



PhD

Brochure August 2018



Offered by



**CSIR - Central Building Research Institute
Roorkee – 247667, Uttarakhand**

Preamble

With the initiative of Government of India on liberalization, globalization and privatization, boom in the construction industry has come to this country. In the last few years the country has seen the construction of golden quadrilateral in the road sector and massive development in the housing sector. The east – west corridor in the road sector is further facilitating the movement of traffic and the goods from one end of the country to the other. With huge shortage of housing in all the economic sectors and the importance attached to the growth and development of the housing sector in the country it is expected that the country is going to see a new horizon in the housing industry in near future. The concept of affordable housing is fast catching up in the country.

Recognising the importance of both housing and roads, the Central Building Research Institute, Roorkee (CBRI) one of the prime laboratories of CSIR is offering the PhD programme in Engineering Sciences in the areas of Structural Engineering, Geotechnical Engineering and Chemical Sciences. Drawing from the rich experience of scientists working in the laboratory, the course work is designed to offer the research scholars sound theoretical knowledge and practical site experience. Such a unique opportunity is seldom available in the country.

Adequate hostel facilities both for the girls and boys are available in the campus.

Number of Seats in the Programme

The total number of seats available is 8 (Eight).

Eligibility for Admission

Ph.D. (Science): Master's degree in Earth Science (Geology / Geophysics) or Chemistry (Inorganic / organic / polymer) or Master's degree in Material Science with specialization in corrosion science having a valid National level fellowship (JRF/SRF of various funding agencies, e.g. CSIR, UGC, DBT, DST etc.), INSPIRE or other equivalent fellowships.

Ph.D. (Engineering): A Master's degree in Engineering / Technology (Civil – Structural, Geotechnical) with GATE qualified or UGC/CSIR NET/NBHM or valid CSIR-SRF or equivalent fellowship.

Programme Fee Structure

Rupees Twelve thousand (Rs 12,000/-) per year is to be deposited annually. For NEFT bank transfer, the amount is to be deposited in the saving account number 32594652804 of AcSIR (IFSC code – SBIN0004285) with appropriate narration statement.

Important Dates

The detailed programme calendar for the course work will be made available before the start of each semester.

Evaluation Procedures and Grading Scheme

(Details are given in AcSIR Handbook available at www.acsir.res.in)

For PhD course work

As a part of the PhD programme one has to register for a number of courses to earn the requisite credit as decided by AcSIR. The evaluation of the courses in the programme is a continuous process with a mid and semester-end examination for all courses. Letter grades are awarded for each course reflecting the students' proficiency and instructors' expectation. The grades and their description along with their equivalent numerical values, where applicable, are as follows:

Letter Grade	Performance	Numerical Value
A+	Outstanding	10
A	Excellent	9
B+	Very Good	8
B	Good	7
C+	Fair	6
C	Poor	4
F	Very Poor	2
I	Incomplete*	0
S	Satisfactory (for Audit course)	Not Applicable
X	Unsatisfactory (for Audit course)	Not Applicable

* "I" grade shall be given to students who have (i) Not Attended Classes; and/or (ii) Not been evaluated. This implies repeating the full course and appearing in the examination so that it could be considered towards final grade calculation.

Performance of the student will be evaluated by two indices, SGPA and CGPA. These will be calculated as follows:

$SGPA = \{\text{Sum of (Course credit * Numerical value of course grade)}\} / \text{Total course credits earned in the semester}$

$CGPA = \{\text{Cumulative grade points scored in all passed courses} / \text{Cumulative credits earned}\}$

A student needs to have a SGPA of over 6.0 (in each of the first and second semesters) and a CGPA of over 6.5 (at the end of the second semester) for continuing beyond the first year. Minimum grade point to be earned to pass any subject is 6.0.

Determination of Distinction and First Class Grade

- Distinction \geq 8.00 CGPA
- First Class \geq 7.00 CGPA
- Pass Marks \geq 6.50 CGPA

Weightage of marks during the semester

There will be one mid-semester and one end semester examination. Before and after the mid-semester examination there will be two class tests. The end semester examination will have 40% weightage. The mid semester examination will have 30% weightage and the two class tests will have 10% weightage each. The balance 10% weightage will be given to the seminar, tutorial, general discipline etc in respective subjects.

Credit requirement

Minimum Credit requirement for PhD is 16. 12 credits have to be earned through course works. In addition to the course works, candidate has to complete project - duration varying from six to eight weeks in rural areas keeping in line with the philosophy of CSIR 800 project scheme. Project will have 2 credit. Additionally candidate has to write two project proposals.

For PhD Thesis work

- ***Doctoral Advisory Committee (DAC)***
 - i) AcSIR Laboratory Coordinator in consultation with the Director of the laboratory shall constitute the Doctoral Advisory Committee for each candidate as soon as the thesis supervisor(s) is/are assigned with approval of Dean & subsequent ratification by Senate Chairman.
 - ii) In addition to thesis supervisor(s), the committee shall have three more members – two members from the same research area as recommended by the supervisor(s) and one member nominated by the Director of the Institute from different field of research.
 - iii) The doctoral advisory committee shall review the progress of the research work on continuous basis and meet at least once in each semester. They shall advice on the next course of action. The committee also recommends when to submit the thesis.
 - iv) The coordinator shall report to dean about the detail of the committees and obtain necessary approval from time to time.

- ***Comprehensive Examination***

- i) A student is eligible to appear at the Comprehensive Examination only after he/she has successfully completed all course requirements with more than the minimum CGPA.
- ii) The Comprehensive examination board shall consist of minimum three members --thesis supervisor(s), one member from the same field of research and one member from other than the candidate's field of research. The board can have a maximum of five members.
- iii) Based on the proposal of the supervisor(s), the Comprehensive examination board would be formed & approved for each student by the Dean with subsequent ratification by the Senate chairman.
- iv) The candidate in consultation with the thesis supervisor(s) shall appear for oral comprehensive examination in between 2nd and 4th semester. If the candidate fails to clear the comprehensive examination in two attempts, his/her provisional PhD registration would be cancelled.
- v) The Comprehensive examination will consist of presentation by the candidate followed by rigorous oral examination. The recommendation of the board would be in the form of "Cleared" or "Not Cleared".

- ***State-of-the-Art and Open Seminar***

- i) The PhD candidate needs to present the State-of-the-Art in a seminar (open) along with PhD proposal in presence of Doctoral Advisory Committee within six months after clearing the Comprehensive examination.
- ii) The PhD candidate shall present his research work in PhD colloquium (Open Seminar) in presence of the DAC members, before synopsis and thesis submission.
- iii) PhD synopsis along with the thesis hard copies (five numbers) & soft copies shall be submitted to laboratory coordinator on recommendation of the DAC and after incorporation of all suggestion, if any.
- iv) The notification of the open seminar shall be circulated by the thesis supervisor in consultation with members of the Doctoral Advisory Committee.

- ***PhD Thesis Evaluation***

- a) A PhD thesis shall be first evaluated by a Thesis board and thereafter by an Oral Board.

- b) The thesis advisor(s) will submit the panel of examiners, normally six experts from the relevant field, to Dean through AcSIR coordinator. None of the examiners shall be from the same Institute.
- c) The senate chairman shall constitute the thesis board by selecting two examiners from the above list.
- d) The examiners shall be contacted through email for their acceptance.
- e) The thesis report from examiners shall be communicated to the respective Deans for endorsement by the laboratory coordinators.
- f) Based on the report of the thesis examiners, the DAC shall recommend the next course of action i.e. recommendation for holding oral examination or rework.
- g) Thesis oral examination board (OEB) shall be constituted by the Senate Chairman on recommendation of the thesis supervisor. The OEB will have minimum three members – minimum one external member, one DAC member and thesis supervisor(s).
- h) The PhD candidate shall present his research work physically in the presence of the above OEB members. Additional external members may be present in video conferencing mode, if desired.
- i) The OEB will look after whether or not the essential modifications, suggested by the thesis examiners, if any, have been incorporated. The board shall authenticate the thesis work as the student's own work based on the presentation and responses to the questions raised during oral examinations.
- j) The candidate is considered to have passed the oral examination if all the members except at the most one member consider that the performance of the candidate is satisfactory.
- k) The committee may recommend re-submission of the thesis at most once after incorporating the suggestions made by the committee for evaluation.
- l) In the rescheduled oral examination, the OEB must declare the candidate either to have passed or failed. There shall not be any recommendation for third oral examination.

Provisional Certificate

The provisional certificate shall be awarded by AcSIR after successfully completion of the PhD oral examination.

About CSIR-CBRI



Introduction

CSIR - Central Building Research institute (CBRI), Roorkee, Uttarakhand, India is one of the National laboratories under the Council of Scientific & Industrial Research (CSIR), India. CSIR- CBRI has built-up excellent facilities and expertise in all the branches of building science and technology e.g. Geotechnical Engineering, Structural Engineering, Building Materials, Environmental Science and Technology, Architecture and Planning, Efficiency of Buildings, Acoustics Instrumentation & Mechanical Systems and Fire Research Engineering. In fact fire research laboratory of the institute is a unique facility in the country. The institute has vast experience in disaster mitigation. Over the years, the institute has developed expertise and facilities in mitigating disasters of different types.

Services of CSIR - CBRI are being extensively used by the Central and State Governments and public and private sector undertakings. Scientists of CSIR - CBRI serve on many national and international committees and the Institute is recognised at the national and international levels as a leading research institution. The institute very actively takes part in the formulation of Indian Standard Specifications.

Vision

A world class research & knowledge centre of national importance for providing innovative solutions to all aspects of building science & technology.

Mission

Dedicated to research, development and innovation (RD&I) in solving national challenges of planning, design, materials, capacity building and construction including disaster mitigation in buildings to achieve safety, sustainability, resilience, smartness, comfort, functional efficiency, speed, productivity in construction, environment preservation, energy efficiency and economy.

Focus

- Strategies for creating sustainable built environment for improving quality of life
- Scientific RD&I in niche areas such as virtual construction to disaster resilience
- To be an institute of global repute for providing innovative and sustainable building solutions

Research & Development Groups

- Geotechnical Engineering
- Structural Engineering
- Organic Building Materials
- Environmental Science and Technology
- Architecture and planning
- Efficiency of Buildings
- Fire Research Engineering and
- Acoustics, Instrumentation and Mechanical systems
- Polymer, Plastic & Composites

Spectrum of Activities / Services

- In-house Research & Development Projects
- Sponsored R&D Projects
- Grant in Aid Projects
- Consultancy Projects
- Inter- Lab & International Collaborative and network projects
- Technical Services
- Conduct/organize advanced courses/seminars/workshops/industry meets, etc.
- Release of Technology / know-how
- Information Dissemination

Special lectures on varied topic of academic relevance, other than curriculum, are held every week under colloquium.

A number of conferences, symposia and workshops are organized by the faculty which attracts participation from scholars all over the world.

The Institute maintains collaborations with several other institutes in the world through scientists exchange programs. The scientists/faculties of the Institute have distinguished themselves through awards for academic activity from national as well as international organizations. CSIR-CBRI, Roorkee has set a fine example of interaction with the industry in the country, through consultancy and technical services offered by the scientists. Innovative ideas are put to practice in many projects sponsored by other institutions.

IT Infrastructure

Internet Connectivity

CSIR-CBRI is provided with 16 Mbps (uncompressed) bandwidth for its Internet facility. Also 1 Gbps National Knowledge Network (NKN) connectivity has helped the institute to get connected with the leading institutes of the country.

Video Conference Facility

State-of-the-art video conferencing facility has been established, enabling effective interaction among the CSIR labs and other institutions.

Library

Library, now known as Knowledge Resource Centre (KRC), is a hub of research activities of the institute. A state of the art RFID system is put in place. The centre has both e-learning facilities and reading through hard copies.

Collection, collation and communication of documents and as repository of knowledge resources in the field of building science and technology and related areas for providing specified information services using various sources of information in print/electronic media and adopting developments in information and communication technology (ICT)

for making services much more effective, exhaustive, dynamic and almost instantaneous to its valued users i.e. S&T community is the focus of the knowledge resource centre.

Information Base

Library has a rich collection of books, journals and non – book materials that include:

Print

- 43,000 books include text books, reference books, technical reports, manuals, conference proceedings, standards, theses, maps etc.
- 19500 Bound volumes of journals collection since 1950
- 109 current subscription to journals (61 foreign + 48 Indian) in print form
- Full text reprints of research publications of S&T members of CBRI
- Collection of Annual Reports of CSIR labs. CSIR as well as other leading scientific institutions
- 56 numbers of microfilms

Online

- Access to over 3000 full text e-journals available on line (access & download facility) of all international leading scientific publishers like Wiley interscience, Springer, Sage, Elsevier, ASCE, Oxford University press, American Chemical society, IEEE, Emerald, Nature, T&F, Institution of Civil engineers, UK, (ICE), London as under CSIR-DST e-journals Consortium.
- Access of Indian journals under Indian journals.com
- Available on line standards database viz. ASTM and Indian (BIS)
- International Construction Database (ICONDA) on CD-ROM since 1976 & now online available
- International patent database: Derwent Innovation Index & Delphion
- Access of science bibliographic database like Web of Science (WOS) cover SCI
- Other utility database like JCCC

Institutional Membership

Library is a member of a number of national & international organizations and institutions like

National

1. Indian Building Congress (IBC)
2. Indian Geotechnical Society (IGS)
3. Institute for Steel Development & Growth (INSDAG)
4. Indian Science Congress Association (ISCA)
5. Life Member of the Institution of Engineers (India), Kolkata
6. Life member of Indian Academy of Science for 'Current Science' journal
7. Life member of 'Disaster Management Institute' (DMI), Bhopal

International

1. International Council for research & Innovation in Building & Construction (CIB), The Netherlands
2. International Union of Laboratories & Experts in Construction, Materials & Structures (RILEM), France
3. International Federation for Structural Concrete (FIB), Switzerland

Services

- Documents circulation
- On line search (OPAC) for in house library database on LAN using Libsys software
- CD-ROM search facilities as well as online available for international database and Indian standards (CED)
- On line access of E-journals (Full text)
- On line patent search
- On line science database search
- Current Awareness Services: a) List of latest additions b) News paper clippings
- Reprographic services
- Inter library loan
- Reference service
- AC reading hall

Major Research Areas:

- Innovative & Alternate Materials
- Green Buildings
- Affordable Housing
- Conservation of Heritage Structures
- Tall Building and Steel Structures
- Smart Cities
- Smart Villages
- Disaster Mitigation

Details of the Institute (CSIR - CBRI):

Year of establishment -- 1947

e-mail: director@cbri.res.in

Phone: (01332) 283323

Fax: (01332) 272272

Web site address: www.cbri.res.in

Name of the Director: Dr N. Gopalakrishnan

Name of the AcSIR Lab Co-ordinator: Dr S.R. Karade

Degrees offered: MTech (started from July 2010)

Integrated MTech - PhD (started from January 2012)

PhD in Civil Engg., Geosciences and Chemical Sciences

Major R&D Projects

- **Development of Fast, Durable and Energy Efficient Mass Housing Scheme**
- **Safety & Security of Vital Installations**
- **Conservation and Restoration of Heritage Structures**

FUTURE RESEARCH PLANS UNDER THE FOLLOWING BROAD AREAS OF RESEARCH

- Development of Innovative & Alternate Materials
- Engineering of Disaster Mitigation
- Numerical Modelling
- Health Monitoring of Building Structures, Retrofitting
- Intelligent Building Systems
- Energy Efficient Systems
- Knowledge Dissemination through Societal Missions & Capacity Building

Research Facilities:

- Dual Cone Calorimeter (ISO: 5660 & ASTM E 1354)
- Fully computerized 1000 kN UTM and 3000 kN UTM
- Corrosion Analyzer "Field Machine"
- Computer controlled Laser Particle size Analyzer
- Computer controlled Triaxial and Consolidation testing system
- Foundation Pile Diagnostic system
- Geotechnical Instrumentation for performance evaluation
- Optical Microscope for petrographic studies of rocks & building materials
- Geo-radar
- Resistivity Imaging System
- Uniaxial Shake Table
- Atomic absorption spectrophotometer
- Infra-red spectrophotometer
- UV and visible spectrophotometer
- Ion selective analyzer
- Stack monitor
- Particle size analyzer

- Portable CO₂/CO/H₂S/ Hydrocarbon analyzer
- Cement testing laboratory
- Lime-pozzolana laboratory
- Thermal analysis laboratory
- X-ray diffraction equipment
- X-ray Florence equipment
- Nano particle synthesizer
- Inductive coupled plasma spectrophotometer
- Energy dispersive X-ray photometer
- Differential thermal analyzer
- Thermo-mechanical analyzer
- Xenon Arc Weatherometer
- Ozone Chamber
- Heavy Testing Laboratory
- Burning Behaviour of Materials for 'Reaction to Fire Studies'
- Toxicity apparatus
- Fire Detection, Extinguishment & Sprinklers Lab.
- Spherical vessel for explosion
- Wall furnace for fire resistance studies
- Floor furnace for fire resistance studies
- Low speed wind tunnel for ventilation and wind pressure distribution in buildings
- Standing wave apparatus for sound absorption coefficient at normal incidence
- Reverberation chamber for sound transmission loss and sound absorption coefficient at random incidence
- Dome type artificial sky for daylighting studies
- Ultrasonic and acoustic emission setup for non-destructive testing of building components
- Field Emission Scanning Electron Microscope (FESEM)
- Low speed wind tunnel for ventilation studies.

Residential Campus

The institute has sprawling 65 acres residential campus adjoining to the academic campus. A large number of amenities such as hostels for both boys and girls, dispensary, guest house, community centre, play grounds, common mess for the hostel residents, a shopping centre, bank with ATM facility, post office apart from the residential apartments exists in the campus. The residential campus is sandwiched between IIT Roorkee campus and the Bengal Engineering Group army base.

Dispensary

The campus has a dispensary equipped with residential Doctor, Pathologist and other dispensary staff. The dispensary caters the need of the residents. Only on emergency patients are transferred to nearby medical college or nursing home with a standby ambulance.

Hostels

Separate hostel accommodation for male and female students is available. The students are required to abide by the Hostel/Mess Rules in force. Messing facility is common for both girls and boys. The mess is equipped with air conditioned dinning hall, water cooler, large LCD wall TV with Dish connectivity etc. Hostels are equipped with internet facilities.

Recreation

The Staff Club and Ladies Club of CBRI organise various activities related to sports and games, Deepavali Fete, Illumination competition etc. These are also, in coordination with CSIR Sports Promotion Board, organizing various sports events for men and women for indoor and outdoor games.

PhD Course Structure

Semester I			Semester II		
Course No.	Course name	L-T-P-C	Course No.	Course name	L-T-P-C
PHY/ENG-CBRI-1-0001*§	Research Methodology & Analysis*§	2-0-0-2	ENG-CBRI-1-1138	Rock Mechanics	3-0-0-3
PHY/ENG-CBRI-1-1119*	Fundamentals of Engineering Geology*	3-0-0-3	ENG-CBRI-1-1146*	Fundamentals of Structural Engineering*	3-0-0-3
ENG-CBRI-3-1101	Wind effects on building structures (WEBS)	3-0-0-3	ENG-CBRI-1-1148*	Fundamentals of Soil Mechanics*	3-0-0-3
ENG-CBRI-3-1103	Structural Response Control for Seismic Protection	3-0-0-3	ENG-CBRI-2-1102	Advanced Seismology	3-0-0-3
ENG-CBRI-3-1107	Continuum Mechanics & Finite Element Analysis	3-0-0-3	ENG-CBRI-2-1110	Landslide Disaster Mitigation	3-0-0-3
ENG-CBRI-3-1109	Corrosion Control in Reinforced Concrete Structures	2-0-2-3	ENG-CBRI-3-1102	Re-engineering of Structures	3-0-0-3
ENG-CBRI-3-1111	Applied Soil Mechanics	3-0-0-3	CHE-CBRI-3-1102	Advanced Environmental Analysis & Management	3-0-0-3
CHE/ENG-CBRI-3-1113	Advanced Instruments in Materials Research	2-0-2-3	CHE-CBRI-3-1104	Introduction to Polymer Materials	3-1-0-4
CHE-CBRI-3-1101	Frontiers in Building Materials	3-0-0-3	CHE-CBRI-3-1106	Plastics and Composites	2-1-0-3
ENG-CBRI-1-1142	Optimisation Techniques	3-0-0-3	CHE-CBRI-3-1108	Geopolymers	3-1-0-4
ENG-CBRI-3-1115	Advanced Structural Mechanics	3-0-0-3	CHE-CBRI-3-1114	Nanotechnology and Analytical Techniques	3-0-0-3

* for Ph.D. students with non-civil engineering background & desirous of working in Civil Engineering area

§ common course for MTech & PhD

Semester I		
Course No.	Course name	Faculty
PHY/ENG-CBRI-1-0001* [§]	Research Methodology & Analysis * [§]	Abha Mittal, S.R. Karade & D.P. Kanungo
PHY/ENG-CBRI-1-1119*	Fundamentals of Engineering Geology*	S. Sarkar, D.P. Kanungo, PKS Chauhan and M. Samanta
ENG-CBRI-3-1101	Wind Effects on Building Structures	A.K. Mittal & S. Behra
ENG-CBRI-3-1103	Structural Response Control for Seismic Protection	Navjeev Saxena & SK Panigrahi
ENG-CBRI-3-1107	Continuum Mechanics & Finite Element Analysis	N. Gopalakrishnan, Ajay Chaurasia and S.K. Singh
ENG-CBRI-3-1109	Corrosion Control in Reinforced Concrete Structures	S.R. Karade & P.C. Thapliyal
ENG-CBRI-3-1111	Applied Soil Mechanics	Manojit Samanta and A. Pain
ENG-CBRI-3-1113	Advanced Instruments in Materials Research	Rajni Lakhani and Harpal Singh
CHE-CBRI-3-1101	Frontiers in Building Materials	A.K. Minocha, L.P. Singh, P.C. Thapliyal and Neeraj Jain
ENG-CBRI-1-1142	Optimisation Techniques	Abha Mittal
ENG-CBRI-3-1115	Advanced Structural Mechanics	N. Gopalakrishnan
Semester II		
Course No.	Course name	Faculty
ENG-CBRI-1-1138 [§]	Rock Mechanics [§]	R.K. Goel & RD Dwivedi
ENG-CBRI-1-1146*	Fundamentals of Structural Engineering*	N. Gopalakrishnan
ENG-CBRI-1-1148*	Fundamentals of Soil Mechanics*	Pradeep Kumar
ENG-CBRI-2-1102 [§]	Advanced Seismology [§]	P.K.S. Chauhan & Abha Mittal
ENG-CBRI-2-1110 [§]	Landslide Disaster Mitigation [§]	S. Sarkar & D.P. Kanungo
ENG-CBRI-3-1102	Re-engineering of Structures	S.K. Singh & Ajay Chaurasia
CHE-CBRI-3-1102	Advanced Environmental Analysis & Management	A.K. Minocha, L.P. Singh and P.C. Thapliyal
CHE-CBRI-3-1104	Introduction to Polymer Materials	Rajni Lakhani & Harpal Singh
CHE-CBRI-3-1106	Plastics and Composites	Rajni Lakhani & Harpal Singh
CHE-CBRI-3-1108	Geopolymers	Rajni Lakhani & Harpal Singh
CHE-CBRI-3-1114	Nanotechnology and Analytical Techniques	L.P. Singh, P.C. Thapliyal, A.K. Minocha & Neeraj Jain

* for Ph.D. students with non-civil engineering background & desirous of working in Civil Engineering area
[§] common course for MTech & PhD

Areas of Research	
Structural Engineering	<ol style="list-style-type: none"> 1. Materials – Cement & Concrete 2. Wind effects on buildings 3. Earthquake effects on building 4. Impact effect on buildings 5. Structural restoration 6. Structural health monitoring 7. Fluid-structure interaction 8. Computational mechanics 9. Corrosion control in RCC structures
Geotechnical Engineering	<ol style="list-style-type: none"> 1. Geotextiles 2. Ground improvement techniques & deep foundation 3. Environmental geotechnique 1. Slope Stability analysis 2. Control Measures for Landslides
Chemical Sciences	<ol style="list-style-type: none"> 1. Polymeric materials 2. Composite materials 3. Nano-materials
Environmental Engineering	<ol style="list-style-type: none"> 2. Use of industrial wastes 3. Control of air pollution 4. Solid waste management
Geological Sciences	<ol style="list-style-type: none"> 1. Landslide Hazard & Risk Assessment 2. Landslide Instrumentation & Early Warning System 3. Landslide modeling 4. Remote Sensing & GIS Applications to Geo-hazards

The Syllabi

SEMESTER I

PHY/ENG-CBRI-1-0001 Research Methodology & Analysis		L-T-P-C 2-0-0-2
Syllabus	<p>Introduction to research and research process</p> <p>Practical information about study phases, course requirements and PhD thesis, personnel involved, psychological and social factors, PhD student's and supervisor's role, overview of research planning; time management.</p> <p>Research terminology and the scientific methods, Design and implementing a research project, type of research, communicating research results, case studies.</p> <p>Research Ethics: Ethics in engineering and natural sciences, convert public resources into private profits, striving for objectivity, handling uncertainty.</p> <p>IPR and Plagiarism, research report writing, communication skills, presentation, inter-personal communication.</p> <p>Research method: Criteria for good scientific practice, literature review, generalise and define limits for generalization of new findings, Scientific publishing.</p> <p>Measurements in Research; design of sample survey, measurement and scaling, data collection, data preparation, descriptive statistics, testing of hypothesis, linear and multiple regression analysis, forecasting, application of computer software like SPSS, MATLAB and MS Excel. Introduction to soft computing techniques.</p>	
Reference Books	<ol style="list-style-type: none"> 1. Gupta, Hira, Operations Research, S. Chand & Company, 1987. 2. Mohan C, K. Deep, Optimization Technique, New Age International, 2009. 3. Sharma J.K., Operation Research -Theory and Applications, Mcmillan Publishers India, 2008 4. Hamdy. A. Taha, Operations Research, PHI, New Delhi. 5. S.S.Rao, Optimization Techniques, New Age International, New Delhi. 6. Gillett, Introduction to operations Research, McGraw Hill, New Delhi 7. Morse Phillip Mccord, Methods of Operational Research, Dover Pub. 8. Sobel methew J., Stochastic Optimization, Dover Pub. 	
Faculty	Abha Mittal, S.R. Karade and D.P. Kanungo	

ENG-CBRI-1-1119 Fundamentals of Engineering Geology		L-T-P-C 3-0-0-3
Syllabus	<p>ROCKS and STRUCTURES: Rocks & rock masses; Structural Geology- Joints & discontinuities, Folds & faults, Effect of discontinuities on slope stability; Structural geology in engineering construction; Earth processes - Weathering</p> <p>ELEMENTARY ROCK MECHANICS & SOIL MECHANICS: Rock mass classification, Engineering properties of rocks, Rocks as engineering materials, Engineering classification of soils, Index properties, Shear parameters</p> <p>GEOLOGICAL INVESTIGATIONS IN CIVIL ENGINEERING: Remote sensing & GIS for Civil Engineering Projects, Engineering geology in planning, design and construction of engineering structures - Dams, Tunnels, Buildings, Roads.</p> <p>GEOPHYSICAL METHODS: Seismic and Electrical methods for Civil Engineering investigations.</p> <p>LANDSLIDES: Landslide types & processes, Causes, Investigation and analysis, Remedial measures</p> <p>GEOHYDROLOGY: Hydrologic cycle – precipitation, runoff, infiltration, Ground water flow; Surface and subsurface exploration of groundwater- Drilling and construction of wells; Pumping tests and evaluation of aquifer parameters.</p>	

Reference Books	<ol style="list-style-type: none"> 1. "Engineering and General Geology ", Parbin Singh, Katson Publication House, 1987. 2. "Engineering Geology and Geotechniques ",Krynine and Judd, McGraw Hill Book Company, 1990. 3. "Geology and Engineering",1998, Legeet, McGraw Hill Book Company. 4. "Geology for Engineers " 1995, Blyth, ELBS. 5. "Engineering Geology – An Environmental Approach", Perry H. Rahn, 1996, Prentice Hall PTR 6. "Ground Water", H.M. Raghunath, 1983, Wiley Eastern Limited
Faculty	S. Sarkar, D.P. Kanungo, P.K.S. Chauhan and Manojit Samanta

ENG-CBRI-3-1101 Wind Effects on Building Structures (WEBS) L-T-P-C 3-0-0-3	
Syllabus	<p>Introduction to wind engineering, wind climate and wind structure including strong wind characteristics and turbulence. Structure of turbulence, probabilistic distribution of wind, extreme wind events.</p> <p>Aerodynamics of bluff bodies, vortex shedding and associated unsteady along and across wind forces.</p> <p>Analytical procedures for along wind and across wind forces. Computational aspects of wind flow around buildings. Wind interference effects.</p> <p>Wind Tunnel Testing and its salient features. Wind effects on buildings, Performance of existing buildings and case studies.</p> <p>Codal provisions- Wind resistant design of buildings, glass panels of doors, windows and facades.</p> <p>Introduction to International Codes. Risk, hazard and vulnerability analysis of wind sensitive structures.</p>
Reference Books	<ol style="list-style-type: none"> 1. Wind Loading of Structures by John D. Holmes, Spon Press, Talor & Francis Group 2. Wind Effects on Structures: An Introduction to Wind Engineering by E. Simiu and R H Scanlan, John Wiley and Sons 3. The Designers Guide to Wind Loading on Building and Structures by N J Cook, BRE Publication, Butterworths, London 4. Wind Forces on Buildings by Peter Sachs, Pergamon Press.
Faculty	A.K. Mittal & S. Behra

ENG-CBRI-3-1103 Structural Response Control for Seismic Protection L-T-P-C 3-0-0-3	
Syllabus	<p>Theory of Vibration Isolation: Theory of vibration isolation-Principle of base isolation-Components of base isolation-Advantages and limitations; Linear theory of base isolation-Applications.</p> <p>Isolation Devices: Different isolation devices-Modeling of isolation devices-Design of isolated devices-Stability of isolation devices-Application of devices to buildings.</p> <p>Energy dissipation devices: Metallic Yield dampers, Friction dampers, Viscoelastic dampers, Tuned mass dampers, Tuned liquid dampers, Shape memory alloy dampers, Application to buildings.</p> <p>Structural Control: Introduction to control theories; Strategies-Active Control-Passive control-Hybrid control-Semi-active control.</p> <p>Case Studies</p>

Reference Books	<ol style="list-style-type: none"> 1. IR Hkinner, WH Robinson & KH Mcberry. An introduction to seismic isolation. John Wiley publication, 1993. 2. JM Kelly. Earthquake resistant design with rubber. Springer publication 1993. 3. LL Beranek and IL Ver. Noise and vibration control engineering. John Wiley publication, 1992. 4. DJ Mead. Passive vibration control. John Wiley publication, 1999. 5. A. Preumont. Vibration control of active structure: An introduction. Kulwer publication 1997.
Faculty	Navjeev Saxena & SK Panigrahi

ENG-CBRI-3-1107 Continuum Mechanics & Finite Element Analysis L-T-P-C 3-0-0-3	
Syllabus	<p>Continuum Mechanics – Introduction - Vectors and Tensors, Analysis of Strains, large deformations and finite strains, Eulerian Lagrangian and Almansi, Green's and Cauchy's strain tensors, Compatibility equations, elastic stress strain equations, generalized Hooke's Law, Material Yield Criteria-Von-mises, Tresca, Mohr-Coloumb, Drucker-Prager etc.</p> <p>Finite-Element Analysis - Finite element technique, discretization, energy and variational approaches, basic theory, displacement, force and hybrid models, shape function, use of isoparametric elements, convergence criteria, numerical intergration, element formulations, 2-D elements, plate bending elements, introduction to 3-D elements, shell elements , interface elements ,boundary elements, infinite elements. Application to non-linear problems; special topics. Usage of commercial packages.</p>
Reference Books	<ol style="list-style-type: none"> 1. Timoshenko S. and Krieger S.W., Theory of Plates and Shells, McGraw Hill. 2. Chen, W.F. and Saleeb, A.F.. Constitutive Equations for Engineering Materials, John Wiley & Sons. 3. Krishnamoorthy, C.S.. Finite Element Analysis- Theory & Programming, Tata McGraw Hill Pub. Co. Ltd., New Delhi. 4. Zienkiewicz, O.C. The finite Element Method in Engineering, McGraw-Hill, London. 5. R.D. Cook, Plesha & Malkus – Concepts in Finite Element Technique 6. J.N. Reddy – Nonlinear finite element technique
Faculty	N. Gopalakrishnan, Ajay Chaurasia and S.K. Singh

ENG-CBRI-3-1109 Corrosion Control in Reinforced Concrete Structures L-T-P-C 2-0-2-3	
Syllabus	<p>Theory</p> <p>Deterioration of concrete structures: Constituent materials, microstructures, mix design for durability, permeability, carbonation, chloride penetration, corrosion damage, sulphate attack, alkali-silica reaction, other chemical attacks, influence of types of cement on corrosion.</p> <p>Basics of Corrosion: Introduction to corrosion process, forms of corrosion, steel corrosion in concrete, corrosion rate measurement instruments.</p> <p>Condition assessment and corrosion monitoring of reinforced concrete structures: condition survey, nondestructive testing (NDT), measurement of half cell potential, resistivity and corrosion rate, permanent corrosion monitoring systems.</p> <p>Repair principles, materials and corrosion control measures: Patches, overlay, repair mortars, sprayed concrete, FRP wrapping, corrosion, inhibitors, surface</p>

	coatings and cathodic protection. Practicals Corrosion rate measurements in laboratory – NDT and corrosion survey techniques at site – Surface coatings acceptance tests – Cathodic Protection.
Reference Books	<ol style="list-style-type: none"> 1. ACI 222R-01. Protection of metals in concrete against corrosion. American Concrete Institute, Farmington Hills, Michigan, 2001. 2. Bertolini, L., Elsener, B., Pedferri, P. and Polder, R.P., Corrosion of steel in concrete, Wiley-VCH, Weinheim, 2004. 3. Broomfield, J.P., Corrosion of steel in concrete: Understanding, investigation and repair, 2nd edition, Taylor & Francis, London, 2007. 4. Bungey, J.H., Millard, S.G. and Grantham, M.G., Testing of concrete in structures, 4th edition, Taylor & Francis, London & New York, 2006.
Faculty	S.R. Karade & P.C. Thapliyal

ENG-CBRI-3-1111		Applied Soil Mechanics	L-T-P-C 3-0-0-3
Syllabus	<p>Foundation in soft soil: problems - estimation of consolidation and creep settlement - improvement methods - quality control in improvement methods - case study.</p> <p>Foundation in liquefiable soil: liquefaction potential and assessment - remedial measures – foundation techniques – case studies.</p> <p>Solution of foundation problems by beams on elastic foundation approach. Application of numerical methods to solve soil – foundation-structure interaction problem. Foundation design including seismic effect.</p> <p>Seismic design of retaining wall/retaining wall with reinforced backfill/gabion wall/gabion wall with reinforced backfill-case study.</p> <p>Stability analysis of landslide – different approach – types of control measures - design aspect of different control measures- case study.</p> <p>Foundation in soft soil: problems - estimation of consolidation and creep settlement - improvement methods - quality control in improvement methods - case study.</p> <p>Foundation in liquefiable soil: liquefaction potential and assessment - remedial measures – foundation techniques – case studies.</p> <p>Solution of foundation problems by beams on elastic foundation approach. Application of numerical methods to solve soil – foundation-structure interaction problem. Foundation design including seismic effect.</p> <p>Seismic design of retaining wall/retaining wall with reinforced backfill/gabion wall/gabion wall with reinforced backfill-case study.</p> <p>Stability analysis of landslide – different approach – types of control measures - design aspect of different control measures- case study.</p>		
Reference Books	<ol style="list-style-type: none"> 1. Soil Mechanics in Engineering Practice by K. Terzaghi, R.B. Peck, G.Mesri. Wiley Interscience Publication, 1996. 2. Geotechnical Earthquake Engineering by S.L. Kramer, Prentice Hall, New Delhi, 1996 3. Geotechnical Slope Analysis by R. Chowdhury, P. Flentje, G Bhattacharya, CRC Press, 2009. 4. Advanced soil Mechanics, B. M. Das, CRC Press, 2009. 5. Ground Improvement, M. P. Moseley & K. Krisch, Taylor and Francis, 1992. 6. Soft Clay Engineering, E. W. Brand & R. P. Brenner., Elsevier Scientific Publishing Company, 1981. 7. Reinforced soil and its Engineering applications., S. Saran., I.K.International.2005 8. IS codes and Manuals 		

Faculty	Manojit Samanta and A. Pain
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ENG-CBRI-3-1113 Advanced Instruments in Materials Research L-T-P-C 2-0-2-3	
Syllabus	Principles and instrumentation of advanced equipments such as thermal analyzer (DMA, TMA, DSC, TGA etc.), Rheometer, Microscopes (SEM, TEM, ESCA, image analyzer and AFM), Dilatometry, Flammability tests (Cone calorimeter, burning test apparatus etc.), IR Spectroscopy, Thermal conductivity apparatus etc. Accelerated exposure test (Humidity chamber, UV chamber etc.), Interpretation of instrumental data.
Reference Books	<ol style="list-style-type: none"> 1. Instrumental Methods of Analysis, Willand H.H., Merritt I.I., Dean J.J. and Settle F. A., 7th Ed., Wordsworth Publishing Co., Latest Edition. 2. Principles of Instrumental Analysis, Skoog D.A., Holler F.J. and Crouch S.R., 6th Ed., Thomson Books, Latest Edition. 3. Polymer Microscopy, L.C. Sawyer and D.T. Grubb, Chapman and Hall, London, Latest Edition. 4. Publishing Co International Plastics Flammability Handbook, Troitzsch., Macmillan., Inc., New York, Latest Edition
Faculty	Rajni Lakhani & Harpal Singh

CHE-CBRI-3-1101 Frontiers in Building Materials L-T-P-C (for students of Chemical Sciences) 3-0-0-3	
Syllabus	Building stone, Bricks, Lime, Cement & Concrete, Aggregate, Water, Ferrous Materials, Non-Ferrous Materials, Paints, Asphalt, Bitumen, Gypsum, Adhesive, Sealants, Advanced Materials(e.g.: Nanomaterials etc.). Physio-chemical Analysis of Building Materials and their Engineering Properties.
Reference Books	<ol style="list-style-type: none"> 1. S.K. Duggal, Building Materials, New Age International, 3rd Edition 2008. 2. S.L. Sarkar, Advances in Building Materials 2006 3. M. Neville, Properties of Concrete, John Wiley & Sons 4th Edition 1996
Faculty	A.K. Minocha, L.P. Singh, P.C. Thapliyal and Neeraj Jain

ENG- CBRI- 1-1142 Optimization Techniques L-T-P-C 3-0-0-3	
Syllabus	Different types of optimization problems, General form of linear programming problem graphical solution - Canonical form of LPP, Simplex method, basic feasible solution, Big M method, degeneracy, revised Simplex Method - Duality in linear programming, application of duality theory, post optimality or sensitivity analysis - Lagrangian function and saddle point, Kuhn Tucker conditions, primal and dual problem - Integer LPP, cutting plane method, branch and bound method, integer non-linear programming - Pseudo-random numbers, random variables, Univariate and Multivariate analysis, Regression analysis, Poisson, Gaussain and point process, uses of simulations - Introduction to neural network and genetic algorithm etc. - Stochastic Programming

Reference Books	<ol style="list-style-type: none"> 1. H. Gupta, Operations Research, S. Chand & Company, 1987. 2. C. Mohan & K. Deep, Optimization Technique, New Age International, 2009. 3. J. K. Sharma, Operation Research -Theory and Applications, Mcmillan Publishers India, 2008. 4. H. A. Taha, Operations Research, PHI, New Delhi, 2010. 5. S. S. Rao, Optimization Techniques, New Age International, New Delhi, 1996. 6. Gillett, Introduction to operations Research, McGraw Hill, New Delhi, 1979. 7. M. P. Mccord, Methods of Operational Research, Dover Pub., 2003. 1. D. P. Heyman & J. S. Methew, Stochastic Optimization, Dover Pub., 2004.
Faculty	Abha Mittal & PK Yadav

ENG-CBRI-3-1115 Advanced Structural Mechanics		L-T-P-C 3-0-0-3
Syllabus	<p>Fundamentals of structural mechanics: Definition of stress, strain, constitutive relationships; Strain Energy principles; Navier-Bernoulli elementary bending theory of beams, Flexural and shear stresses. Concept of shear center, Deep Beams. Torsion - St Venant torsion and distortion.</p> <p>Computer methods of structural analysis: Introduction to stiffness and flexibility methods. Matrix methods of structural analysis. Strain energy methods of deriving the stiffness matrix. Analysis of redundant structures. Special structures</p> <p>Introduction to structural stability: Stability of structural systems. Euler buckling loads and approximate methods of critical load evaluation.</p> <p>Mechanics of thin plates: Thin plate theory, Imposition of boundary conditions, Kirchoff shear and corner lift up of rectangular plates. Methods of Navier and Levy solutions.</p> <p>Mechanics of Shells: Types of shells, Shells of translation and rotation. Membrane theory of shells. Cylindrical and spherical shells.</p>	
Reference Books	<ol style="list-style-type: none"> 1. Crandall, S. H. An Introduction to Mechanics of Solids. Tata McGraw-Hill Education, 2012. 2. Popov E. P. Engineering Mechanics of Solids, Prentice Hall, 1998 3. Timoshenko, S. P., and Woinowsky-Krieger, S. Theory of Plates and Shells. McGraw-Hill, 2010 	
Faculty	N. Gopalakrishnan	

SEMESTER II

ENG-CBRI-1-1138	Rock Mechanics	L-T-P-C 3-0-0-3
Syllabus	<p>Introduction to rock mechanics</p> <p>Rocks, rock structures and their importance: Rocks (Igneous, sedimentary, metamorphic) & rock masses; Joints & discontinuities; Folds & faults; Effect of discontinuities on stability using stereographic approach</p> <p>Surface and subsurface investigations: Geological and geophysical investigations</p> <p>Engineering rock mass classifications & their application: Terzaghi's rock load concept; RMR; Q; GSI</p> <p>Physico-mechanical properties of rocks: Important physico-mechanical properties; Effect of temperature on rock strength; Dynamic properties</p> <p>Stresses in elastic and plastic ground conditions: In situ stresses; Induced stresses after excavation; Stress variation around horizontal circular opening in elastic & plastic ground conditions</p> <p>Excavation Methods: Drill & blast methods for surface and underground; Tunnel boring machine (TBM)</p> <p>Support design and instrumentation in tunnels and slopes: Analytical and empirical approaches in brief; GRC & SRC; NATM; Support types; Design considerations under dynamic conditions; Instrumentation</p> <p>Problems and their remedies in rock engineering: Stress problems (Squeezing and rock-burst); Swelling and water pressure</p> <p>Application of rock mechanics: Traffic tunnels; Hydro-electric tunnels; Building/dam foundations on rock; Underground civic facilities; Underground defence shelters, storage of petroleum and nuclear waste repository etc.</p>	
Reference Books	<ol style="list-style-type: none"> 1. Rock Mass Classification – A Practical Approach in Civil Engineering, B. Singh, R. K. Goel, Elsevier Science Ltd., U.K. 2. Software for Engineering Control of Landslide and Tunnelling Hazards, B. Singh, R. K. Goel, Balkema/ Swets & Zeitlinger, Netherlands 3. Tunnelling in Weak Rocks, B. Singh, R. K. Goel, Elsevier Ltd., U.K. 4. Rock Mechanics for Engineers, B.P. Verma, Khanna Publishers, Delhi 	
Faculty	R.K. Goel, R.D. Dwivedi and K. Pandit	

ENG-CBRI-1-1146	Fundamentals of Structural Engineering	L-T-P-C 3-0-0-3
Syllabus	<p>Introduction – Structural systems – Determinate & Indeterminate structural forms – different principles for analysis of structural systems – Loading on structural systems;</p> <p>Concept of Matrix method of structural analysis – 1D, 2D & 3D forms; Other analysis methodologies.</p> <p>Concept in structural designs – concrete & steel as structural material – Basics of design processes; Effects of different kinds of loads on structural systems and consequences on the design process.</p>	

Reference Books	<ol style="list-style-type: none"> 1. Structural Analysis – Willber Narris, Utech 2. Matrix method of structural Analysis – H.C. Martion 3. Design of Steel Structures – Arya & Ajmani 4. Limit state design of concrete structures – A.K. Jain 5. Concrete Structural Design – Park & Pauley 6. Plastic Analysis of Structures – B.G. Neal 7. Concepts in Finite Element Analysis – R.D. Cook, Plesha & Malkush 8. Design of Metal Structures – K. Mukhanov
Faculty	N. Gopalakrishnan

ENG-CBRI-1-1148	Fundamentals of Soil Mechanics	L-T-P-C 3-0-0-3
Syllabus	<p>Introduction to Soil and Soil Mechanics</p> <p>Formation of soil - types of soil – phase diagram - index properties & its determination - soil classification - permeability of soils & its determination -effective stress concept – compaction - one dimensional compression - magnitude of settlement - oedometer test - shear strength of soil - failure criterion - measurement of shear strength-drainage conditions and strength parameters - Boussinesq equation - New Mark's influence Chart - approximate stress computation- Westergaard's equation - different types of earth pressure – theories of earth pressure - determination of earth pressure - infinite & finite slopes - different approach of stability analysis</p> <p>Foundation Engineering</p> <p>Introduction - functions – types – capacity from various theory and load test - settlement-IS codal provision – design</p> <p>Stabilization</p> <p>Introduction-needs-principles-different stabilizer-essential properties of stabilizer-methods of applications-effect of stabilizer on engineering properties of soil-design</p>	
Reference Books	<ul style="list-style-type: none"> • Soil Mechanics in Engineering Practice by K. Terzaghi, R.B. Peck, G.Mesri. • Principal and Practices of Soil Mechanics and Foundation Engineering by V.N.S. Murthy. • Advanced soil Mechanics by B.M.Das 	
Faculty	Pradeep Kumar	

ENG-CBRI-2-1102	Advanced Seismology	L-T-P-C 3-0-0-3
Syllabus	<p>Science of Earthquakes, Types and causes, Earthquake Parameters, Seismic Waves, Magnitude & Intensity, Earthquake Source Mechanism, Seismic Instrumentation, Seismicity & Seismic Zoning Map, Indian Earthquake Scenario, Strong Motion Seismology, Strong Motion Parameters, Site Response Studies, Seismic Attenuation, Source and Path effect, Seismic Hazard Analysis, Seismic Risk and its estimation, Post earthquake Investigations, Seismic Micro-zonation, Earthquake Prediction Studies, Seismic Alert Systems</p>	

Reference Books	<ol style="list-style-type: none"> 1. Engineering Seismology by P.N. Agrawal. Published by Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi 2. Earthquakes by Bruce A. Bolt. Published by W.H. Freeman & Company. ISBN – 978-0716722366. 39.63\$ 3. Quantitative Seismology; Theory & Methods, by Aki, K. and Paul G. Richards. Published by W.H. Freeman & Company, San Francisco, Vol. 1 & 2. 4. Geotechnical Earthquake Engineering by Ikuo Towhata. Published by Springer Berlin Heidelberg. ISBN – 978-3-540-35782-7. 69.
Faculty	PKS Chauhan & Abha Mittal

ENG-CBRI-2-1110		Landslide Disaster Mitigation	L-T-P-C 3-0-0-3
Syllabus	Introduction - Landslide Types and processes - Landslide causes - Application of Remote Sensing and GIS in Landslide studies: Spatial data acquisition and spatial operations, Digital Elevation Modeling & Surface analysis, Thematic mapping, Spatial analysis and model development - Landslide Hazard and Risk Assessment: Concept & Techniques, Case Studies - Landslide Investigations: Geological, geophysical & geotechnical - Landslide Instrumentation: Surface & sub-surface monitoring - Slope Stability Analysis: Rock & soil slopes - SMR & Slope Stability Assessment - Landslide Control Measures: Types of measures & design - Landslide case studies		
Reference Books	<ol style="list-style-type: none"> 1. Landslides – Risk Analysis and Sustainable Disaster Management by Sassa 2005; ISBN:978-3-540-28664-6; Springer Publishers 2. Landslides – Investigation and Mitigation, Ed: Turner and Schuster, 1996 3. Rock Slope Engineering by Hoek & Bray 4. Geotechnical Slope Analysis by Robin Chowdhury; Taylor & Francis, 5. Burrough, P.A. and McDonnell, R.A., “Principles of Geographic Information System”, Oxford University Press. 6. Lo, C.P. & Yeung A.K.W., Concepts and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi, 2002. 		
Faculty	S. Sarkar & D.P. Kanungo		

ENG-CBRI-3-1102		Re-engineering of Structures	L-T-P-C 3-0-0-3
Syllabus	Structural behaviour of multi-storeyed and Industrial buildings; various design loads- combinations and design requirements for each component; characteristics of commonly used materials in engineered/non-engineered construction; qualitative and quantitative methods of evaluation of buildings; assessment of structural adequacy against different loading systems; local and global methods of retrofitting/ strengthening of RC buildings; design of retrofitting/ strengthening of existing buildings; different techniques and application of repair measures for building components, re-evaluation of buildings with retrofitted / strengthened elements, modelling of strengthening techniques; case studies.		

Reference Books	<ol style="list-style-type: none"> 1. Denison Campbell, Allen and Harold Roper, "Concrete Structures", Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991. 2. R.T.Allen and S.C. Edwards, "Repair of Concrete Structures", Blakie and Sons, UK, 1987. 3. Raikar, RN, "Learning from failures - Deficiencies in Design", Construction and Service - R and D Centre (SDCPL), Raikar Bhavan, 1987 4. George G. Penelis and Andreas J. Kappos, "Earthquake Resistant Concrete Structures", E&FN SPON, 1997 5. ASCE/SEI Seismic Rehabilitation Standards Committee. "Seismic Rehabilitation of Existing Buildings (ASCE/SEI 41-06)." American Society of Civil Engineers, Reston, VA, US (2007).
Faculty	S.K. Singh, Ajay Chaurasia and SR Karade

CHE-CBRI-3-1102 Advanced Environmental Analysis & Management		L-T-P-C 3-0-0-3
Syllabus	<p>Materials: Building Stone, Bricks, Lime, Cement & Concrete, Aggregate, Water, Ferrous Materials, Non-Ferrous Materials, Paints, Asphalt, Bitumen, Gypsum, Adhesive, Sealants, Advanced Materials etc. Physio-chemical Analysis, Engineering properties.</p> <p>Environmental Science: Air Pollution, Water Pollution, Monitoring and remedial measures, Environmental Audit and Environmental Impact Assessment</p> <p>Waste management: Industrial Solid waste, Municipal waste, Hazardous waste and Analysis and Utilization / Management</p> <p>Advanced Instrumentation Analysis: Powder X-ray Diffraction, Electron Microscopy, X-ray Fluorescence, Inductive Couple Plasma, Thermal Analysis, Spectroscopy</p>	
Reference Books	<ol style="list-style-type: none"> 1. C. A. Herubin & T. W. Marotta, Basic Construction Materials, Prentice-Hall International (UK) Ltd., London. 2. E. I. Shateen, Technology of Environmental Pollution Control, Science- Pennwell Books. 3. D. C. Wooten & J.G. Ran, Environmental Impact Analysis Handbook, McGraw – Hill ISBN – 100070512175 (1979). 4. Vogel's A textbook of Quantitative Chemical Analysis by ELBS Pub., UK. 5. D.A. Skoog, F.J. Holler & T.A. Nieman, Principles of Instrumental Analysis; Harcourt Asia PTE Ltd. 	
Faculty	A.K. Minocha, L.P. Singh and Neeraj Jain	

CHE-CBRI-3-1104		Introduction to Polymer Materials	L-T-P-C 3-1-0-4
Syllabus	<p>Basic concepts: Polymer raw materials, Polymerization principles and processes, Thermoplastic and thermosetting polymers, Characterization of polymers/plastics, Polymer modification, Introductory concepts on biodegradable polymers, Polymer degradation, High temperature polymers, Nano polymers, Self-cleaning polymer materials, Recycled polymers etc.</p>		

Reference Books	<ol style="list-style-type: none"> 1. Polymer Chemistry: The Basic Concept, Hiemenz, P.C., M. Dekker, New York, Latest Edition. 2. Structure and Properties of Polymer, Boenig, H.V., Georg Thieme Publishers, Stuttgart, Latest Edition. 3. Text Book of Polymer Science, Billmeyer, F.W., 3rd Edition, Wiley Interscience, New York, Latest Edition. 4. Heat Resistant Polymers, Critchley, J.P., Knight, G.H. and Wright, W.W., Plenum Press, New York and London, Latest Edition
Faculty	Rajni Lakhani & Harpal Singh

CHE-CBRI-3-1106		Plastics and Composites	L-T-P-C 2-1-0-3
Syllabus	Polymer blends, Filled plastics, Fire retardant polymers and methods of imparting fire retardancy, Polymer matrix composites, Sandwich composites, Lignocellulosic fibres and their composites, Composite processing, Fire hazards and toxicity, Polymers and plastics in building construction.		
Reference Books	<ol style="list-style-type: none"> 1. Polymeric Building Materials, Dorel Feldman (eds), Elsevier Science Publishers Ltd., England, 1989 (ISBN 1-85166-269-3). 2. Glass Reinforced Plastics in Construction: Engineering Aspects, Leonard Hollaway (ed), Surrey University Press, Bishopbriggs, Glasgow G 64 2 NZ, 1978 (ISBN 0 903384 21 3). 3. Fire retardancy of polymeric materials, Charles, A. Wilkie, Alexander B. Morgan, CRC Press, Taylor & Francis Groups, Boca Raton, USA, 2010. 4. International Plastics Flammability Handbook, Jurgen Troitzsch, Hanser Publishers, Macmillan Publishing Co., New York, USA, Latest Edition. 5. Polymer Blends, Lloyd, M. Robeson, Hanser Gardner Publication, Cincinnati, Ohio, USA, Latest Edition. 		
Faculty	Rajni Lakhani and Harpal Singh		

CHE-CBRI-3-1108		Geopolymers	L-T-P-C 3-1-0-4
Syllabus	Raw materials, Synthesis and characterization of geopolymers, Activation chemistry and compositional effect, Durability in chemical environments, Application of geopolymer in building construction (concrete, coatings, bricks etc.), Processing of fly ash and its pozzolanic reactivity for use in cementitious materials.		
Reference Books	<ol style="list-style-type: none"> 1. Geopolymers structure, processing, properties and industrial applications, John L. Provis and Jannie S.J. van Deventer (eds), CRC Press, Woodhead Publishing Ltd., U.K., 2009. 2. Supplementary Cementing Materials for Concrete, V. M. Malhotra (ed), Canadian Government Publishing Centre, Ottawa, Canada K1A 0S9, Latest Edition. 3. Fire Retardant Materials, R. Horrocks, D. Price, CRC Press, Woodhead Publishing Limited, 2004, UK. 		
Faculty	Rajni Lakhani & Harpal Singh		

CHE-CBRI-3-1114 Nanotechnology and Analytical Techniques (for students of Chemical Sciences)		L-T-P-C 3-0-0-3
Syllabus	Introduction, General considerations, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of Nanomaterials-XRD, UV-Vis, FTIR, Microscopy, XPS, Applications of Nanomaterials	
Reference Books	<ol style="list-style-type: none"> 1. A.S. Edelstein, R.C. Cammarata, Nanomaterials: Synthesis, Properties, and applications 2. D.A. Skoog, F.J. Holler & T.A. Neiman, Principles of Instrumental Analysis; Harcourt Asia PTE Ltd. 3. V.M. Rotello, Nanoparticles: Building Blocks for Nanotechnology. 4. Hosono, H, Nanomaterials: from research to applications. 5. Kelsall, R.W.; Hamley, I.W.; Geoghegan, M, Nanoscale Science and Technology. 	
Faculty	L.P. Singh, P.C. Thapliyal , A.K. Minocha and Neeraj Jain	

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PhD programme: for details of the MTech programme, refer to the MTech brochure (website: www.cbri.res.in)

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