

# Analytical Reasoning & Experiential Learning

## With Applications to Software and Program Analysis

---

### Overview

Software analytics and Bioinformatics are two fields that significantly impact national economy, national security, industrial growth, healthcare, and environment. This course will promote critical problem solving and experiential learning that deeply binds the two fields together. The course shall aim at tackling complex scenarios including that of automated vulnerability exploitation.

*Programs and encodings of programs* are central to software analytics. The software programs are recipes to perform actions through computers similar to the genetic programs that are recipes to perform actions through chemical molecules. Software programs are encoded using a binary alphabet whereas the genetic programs are encoded using the so-called nucleic acid alphabet. Both suffer from problem spots – in software programs they take the shape of safety and security vulnerabilities whereas in genetic programs they take the shape of disease genes. In both disciplines, the fundamental questions center on how to analyze and understand programs, detect the problem spots, and modify the programs to correct defects or add new features. If properly understood and modeled, we can solve complex problems of software and systems security.

The enormous program size is first fundamental barrier for program analysis. On the surface, both programs look like a long string – a linear graph. However, this linear graph encodes an enormously complex non-linear recipe. Thus, ultimately the analysis shall require the mathematical abstraction of graph. The course will teach critical problem solving using graphs and bring out the practical applicability to software analytics and bioinformatics. It will introduce the automated tools needed to do computations on enormous graphs. We will introduce graph databases in general and a graph database platform for software analysis in particular.

The course will follow the experiential learning paradigm. Each day a topic will start with an important *discovery question* and its significance followed by discussion on the *design and evaluate a solution*. We will follow it up with an *implementation using a graph database platform*. As the final phase of experiential learning, the participants will be given *open-ended questions to reflect* on what they have learnt and its applicability. The course has the following objectives:

1. The course shall aim to work on analytical reasoning and critical thinking for improved problem solutions.
2. Enhance the participant's knowledge in following areas: (a) modeling complex systems and software analytics problems as graph problems, (b) data structures and algorithms from applied graph theory.
3. Expose the participants to graph database platforms and other modern technology and tools of applied graph theory.
4. Illustrate the importance of cross-fertilization of ideas from software engineering and program analysis to create and enrich the core of applied graph theory knowledge that benefits both applications.
5. The course targets to create capacity for automated systems security through broad exposure to the state of the art.

For more details, please visit GIAN cell at <http://mnit.ac.in>.

<b>Dates</b>	Course Duration : <b>Oct. 9 – 13, 2017</b> Last date of Registration : <b>Oct. 3, 2017</b>
<b>You Should Attend If you are ...</b>	<ul style="list-style-type: none"><li>▪ Executives, engineers and researchers from manufacturing, service and government organizations including R&amp;D laboratories.</li><li>▪ Student at all levels (BTech/MSc/MTech/PhD) or Faculty from academic institutions and technical institutions.</li></ul>

<b>Lectures/ Modules</b>	<ol style="list-style-type: none"> <li>1) Important discovery problems in program analysis and software analytics</li> <li>2) Key graph algorithms to address those problems - Page Rank algorithm</li> <li>3) Graph database and query language</li> <li>4) Modeling complex software analytics problems</li> <li>5) Graph database for detecting software safety and security vulnerabilities</li> <li>6) Atlas graph database platform to detect software vulnerabilities</li> <li>7) Graph matching algorithms and their applications in software analytics/program analysis.</li> <li>8) Software vulnerabilities and challenges in their detection and exploitation</li> <li>9) Modeling and verification of control flow and leakage paths</li> <li>10) Static and dynamic program analysis: Tools and Techniques</li> <li>11) Exercising the UI intensive I/Os in Apps: Use cases</li> </ol> <p><b>Number of participants for the course will be limited to forty. Selection of participants shall be on “First Come First Served” basis only.</b></p>														
<b>Fees</b>	<p><b>GIAN Portal registration fee : Rs 500 (mandatory for all participants).</b></p> <p>Registration to the GIAN portal is one time affair. Once registered in the portal, an applicant will be able to apply for any number of GIAN courses as and when necessary. One time Non-refundable fee of Rs. 500/- is to be charged for this service. Please also note that mere registration to the portal will not ensure participation in the courses. The course coordinator has the final say on the selection of participants. This is NOT course participation fee. The candidate has to pay course participation fee as per directive from the course coordinator/host Institute to the local Institute only. You are required to apply online using the following steps:</p> <ol style="list-style-type: none"> <li>1. Create login and password at <a href="http://www.gian.iitkgp.ac.in/GREGN/index">http://www.gian.iitkgp.ac.in/GREGN/index</a></li> <li>2. Login and complete the Registration Form and select Course(s)</li> <li>3. Confirm application and pay Rs. 500/- (non-refundable) through online payment gateway.</li> <li>4. Download “pdf file” of the application form and email it to the Course Coordinator.</li> </ol> <p><b>Registration Fee (exclusive of GIAN Portal Registration Fee)</b></p> <table style="width: 100%; border: none;"> <tr> <td><b>Participants from abroad</b></td> <td style="text-align: right;"><b>: US \$100</b></td> </tr> <tr> <td><b>Industry/ Research Organizations</b></td> <td style="text-align: right;"><b>: Rs 5000</b></td> </tr> <tr> <td><b>Faculty from other Academic Institutions</b></td> <td style="text-align: right;"><b>: Rs 4000</b></td> </tr> <tr> <td><b>Students from other Academic Institutions</b></td> <td style="text-align: right;"><b>: Rs 2000</b></td> </tr> <tr> <td><b>Faculty/Students from IIT Kota*</b></td> <td style="text-align: right;"><b>: Rs 2000/-</b></td> </tr> <tr> <td><b>Faculty/Research Scholars (MNIT)</b></td> <td style="text-align: right;"><b>: NIL</b></td> </tr> <tr> <td><b>Postgraduate/Undergraduate students (MNIT)</b></td> <td style="text-align: right;"><b>: NIL</b></td> </tr> </table> <p>The above fee includes all instructional materials, computer use for tutorials, 24 hr free Internet facility. The participants will be provided with accommodation, if available, on payment basis.</p>	<b>Participants from abroad</b>	<b>: US \$100</b>	<b>Industry/ Research Organizations</b>	<b>: Rs 5000</b>	<b>Faculty from other Academic Institutions</b>	<b>: Rs 4000</b>	<b>Students from other Academic Institutions</b>	<b>: Rs 2000</b>	<b>Faculty/Students from IIT Kota*</b>	<b>: Rs 2000/-</b>	<b>Faculty/Research Scholars (MNIT)</b>	<b>: NIL</b>	<b>Postgraduate/Undergraduate students (MNIT)</b>	<b>: NIL</b>
<b>Participants from abroad</b>	<b>: US \$100</b>														
<b>Industry/ Research Organizations</b>	<b>: Rs 5000</b>														
<b>Faculty from other Academic Institutions</b>	<b>: Rs 4000</b>														
<b>Students from other Academic Institutions</b>	<b>: Rs 2000</b>														
<b>Faculty/Students from IIT Kota*</b>	<b>: Rs 2000/-</b>														
<b>Faculty/Research Scholars (MNIT)</b>	<b>: NIL</b>														
<b>Postgraduate/Undergraduate students (MNIT)</b>	<b>: NIL</b>														
<b>Registration</b>	<ol style="list-style-type: none"> <li>1. Fees may be paid via Demand Draft in favour of “REGISTRAR (SPONSORED RESEARCH) MNIT Jaipur” payable at Jaipur. OR Fees can be paid through National Electronic Funds Transfer (NEFT) Account No. : 676801700388 In name of “REGISTRAR (SPONSORED RESEARCH) MNIT Jaipur” Bank : ICICI Bank, Branch MNIT Jaipur IFSC Code: ICIC0006768. Preferred mode of registration is <b>Demand Draft</b>.</li> <li>2. Email filled in “Registration Form”, scan copy of “Demand Draft/ NEFT Transaction Receipt” and pdf file (downloaded from GIAN Portal Registration) to <a href="mailto:vlaxmi@mnit.ac.in">vlaxmi@mnit.ac.in</a>. Please mention “GIAN (Analytical Reasoning &amp; Experiential Learning) in Subject and email on/before October 3, 2017.</li> </ol>														

## The Faculty



**Prof. Suresh Kothari** (Suraj) is the Richardson Professor of Electrical and Computer Engineering (ECE) at Iowa State University (ISU) and the founder President of EnSoft. He is a leader in machine-enabled reasoning to solve complex problems of developing and maintaining large software including cybersecurity and safety. He has served as a PI for the DARPA Automated Program Analysis for Cybersecurity (APAC) program, and a Co-PI for the DARPA Software Enabled Control (SEC) program. Currently he is a PI for the Space/Time Analysis for Cybersecurity (STAC) program. EnSoft, the company he founded

in 2002, provides software products and services worldwide to more than 300 companies including major avionics and automobile companies. He was awarded in 2012 the Iowa State Board of Regents Professor Award for excellence in research, teaching, and service. He has served as a Distinguished ACM Lecturer. His tutorials at major conferences, short courses, and invited talks are widely appreciated by industry and academia.

URL: <http://class.ece.iastate.edu/kothari/>

Research Lab URL: <http://www.ece.iastate.edu/kcsl/>



**Dr. Vijay Laxmi** is an associate professor at Computer Science and Engineering Department of Malaviya National Institute of Technology Jaipur. She has been teaching in MNIT since 1995. Her research interests include information security. She obtained PhD from University of Southampton, UK under Commonwealth Scholarship and Fellowship Plan. She has guided 12 PhDs and has 125 publications in Journals and Conferences. She has been involved in various R&D projects, some of which are International Collaboration. She is an IEEE and ACM member. She has been a member of TPC of various conferences.



**Prof. M. S. Gaur** is a professor at Computer Science and Engineering Department of Malaviya National Institute of Technology Jaipur. His research interests include information security and NoC (Networks on Chip). He has obtained his B.E. (JNV University, 1988), M.E. (IISc, 1992) and PhD (from University of Southampton, UK, 2004). He has guided 14 PhDs and has 150 publications in Journals and Conferences. He has coordinated national and international projects in the domains of Information Security and Networks on Chip. He is a member of IEEE, ACM, VLSI Society of India.

## Course Coordinators

Dr. Vijay Laxmi  
Associate Professor,  
Computer Science and Engineering,  
Malaviya National Institute of  
Technology Jaipur  
Tel: +91-141-2713333 (O),  
+91-141-2713127 (R)  
Email: [vlaxmi@mnit.ac.in](mailto:vlaxmi@mnit.ac.in)

Prof. Manoj Singh Gaur  
Professor  
Department of Computer Science  
and Engineering  
Malaviya National Institute of  
Technology Jaipur  
JLN Marg, Jaipur – 302017, India.  
Tel: +91-141-2713227 (O),  
+91-141-2713127 (R)  
Email: [gaurms@mnit.ac.in](mailto:gaurms@mnit.ac.in)