION FORM

Name (In Block Letters): _____

Designation: _____

Qualification: _____

Institution: _____

Address: _____

_____

Email address: _____

Mobile No: _____

Payment by DD in favor of "Registrar, MNIT Jaipur" payable at Jaipur.

Details of Demand Draft:

DD No: _____

Bank: _____

Amount Rs: _____

Date: _____ **Place:** _____

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Signature of the Candidate