



A Five-Day GIAN Course on

Isogeometric Analysis (IGA): Basic and Advanced Applications

(IGA is a unified frame work of CAD and FEM)

11 – 15, November 2019

Call for Registration and Participation

International Faculty

Prof. Alessandro Reali

Professor of Solid and Structural Mechanics

University of Pavia, Italy

Course Coordinator

Dr. Hari Kumar Voruganti

Associate Professor

Department of Mechanical Engineering

National Institute of Technology Warangal – 506 004. India

Phone: +91 870 246 2378/2318. Email: harikumar@nitw.ac.in

**T
o
p
i
c
s**

- Introduction to Isogeometric Analysis (IGA)
- Spline basics and IGA implementation aspects
- IGA advanced applications
- IGA collocation
- IGA implementation tutorials in Matlab
- Structural optimization through IGA
- Biomechanical applications

**Learn from a Pioneer of
Isogeometric Analysis**

Overview of the Course:

Isogeometric Analysis (IGA) is a recent idea introduced to bridge the gap between Computational Mechanics and CAD. The key feature of IGA is to extend the finite element method representing geometry by functions which are typically used by CAD systems, and then invoking the isoparametric concept to define field variables. Thus, the computational domain exactly reproduces the CAD description of the physical domain. Numerical testing in different situations has shown that IGA holds great promises, with a substantial increase in the accuracy per degree of freedom with respect to standard finite elements. Along with geometric efficiency and flexibility, IGA can help in cost-saving simplification of the typically expensive mesh generation and refinement processes required by standard FEA.

Moreover, thanks to the high-regularity properties of its basis functions, IGA has shown better accuracy and enhanced robustness with respect to standard FEA in a number of applications ranging from solids and structures to fluids and fluid-structure interaction problems, opening also the door to geometrically flexible discretization of higher-order partial differential equations in primal form (e.g, Kirchhoff shells, Cahn-Hilliard phase-field modeling, etc.). Some of the emerging application areas of IGA include: dynamics, wave propagation and advanced biomechanics applications.

Course Contents: *(Lecture topics/schedule is included in the last page of this document)*

Within this framework, this course aims at giving a practical, concise introduction to Isogeometric Analysis, covering some basic concepts of IGA and its implementation, to move to some advanced applications where the potential of IGA can be exploited to get far superior results with respect to standard FEA.

Therefore, some basics of B-Splines and NURBS will be given first, and the main ingredients toward the implementation of simple isogeometric codes will be shown and discussed. Then, some advanced applications will be dealt with, including vibrations and dynamics, wave propagation, structural elements, laminated composites, phase-field modeling, immersed methods, biomechanics simulations, collocation methods. The main objective of the course is to give participants an idea on how to start with IGA, along with an overview of its potential (and the basic tools to exploit it).



Dr. Alessandro Reali is Professor of Solid and Structural Mechanics and Dean at the University of Pavia, Italy. His research interests mainly lie in the area of *Computational Mechanics methods, in particular Finite Elements and Isogeometric Analysis for the simulation of problems involving solids and structures (including, e.g., dynamics, contact, fracture, etc.), fluids, fluid-structure interaction, and other coupled problems in Mechanical, Civil, Aerospace, Biomedical Engineering.* Prof.

Reali authored **more than 100 papers** on international journals, including a number of seminal articles which have recently led to his identification as “**ISI Highly Cited Researcher**” by Thomson-Reuters/Clarivate Analytics (in 2014, 2015, 2016, 2017, 2018). He was invited to give seminars at many internationally renowned academic institutions, as well as to deliver plenary and keynote lectures at many international conferences. He authored/co-authored more than 350

contributions (more than 270 invited) at conferences, workshops, seminars. In 2017 he was appointed **Commander** (“Commendatore”) of the **“Order of Merit of the Italian Republic”** by the President of the Italian Republic. He received many important research awards such as the **“Bruno Finzi Prize”** for Rational Mechanics (2018), **IACM “Fellows” Award** (2016), the **TUM-IAS “Hans Fischer Fellowship”** (2015), **IACM “John Argyris” Award** (2014), the **“AIMETA Junior” Prize** (2013), the **ECCOMAS “O.C. Zienkiewicz” Award** (2012), as well as an **“ERC Starting Grant”** (2010). He also participated in many research projects (being the coordinator for some of them) funded, among others, by the European Research Council (ERC), the European Commission (EC), the European Science Foundation (ESF), the Italian Government (MIUR) as well as by companies such as, e.g., Total, Hutchinson, Nokia Corporation, and Saes Getters. *He is one of the pioneers of Isogeometric Analysis and one of the original developers of the open research software “GeoPDEs: a research tool for IsoGeometric Analysis of PDEs”, which collected more than 5,000 downloads.*

Who can participate?

This program is open to the Faculty, PG and Research students of Mechanical Engineering and allied disciplines from various Institutes. Practicing Engineers from industries can also participate.

About GIAN Course

MHRD, Govt. of India has launched an innovative program titled “Global Initiative of Academic Networks (GIAN)” in higher Education, in order to garner the best international experience. As part of this, internationally renowned Academicians and Scientists are invited to augment the Country’s academic resources, accelerate the pace of quality reforms and elevate India’s scientific and technological capacity to global excellence.

About the Institute and Warangal

National Institute of Technology, Warangal (NITW) formerly known as RECW is the first among seventeen RECs set up in 1959. Over the years, the Institute has established itself as a premier Institution in imparting technical education of a very high standard, leading to B.Tech, M.Tech. and Ph.D. programmes in Science and Engineering streams.

Warangal is known for its rich historical and cultural heritage. It is situated at a distance of 140 km from Hyderabad. Warangal is well connected by rail and road. National Institute of Technology, Warangal campus is 2 km away from Kazipet railway station and 12 km away from Warangal railway station.

About The Department

The Department of Mechanical Engineering was established in the year 1959. The Department offers one UG program and seven PG programs. The Department has experienced faculty and well-established laboratories. The Department has liaison with reputed industries and R&D organizations like NFTDC, BHEL, DMRL, DRDL, ARCI, Praga Tools GTRE, etc. Presently the Department is handling several R&D and consultancy projects. The Department has been recognized as QIP centre for M.Tech and Ph.D.

How to Register?

Stage-1: Web Portal Registration:

Visit <http://www.gian.iitkgp.ac.in/GREGN/index> and create login User ID and Password. Fill up the blank registration form and do web registration by paying Rs.500/- online through Net Banking/Debit/Credit card. This provides the user with life time registration to enroll in any number of GIAN courses offered.

Stage-2: Course Registration:

Login to the GIAN portal with the user ID and Password already created in Stage 1. Click on Course Registration option at the top of Registration form. Select the Course titled “Isogeometric Analysis (IGA): Basic and Advanced Applications” from the list and click on Save option. Complete your registration by clicking on ‘Confirm Course’.

REGISTRATION FEE:

Faculty (Internal & External) & Scientists from R&D Labs	Rs. 2,000/-
Persons working in Industry / Consultancy firms	Rs. 4,000/-
Students & Research Scholars	
• Without award of Grade	Rs. 500/-
• With award of Grade	Rs. 1,000/-
Students from abroad	\$ 50
Faculty/Scientists/Persons working in Industry and Consultancy firms from abroad	\$ 100

The Registration fee includes instructional materials, tutorials, laboratory and computer use and free internet facility. The participants will be provided with boarding and lodging on additional payment of Rs.3,000/- on sharing basis.

Selection and Mode of Payment

Selected candidates will be intimated through e-mail. They have to remit the necessary course fee to the Bank as per the details given below. **Outstation participants requiring Lodging and Boarding facilities have to pay Rs. 3,000/- in addition to the course fee.**

Account Name	GIAN NITW
Account No.	62447453600
Bank	State Bank of India
Branch	NIT Warangal
Branch Code	20149
IFSC	SBIN0020149
MICR Code	506004011
SWIFT Code	SBHYINBB018

Candidates registering early will be given preference in short listing process.

For any queries regarding registration of the course and accommodation, please contact the Course Coordinator:

Dr. Hari Kumar Voruganti, Department of Mechanical Engineering, National Institute of Technology Warangal - 506 004, Telangana, India. Tel: +91- 870 246 2378/2318

Email: harikumar@nitw.ac.in

Proposed Lecture Topics/Schedule (Tentative)		
Date	Day	Topic
Day 1	MON	<ul style="list-style-type: none"> • Motivation (CAD-FEA Gap, issues in FEA); • Original IGA idea and basics of splines (I) • Basics of splines (II)
Day 2	TUE	<ul style="list-style-type: none"> • Basic implementation aspects of IGA • IGA modal analysis and comparison with FEM; IGA structural dynamics (I) • IGA structural dynamics (II); Dispersion properties in wave propagation problems • Matlab IGA implementation: basics • Matlab IGA implementation: 1D elastic bar • Matlab IGA implementation: 2D plane strain elasticity
Day 3	WED	<ul style="list-style-type: none"> • IGA structural elements • IGA laminates; IGA shell-BEM coupling for fluid-structure interaction • IGA phase-field modeling with applications to brittle fracture and its coupling to Kirchhoff-Love shells • Stent and aortic valve structural simulations • Immersogeometric analysis and its application to aortic valves • Other applications including phase-field modeling of tumor growth.
Day 4	THUR	<ul style="list-style-type: none"> • IGA collocation basic idea • IGA collocation advanced applications (I) • IGA collocation advanced applications (II) • Matlab IGA collocation implementation in 1D • Matlab IGA collocation implementation in 2D
Day 5	FRI	<ul style="list-style-type: none"> • Topics on complex IGA geometrical modeling (I) • Topics on complex IGA geometrical modeling (II) • Structural optimization using IGA • Tutorial on geometrical modeling • Tutorial on structural optimization