

# A Short Term Course (online) on Computational Fracture Mechanics

24 May-4 June 2021

Under the Quality Improvement Program of AICTE  
School of Mechanical Sciences, IIT Bhubaneswar



## Inaugural Program

24 May 2021

- 8:30 - Welcome Address by Dr. P.R. Budarapu, course coordinator
- 8:35 - Address by Prof. S.K. Mahapatra  
Dean, Continuing Education,  
IIT Bhubaneswar
- 8:40 - Address by Dr. A.K. Pradhan, Head,  
School of Mechanical Sciences,  
IIT Bhubaneswar
- 8:45 - Address by the chief guest, Dr. S.  
Natarajan, IIT Madras
- 8:50 - Vote of thanks by Dr. P.R. Budarapu

## Schedule of Lectures and Tutorials

Date	09:00 - 09:55	10:00 - 10:55	11:15 - 12:10	12:15 - 13:10	14:30 - 15:25	15:30 - 16:25	16:40 - 17:35
Week 1 (24/05/2021 - 28/05/2021)							
24/05/2021	L1	L2	L3		L4	T1	
25/05/2021	L5		L6	L7	L7	T2	
26/05/2021	L8		L9	L10	L11		
27/05/2021	L12		L13	L14		T3	
28/05/2021	L15	L16	T4		L17		L18
Week 2 (31/05/2021 - 04/06/2021)							
31/05/2021	L19		L20	L21	L22		
1/6/2021	L23		L24	L25	L26	T5	
2/6/2021	L27		L28	L29	L30		
3/6/2021	L31		L32		T6		L33
4/6/2021	L34	L35	L36		T7		

## Faculty

1. Dr. P.R. Budarapu, IIT Bhubaneswar
2. Dr. S. Natarajan, IIT Madras
3. Dr. V. Pandu Ranga, IIT Bhubaneswar
4. Dr. S. Roy Chowdhury, IIT Bhubaneswar
5. Dr. M.M. Mahapatra, IIT Bhubaneswar
6. Dr. M. Agrawal, IIT Ropar

## Guest speakers

1. Dr. P. Mastanaiah, Scientist F,  
Head of the Special fabrication division,  
DRDL, Hyderabad.
2. Prof. P.K. Yalavarthy,  
Department of Computational and Data  
Sciences, IISc Bangalore
3. Prof. X. Zhuang, Heisenberg Professor,  
Chair of Computational Science  
and Simulation Technology, Institute of  
Photonics, Leibniz University, Germany

## Participants

Total 53 participants  
from across the country

- 34 faculty members from AICTE approved institutions
- 2 employees
- 17 students

## Course coordinator

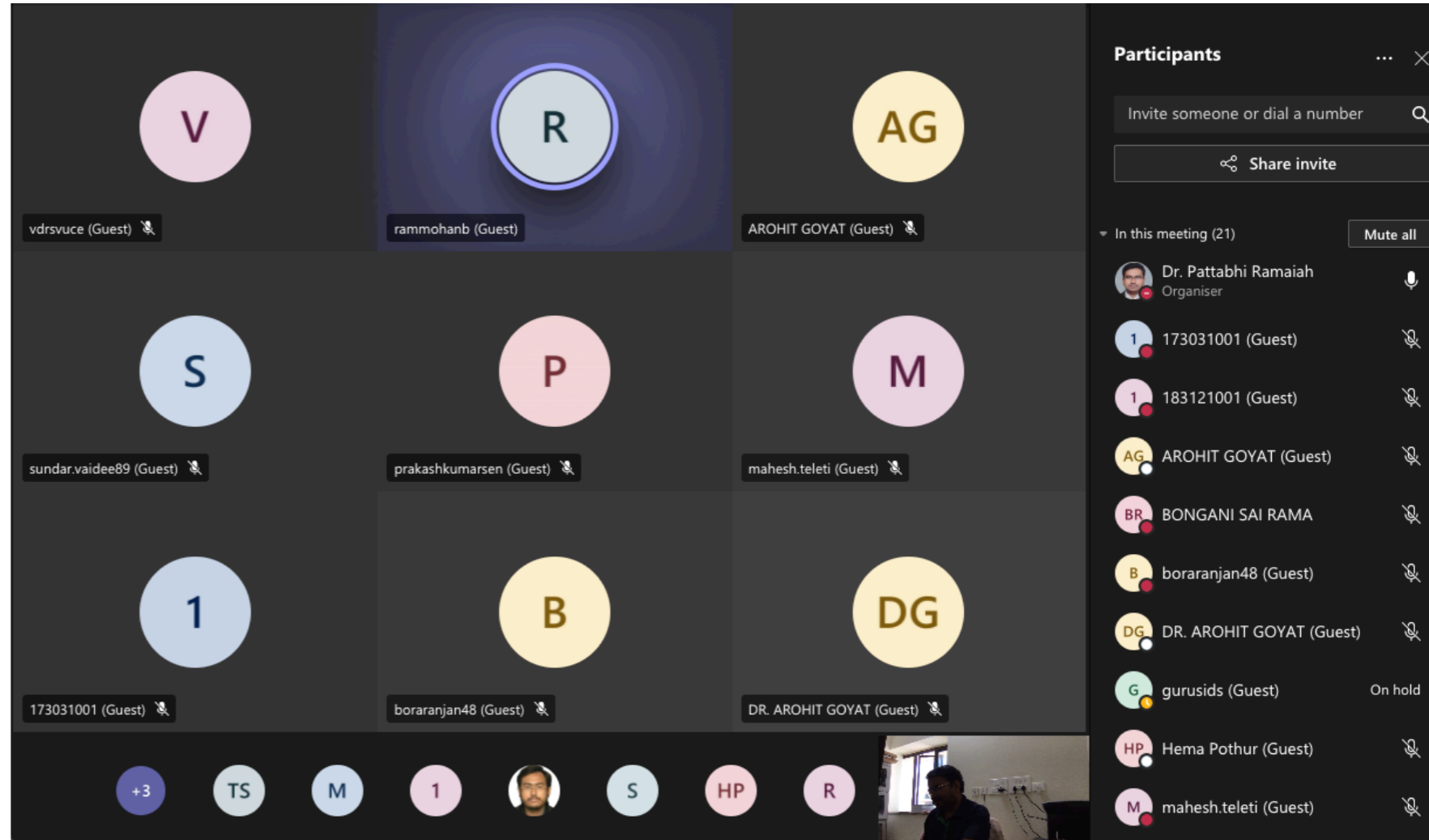
**Dr. P.R. Budarapu**, Asst. Prof.,  
School of Mechanical Sciences  
IIT Bhubaneswar,  
Argul, Jatni, Odisha  
Email: [pattabhi@iitbbs.ac.in](mailto:pattabhi@iitbbs.ac.in)  
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## Technical activities

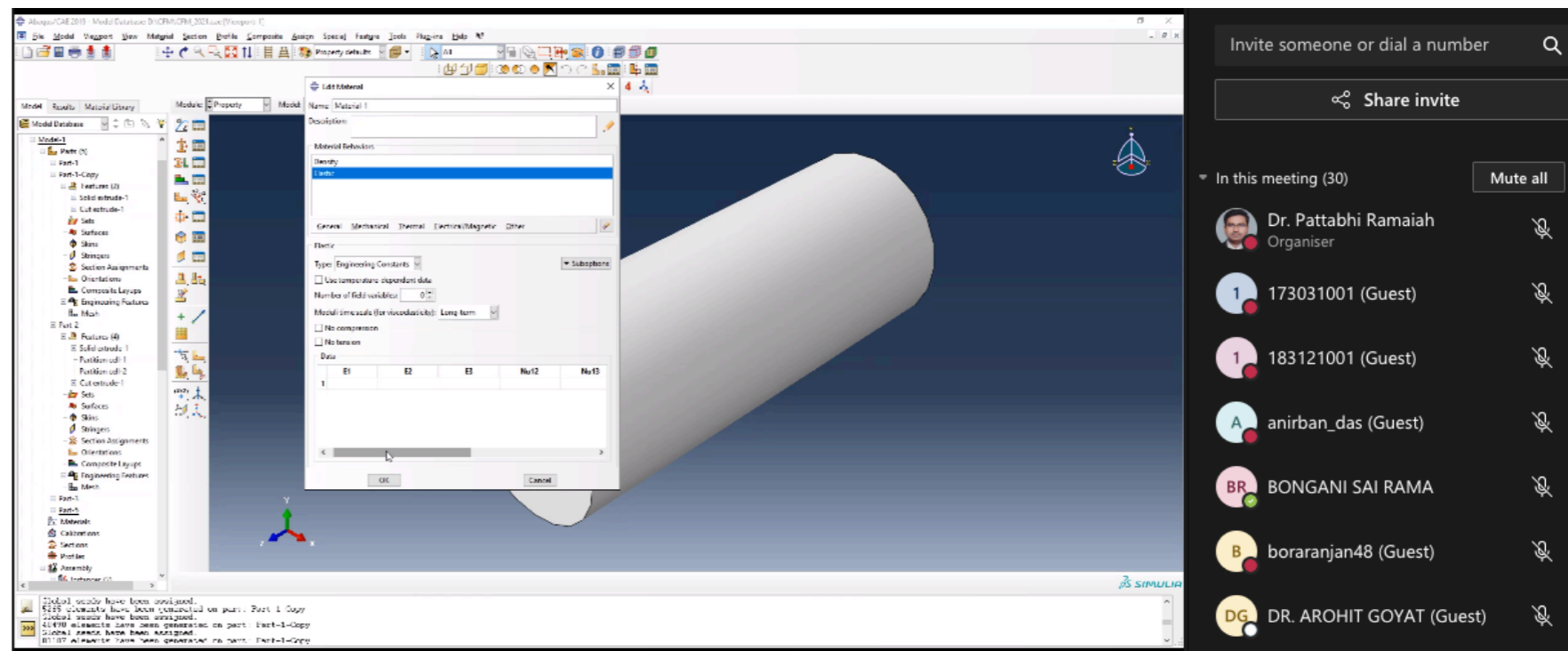
The major objective is to introduce various tools to understand the mechanics of failure/fracture, which will help to develop better and efficient techniques for the design of materials.

1. Exposed the participants to the fundamental aspects of material design:
2. Introduced the computational methods through governing equations, strong and weak forms, overview of the finite element method (FEM), partition of unity and enrichment techniques and level sets.
3. Discussed the macro and micro-mechanical behaviour of composites
4. Introduced ANN based machine learning methods to solve partial differential equations for mechanical problems.
5. Discussed experimental techniques to predict the residual stresses and the estimation of stress intensity factor and remaining life.
6. Introduced the extended finite element method (XFEM), a technique to simulate crack growth where the mesh is not required to conform to the free surface and the discontinuous quantities can be captured in the finite element interpolant with minimal smearing.
7. Discussed the recent computational methods to simulate fracture: discrete crack and smeared/diffused crack approaches, special singular elements, meshless methods, semi-analytical displacement formulation, phase field method for brittle fracture and cohesive zone model for fracture, where derivation of basic theory and implementation aspects will be discussed.
8. Introduced sub-scale (micro and nano) modelling of fracture and recent multiscale methods to simulate fracture.

## Dr. Budarapu's interaction with participants during one of his lecture



## Modelling and simulations using ABAQUS software



## Highlights

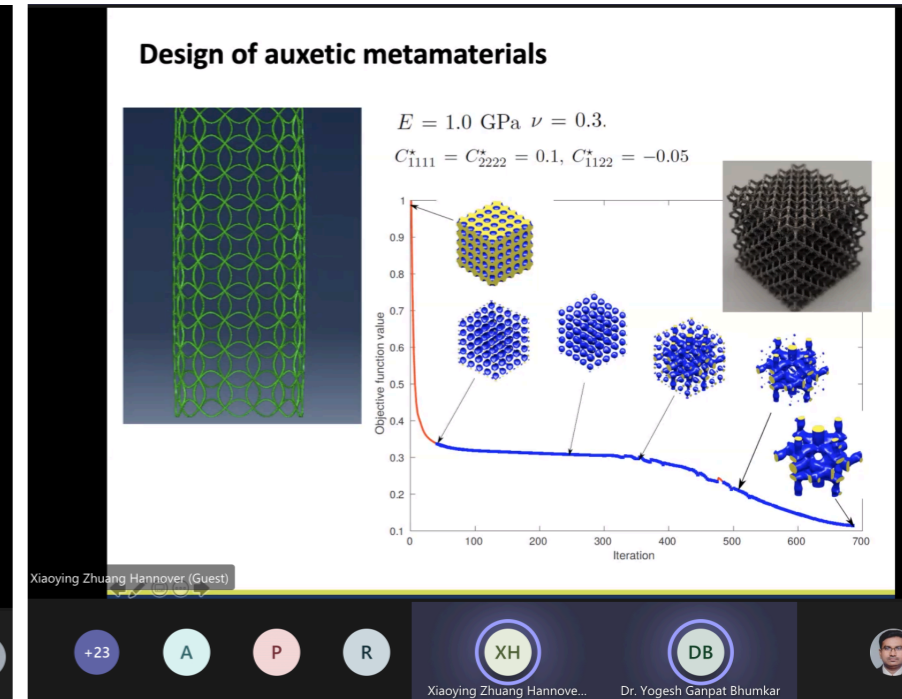
1. The course involved 36 lectures, 7 Tutorials and 3 Guest talks in total for 63 hours over a period of 2 weeks, i.e. during 24 May - 04 June 2021.
2. There were 53 participants in total consisting of, 34 faculty members from AICTE approved institutions, 1 specialist from industry, 3 research scholars, 1 senior research fellow, 2 M.Tech students and 12 B.Tech students.
3. The course is organised with the help of 10 experts in total, involving: 5 faculty members from IIT Bhubaneswar, one each faculty member from IIT Madras and IIT Ropar, respectively, and
4. Three guest talks were organised by inviting the experts from DRDL Hyderabad, IISc Bangalore and Leibniz University Hannover, Germany.

## Guest talks: Prof. P.K. Yalavarthy and Prof. X. Zhuang

**Deep Learning in Medical Imaging : The Road Ahead**

Phaneendra K. Yalavarthy, Ph.D.  
E-mail: yalavarthy@iisc.ac.in

CDS  
Department of Computational and Data Sciences  
Indian Institute of Technology Bhubaneswar  
Computational Fracture Mechanics (QIP Short Term Course)  
May 28, 2021



## Feedback on 17 different questions from 41 participants is captured through google forms. Some testimonials:

Computational fracture mechanics is itself a vast subject and covering computational aspects of the course is indeed a typical challenge in the current scenario. The effort and pain that you had taken in delivering 2 weeks of presentations commencing from solid mechanics, fundamentals of FEM, XFEM and exposing us to the various domains requires patience, perseverance & dedication. You have exceeded the expectations in delivering them in a fantastic manner. The demonstrations provided using Matlab code in today's lecture was awesome. My sincere thanks to you for patiently clarifying all the doubts in the lecture series. The tutorial that you have prepared will be preserved as a repository & will certainly serve as a guideline for any futuristic courses that can be done from my institute - Prof. B. Rammohan, Dayananda Sagar University, Bangalore.

**Course:** Understood the importance of "Computation Fracture Mechanics" through the experts from highly reputed institutions across India. None wouldn't be possible without the tremendous effort by Dr. Pattabhi Ramaiah Sir. In fact, this Short Term Course enriches the titled concept and motivates the participants to do the futuristic work on the same. **Schedule:** Very well organised and tireless effort on sending the meet link the day before and informing about the speaker. It enthuses the new topic which are to be grasped. **Guest Talks:** It is an knowledge enriched bonus to everyone, which actually not expected. First time, I personally observe such type of guest talks from the experts are being a part of the Short term course. It is more than highly appreciated. - Balaji Rajendran, Rajyalakshmi Engineering College, Chennai.

The workshop was really good and provided us new thinking for the research. Your team commitment and effort are really appreciable; especially your honesty while delivering the concepts and sharing the new ideas. In a limited duration, you comprehensively covered many topics involving fundamental and advanced topics. In the future, I will be very happy to attend similar kinds of workshops - Y.S. Thube, Research scholar, IIT Dharwad.

As a BTech ongoing student , the first week of the course was really helpful in bringing together the concepts studied previously and going a bit more deep on few topics. The notes are really helpful for future reference. Regarding the 2nd week I was introduced to fracture mechanics which was a new topic , but computational implementation was a bit hard - Hudson Samuel, B.Tech. in Mechanical Engg., IIT Bhubaneswar.