



# Master of Technology

in

## Building Engineering & Construction Technology (BECT)

Brochure 2018-20



Offered by



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

**MTech**  
**in**  
**Building Engineering & Construction Technology (BECT)**  
**CSIR – CBRI, Roorkee**

**Preamble**

With the initiative of Government of India on creation of infrastructural facilities a large sum of money is being invested in the construction sector. 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 concepts of Make in India, Innovate in India, Smart Cities, Smart Villages, Clean and Renewable Energy and Affordable Housing is fast catching up in the country.

Recognising the importance of housing, one of the prime infrastructures required for the growth of the country, the CSIR - Central Building Research Institute, Roorkee (CBRI), one of the prime laboratories of CSIR is offering programmes leading to Master of Technology (MTech) in “Building Engineering and Construction Technology (BECT)” and PhD in Engineering and Sciences.

The theme of disaster mitigation fulfils adequately the requirement of mitigating the risk of earthquake, landslide and fire which often destroy the infrastructures and creates havoc. The country has seen many such disasters in the past. The multidisciplinary expertise required to meet the requirements are available in the institute and the course is designed to impart practical training to the students on these themes. Thus the course is a perfect blend of both theory and practice. Drawing from the rich experience of scientists working in this laboratory, the course is designed to offer to the participants sound theoretical knowledge and practical site experience. Such a unique opportunity is not available anywhere in the country. Also the programme is unique by itself.

**Number of Seats in the Programme**

The total number of seats available for the MTech programme is 10 (**Ten**).

**Admission Process and Eligibility for Admission**

Engineering graduates who have completed B.Tech / B.E / B.Sc(Engg) in Civil Engineering / Construction Engineering / Building Science and Technology or are expected to complete successfully by 31<sup>st</sup> October 2018 are eligible for the programme. Please see the CSIR website, <http://www.acsir.res.in> for more information.

**Fellowship**

Please see the website, <http://www.acsir.res.in/>.

**Programme Fee Structure**

Please see the website, <http://www.acsir.res.in/>.

The fees/charges are required to be deposited before the start of every semester. For NEFT bank transfer, please transfer the amount to the saving account number 32594652804 of AcSIR (IFSC code – SBIN0004285, Branch Code: 04285) State Bank of India, Tidel Park, Chennai with appropriate narration statement.

## Important Dates

Please see the website, <http://www.acsir.res.in/>, for more information. The detailed programme calendar will be made available before the start of each semester.

## Evaluation Procedures and Grading Scheme

A number of course works are to be completed as a part of the programme primarily in the first two semesters and a few courses spread over other semesters as stipulated are to be taken. The evaluation process for the course is continuous with a semester-end examination. Letter grades will be 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:

GRADE	POINTS	REMARKS	GRADE	POINTS	REMARKS
A+	10	Outstanding	A	9	Excellent
B+	8	Very Good	B	7	Good
C+	6	Average	C	5	Not qualified

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 6.0 (in each of the first and second semesters) and above and a CGPA of 6.5 (at the end of the second semester) or above for continuing beyond the first year. Minimum grade point to be earned to pass any subject is 6.0. The time period to complete the MTech programme is two years and that for PhD is four years. Extension, if needed beyond the stipulated period for completing the courses will be decided on a case by case basis.

## Weightage of marks during the semester

There will be one mid-semester and one end semester examination in each semester. 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 tutorials, assignments and general discipline etc. in respective subjects.

## Examination & Evaluation procedures for Thesis work

- Every student shall have at least one thesis supervisor from amongst the faculty members of the Institute. No Student can have more than two supervisors from the same Institute. However, another co-supervisor from outside the institute, if necessary, may be appointed.
- The appointment of supervisors is normally done keeping in view the students' aspirations and the research interest of the faculty / institute.

## **For Thesis work**

- The thesis Oral Examination Board (OEB) shall be constituted by the Director of the laboratory on recommendation of Coordinator and thesis supervisor for each student. The OEB will have minimum three members –one examiner from same field of research, one examiner from areas other than the candidate's field of research and the thesis supervisor(s). The Dean approves the committee and senate chairman subsequently ratifies it. The communication in this regard would be done by the Lab Coordinator.
- The candidate, at the earliest, would be allowed to submit the thesis two weeks before the completion of the fourth semester with recommendation of the thesis supervisor(s).
- The last allowable date for submission of the MTech thesis should be fifteen days before the commencement of the fifth semester.
- The notification of the open seminar would be circulated by the thesis supervisor in consultation with members of the OEB.
- The candidate shall present his / her thesis work physically in colloquium (Open Seminar) in presence of the OEB members.
- The candidate is considered to have passed the oral examination if all the OEB members consider that the performance of the candidate is satisfactory.
- Based on the presentation and responses to the questions raised during oral examinations, the committee may recommend re-submission of the thesis at most once after incorporating the suggestions made by the committee for evaluation.
- 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.

## 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 in India.

## **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) Newspaper 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 (January 2012-Aug. 2015)

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 CO<sub>2</sub>/CO/H<sub>2</sub>S/ 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
- Scanning Electron Microscope
- 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**

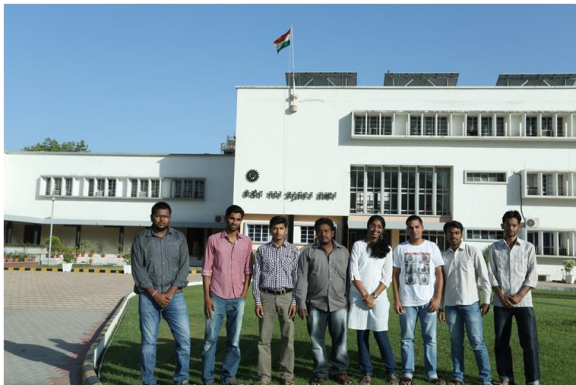
The campus has a dispensary equipped with residential Doctor, Pathologist and other dispensary staff. The dispensary caters the need of the residents. Only on emergency patients are transferred to nearby medical college or nursing home with a standby ambulance.

### **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 dining 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.



**Students Activities in the Campus**

## **Abhivyakti**

The students publish a quarterly wall magazine “Abhivyakti” to express their literary acumen.

## **Auditorium / Lecture Hall / Seminar Hall / Conference Room**

CBRI campus houses an auditorium (Rabindranath Tagore auditorium with 260 seating capacity) and conference rooms with computerized data projection systems and Audio-Visual facilities.

## **Field Visits**

Field visits are organised as a part of educational programme to impart the field knowledge and share the rich experience of the scientists for handling the projects at site.



Students during field visits at a construction site in Himalaya

## Building Engineering and Construction Technology (BECT)

### MTech Course Structure

SEMESTER I			SEMESTER II		
<i>Course Code</i>	<i>Course Title</i>	<i>L-T-P-C</i>	<i>Course Code</i>	<i>Course Title</i>	<i>L-T-P-C</i>
ENG-CBRI 1-1121	Automation in Building Construction	3-0-0-3	ENG-CBRI 1-1102	Design of Building Structures	3-0-0-3
ENG-CBRI 1-1103	Advanced Foundation Engineering	3-0-0-3	ENG-CBRI 1-1104	Disaster Resistant Building Systems	3-0-0-3
ENG-CBRI 1-1105	Engineering Materials for Infrastructure	3-0-0-3		<b>Elective I</b>	3-0-0-3
ENG-CBRI 1-1107	Analysis of Building Structures	3-0-0-3		<b>Elective II</b>	3-0-0-3
PHY/ENG-CBRI 1-0001	Research Methodology & Analysis	2-0-0-2	ENG-CBRI 1-1106	Laboratory-II (Structural Engineering & Fire Engineering)	0-0-4-2
ENG-CBRI 1-1111	Laboratory – I (Geotechnical Engineering, Materials and Environmental Science & Technology)	0-0-4-2	ENG-CBRI 1-1108		Seminar-II
ENG-CBRI 1-1113	Seminar-I	0-0-2-1			
<b>Total Credits</b>		<b>17</b>	<b>Total Credits</b>		<b>15</b>
SEMESTER III			SEMESTER IV		
<i>Course Code</i>	<i>Course Title</i>	<i>L-T-P-C</i>	<i>Course Code</i>	<i>Course Title</i>	<i>L-T-P-C</i>
ENG-CBRI 1-1125	Building Information Modelling & Construction Management	3-0-0-3	ENG-CBRI 1-1110	Dissertation-II including Viva Voce	0-8-24-16
ENG-CBRI 1-1121	Mini Project	0-0-8-4			
ENG-CBRI 1-1117	Dissertation-I	0-4-12-8			
<b>Total Credits</b>		<b>15</b>	<b>Total credits</b>		<b>16</b>
<b>Total Credit : 63</b>					

For details of the PhD programme refer to the PhD brochure.

## ELECTIVE COURSES

Course Code	Course Title	<i>L-T-P-C</i>
ENG-CBRI- 1-1120	Concrete Technology	3-0-0-3
ENG-CBRI- 1-1124	Industrialized Building Systems	3-0-0-3
ENG-CBRI- 1-1126	Repair, Rehabilitation & Retrofitting of Building Structures	3-0-0-3
ENG-CBRI- 1-1128	Environmental Impact Assessment	3-0-0-3
ENG-CBRI- 1-1130	Sustainable Design & Energy Efficient Building Systems	3-0-0-3
ENG-CBRI- 1-1132	Construction, Planning & Management	3-0-0-3
ENG-CBRI- 1-1134	Fire Protection Engineering	3-0-0-3
ENG-CBRI- 1-1136	Environmental Engineering & Management	3-0-0-3
ENG-CBRI- 1-1140	Ground Improvement Techniques	3-0-0-3
ENG-CBRI- 1-1144	Deep Excavation	3-0-0-3
ENG-CBRI- 2-1104	Health Monitoring of Building Structures	3-0-0-3
ENG-CBRI- 2-1106	Tall Buildings & Structures	3-0-0-3
ENG-CBRI- 2-1108	Behaviour of Metal Structures	3-0-0-3
ENG-CBRI 1-1101	Numerical Methods	3-0-0-3
ENG-CBRI 1-1150	Subsurface Investigation & Geo-hazards	3-0-0-3

Note: The electives will be selected by the students depending on their broad areas of research.

## Core Courses

## SEMESTER I

ENG-CBRI-1-1121 Automation in Building Construction		L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p><b>Automation in construction:</b> Introduction, Importance of automation in Construction sector, Automation in Prefabrication, Mechanization in construction sector, Impact and barriers of mechanization and automation in building construction</p> <p><b>Mechanization in production of building components:</b> Types of construction machineries, Concept of machine design, Production process, Return on investment, Machine and plant cost optimization, Production cycle optimization</p> <p><b>Mechanization of construction process:</b> Mechanized process for wall plastering, Material handling, Inspection, and Maintenance</p> <p><b>Infrastructure Robotics:</b> Classifications, Research challenges and opportunities, Dynamics and control</p> <p><b>Instrumentation:</b> Measurements, Transducers, Signal Conditioning, Data Acquisition</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"><li>1. Sharma S.C. "Construction Equipment and Management", Khanna Publishers, Delhi, 1988</li><li>2. Peurifoy R L, "Construction Planning, Equipment and Methods", McGraw Hill</li><li>3. James F Russell, "Construction Equipment", Prentice Hall</li><li>4. Saha, S.K., 2014. Introduction to robotics. Tata McGraw-Hill Education.</li><li>5. Rangan C.S., Sarma G.R. and Mani V.S.V., "Instrumentation Devices and Systems", Tata McGrawHill</li></ol>	
<b>Faculty</b>	S. K. Panigrahi, R. S. Bisht and Soju. J. Alexander	

ENG-CBRI-1-1103 Advanced Foundation Engineering		L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p><b>Shallow Foundation:</b> Limit equilibrium analysis, Prandtl, Terzaghi, Vesic and Meyerhof's methods of analysis, safe and allowable bearing pressures, contact pressure distribution, rigid and flexible foundation, analysis of combined footings, elastic analysis of raft foundation, floating raft, foundation on slope, settlement calculations, elastic and consolidation settlement, bearing capacity and settlement, Earthquake induced foundation failure, Propagation of elastic waves in soil, waves in layered soil, dynamic properties of soil and its evaluation, seismic bearing capacity of shallow foundations</p> <p><b>Deep foundation:</b> Load transfer mechanism, critical length, comparison of different methods of analysis of pile foundation, group capacity, group efficiency, settlement under vertical load, lateral capacity of short and long piles, seismic analysis of pile foundations, liquefaction hazard, theory of pile failure in seismic liquefaction</p> <p><b>Landslide:</b> Landslide Types and processes; Landslide Hazard and Risk Assessment: Concept &amp; Techniques, Landslide Investigations: Geological, geophysical &amp; geotechnical; Landslide Instrumentation: Surface &amp; sub-surface monitoring; Slope Stability Analysis &amp; control measures: Methods, Types &amp; design; Case Studies</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"><li>1. K. Terzaghi, R. B. Peck &amp; G. Mesri, Soil Mechanics in Engineering Practices, Wiley Interscience Publication, 1996.</li><li>2. J. E. Bowles, Foundation Analysis and Design (4 ed.), McGraw Hill, New York, 1996.</li><li>3. H. G. Poulos &amp; E.H. Davis, Pile foundation Analysis and Design, John-Wiley &amp; Sons, New York, 1980.</li><li>4. M. J. Tomlinson, Foundation Design and Construction, Pitman Publishing Limited, London, 1975.</li><li>5. S. K. Gulhati &amp; M. Datta, Geotechnical Engineering, Tata McGraw Hill, 2005.</li><li>6. M. R. Hausmann, Engineering Principles of Ground Modification, McGraw Hill, 1990.</li></ol>	
<b>Faculty</b>	Anindya Pain, Koushik Pandit, S. Sarkar, DP Kanungo	



ENG-CBRI-1-1105      Engineering Materials for Infrastructure		L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p>Newer smart materials for construction, Properties and functional requirements of materials, New and alternate cements, Supplementary cementitious materials, Utilization of industrial wastes in cementitious binders, Wood substitutes: Development, Raw materials, Current production processes, properties and end use. Composites: Reinforcement, matrices, processing techniques and use in infrastructures. Polymers and plastics in buildings: Plastic products, Sandwich composites, Coatings &amp; Sealants, and Polymer concrete, Construction chemicals: Water reducing agents, Consistency improvers, Accelerating admixtures, Set retarders, permeability reducers, etc., Roofing, walling and flooring materials, Steel and non-ferrous materials.</p> <p>Performance and durability: Strength and deformation of materials, Life cycle cost, Effect of environmental agents such as weathering, moisture, chemical attack, frost action and efflorescence, Fire behaviour of building materials, fire retardance/resistance of materials and properties</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. K. S. Jagadish, B. V. V. Reddy &amp; K. S. N. Rao, Alternative Building Materials and Technologies, New Age International, 2006.</li> <li>2. R. Rixom &amp; N. Mailvaganam, Chemical Admixtures for Concrete, 3rd Edition, E &amp; FN Spon, 1999.</li> <li>3. H. F. W. Taylor, Cement Chemistry, Thomson Telford, 1997.</li> <li>4. C. A. Wilkie &amp; A. B. Morgan, Fire retardency of polymeric materials, CRC Press, Taylor &amp; Francis Groups, Boca Raton, USA, 2010.</li> </ol>	
<b>Faculty</b>	Rajni Lakhani, S.K.Singh, Harpal Singh and Hemlata	

ENG-CBRI -1-1107      Analysis of Building Structures		L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p><b>Static analysis:</b> Fundamentals of elasticity, Static and kinematic indeterminacy, stiffness and flexibility methods, Finite element formulation of 1D, 2D and 3D problems and applications, Analysis of plane stress, plane strain, axi-symmetric and plate bending problems, Introduction to non-linear analysis.</p> <p><b>Dynamic analysis:</b> Free and forced vibration of damped and undamped Single Degree Freedom systems (SDF), Harmonic excitations, vibration isolation, force transmissibility and support excitations, short duration impulse, Duhamel integral, time history analysis, Response spectra. Multiple degree of freedom systems, Orthogonality and normalization of modes, Solution methods for eigen values and eigen vectors, mode -superposition method, Computational programs for dynamic analysis.</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. S. P. Timoshenko &amp; J. N. Goodier, Theory of Elasticity, McGraw Hill Education (India) Pvt Ltd, 1970.</li> <li>2. J. M. Gere &amp; W. Weaver, Matrix analysis of framed structures, Springer US, 1990.</li> <li>3. H. C. Martin, Introduction to Matrix Methods of Structural Analysis, McGraw-Hill, 1966.</li> <li>4. R. W. Clough &amp; J. Penzien, Dynamics of Structures, McGraw-Hill, 1993.</li> <li>5. Mario Paz, Structural Dynamics Structural Dynamics: Theory and Computation, Kluwer Academic Publishers, 2004.</li> <li>6. K. J. Bathe &amp; E. L. Wilson, Numerical methods in finite element analysis, Prentice-Hall, 1976.</li> <li>7. R. D. Cook, D. S. Malkus, M. E. Plesha &amp; R.J. Witt, Concepts and Applications of Finite Element Analysis, Wiley Publisher, 1989.</li> <li>8. C.S. Krishnamoorthy, Finite Element Analysis-Theory &amp; Programming, Tata McGraw-Hill, 1994.</li> <li>9. Anil K Chopra, Dynamics of Structures, Theory and Applications to Earthquake Engg, 2<sup>nd</sup> Edition, Pre Hall of India Pvt. Ltd, 2004.</li> </ol>	
<b>Faculty</b>	Achal Mittal,,S.K. Panigrahi, Micky Dalbehera and R. Siva Chidambaram	

PHY/ENG-CBRI-1-0001		Research Methodology & Analysis	
L-T-P-C		2-0-0-2	
<b>Syllabus</b>	<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>		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. C. R. Kothari, Research Methodology: Methods and Techniques, New Age Publications, 2011.</li> <li>2. Ranjit Kumar, Research Methodology: A Step-By-Step Guide for Beginners, SAGE publication, 4th edition, 2014</li> <li>3. D K Bhattacharyya, Research Methodology, Excel Books India, 2009.</li> </ol>		
<b>Faculty</b>	Abha Mittal, S.R. Karade and DP Kanungo		

ENG-CBRI- 1-1111		Laboratory - I	
		Geotechnical Engineering, Materials and Environmental Laboratory	
		L-T-P-C	
		0-0-4-2	
<b>Syllabus</b>	<p><b>Geotechnical Laboratory:</b> Physical properties and compressibility characteristics of soils, Drained and Undrained shear strength parameters and hydraulic properties of soil, Dynamic properties of soil, Field test: SPT, DCPT, Plate load, Vane shear test.</p> <p><b>Materials and Environmental laboratory:</b> Testing of plastics building products: Plastic pipes (dimensions, hydrostatic pressure test, reversion etc.), Water storage tanks (dimensions, impact, tensile strength, resistance to deformation etc.), Door shutters (dimensions, edge loading test, buckling test, misuse, slamming etc.), Waterproofing membrane (sticking test, heat resistance test, water penetration test etc.).</p> <p>Instrumental methods for analysis: Scanning electron microscopy, X-ray diffraction, Thermal analysis, Inductive coupled plasma, X-ray florescence, surface area analyser etc. Air pollution test, water quality test, testing of cernentitious materials, Micological and Termite Resistance Test.</p>		
<b>Faculty</b>	L.P. Singh Manojit Samanta and Hemlata		

**Core Courses****SEMESTER II**

<b>ENG-CBRI-1-1102</b>		<b>Design of Building Structures</b>	<b>L-T-P-C</b> <b>3-0-0-3</b>
<b>Syllabus</b>	Concept and philosophy of earthquake resistant design of buildings, Wind effects on buildings: Codal provisions Criteria for wind resistant design of buildings; Design of glass facades for buildings  Design concepts of tall building system.  Design of columns for combined axial and biaxial bending, design of slender columns, shear wall, flat slabs, Concepts of LRFD design and Codal provisions, Introduction to plastic analysis in steel structures, Design of Industrial Buildings  Computer aided structural design.		
<b>Reference Books</b>	<ol style="list-style-type: none"><li>1. S. U. Pillai &amp; D. Menon, Reinforced Concrete Design, Tata McGraw-Hili Publishing Company Limited, New Delhi, 2003.</li><li>2. A. K. Jain, Reinforced Concrete Limit State Design, Nem Chand &amp; Bras, Roorkee, 2002.</li><li>3. P. C. Varghese, Advanced Reinforced Concrete Design, Prentice-Hall of India Pvt. Ltd., New Delhi, 2001.</li><li>4. A. S. Arya &amp; Ajmani, Design of Steel Structures, 1989.</li><li>5. J. D. Holmes, Wind Loading of Structures, CRC Press, 2007.</li><li>6. N. Subramanian, Design of Steel Structures, Oxford University, 2011.</li><li>7. D. Dubina, V. Ungureanu &amp; R. Landolfo, Design of Cold formed Steel Structures, Wiley VCH, 2012.</li></ol>		
<b>Faculty</b>	A.K. Mittal, Ajay Chaurasia and Siddharth Behera,		

ENG-CBRI-1-1104	Disaster Resistant Building System	L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p><b>Fire safety system in buildings:</b> Fundamentals of fire, Fire Growth, Stages of fire development, Spread of fire, Reaction to fire characteristics: Combustibility, Ignitability, Surface spread of flame, Smoke generation etc., Fire retardancy, Fire severity &amp; Controlling factors, Fire resistance of building elements: Heating conditions, Performance criteria for load bearing capacity, integrity, thermal insulation, Smoke movement and control, Fire dynamics and modelling, Fire detection, Fire extinguishment.</p> <p><b>Earthquake resistant building structure:</b> Characteristics of earthquakes, analysis of structures for earthquake loading, Linear and Dynamic analysis, Comparison of IS 1893 vs Eurocode 8, Ductility and detailing of RC members, Introduction to Pushover Analysis, Strengthening of existing RC buildings.</p> <p><b>Introduction to Tsunami</b> - Design of Tsunami Evacuation Buildings, Application of CFD in Tsunami modelling.</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. S. Bhattacharya, Design of foundation in seismic areas: Principles and some applications, Published by NICEE [National Centre for Earthquake Engineering (India)], , 2007.</li> <li>2. R. W. Day, Geotechnical Earthquake Engineering, Handbook, McGraw - Hill, New York, 2002.</li> <li>3. G. Madabhushi, J. Knappett &amp; S. Haigh, Design of Pile Foundations in Liquefiable Soils, Imperial College Press, London, 2010.</li> <li>4. S. Prakash, Soil dynamics, McGraw Hill, New York, 1981.</li> <li>5. S. L. Kramer, Geotechnical Earthquake Engineering, Prentice Hall, New Delhi, 1996.</li> <li>6. D. D. Drysdale, Introduction to Fire Dynamics, 2011.</li> <li>7. Sassa, Landslides - Risk Analysis and Sustainable Disaster Management, Springer Publishers, 2005.</li> <li>8. R. Chowdhury, P. Flentje &amp; G. Bhattacharya, Geotechnical Slope Analysis, Taylor &amp; Francis, 2009.</li> <li>9. K. Chopra, Dynamics of Structures: Theory and application to Earthquake Engineering, Prentice Hall, 2001.</li> <li>10. T. Pauley &amp; M. J. N. Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons Inc. New York, Australia, 1992.</li> <li>11. D. J. Dowrick, Earthquake Risk Reduction, John Wiley &amp; Sons Limited, 2003.</li> <li>12. ACI 440.2R-08, Guide for the design &amp; construction of externally bonded FRP systems for Strengthening of Concrete Structures.</li> <li>13. Seismic evaluation of retrofit of concrete buildings, ATC-40.</li> </ol>	
<b>Faculty</b>	Suvir Singh, Shorab Jain, Siddharth Behera and Debdutta Ghosh.	

## Elective Courses

ENG-CBRI-1-1101	Numerical Methods	L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p>Interpolation, errors, divided differences, polynomial approximation, numerical differentiation and integration, matrices: Eigen values and Eigen vectors, numerical solution of ordinary and partial differential equations and their convergence, initial and boundary value problem, Laplace and Poisson equations, special functions: Legendre's function, Rodrigue's formula, Bessel's function and recurrence formula, finite element method and applications, fuzzy logic, artificial neural network and genetic algorithms.</p> <p>Introduction to the software- like Ms-Excel, SPSS and MATLAB</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. S. R. K. Iyengar, R. K. Jain &amp; M. K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age International Publishers, 2003.</li> <li>2. B. S. Grewal, Numerical Methods in Engineering &amp; Sciences, Khanna Publishers, 2010.</li> <li>3. E. Kreyszig, Advanced Engineering Mathematics, Wiley Publishers, 2008.</li> <li>4. S. Chakraborty &amp; R. B. Bhatt, Numerical Methods in Engineering, Narosa Publ. House, 2004.</li> <li>5. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall, 2012.</li> <li>6. J. Mathew &amp; K. Fink, Numerical Methods with MATLAB, Pearson Education, 2006.</li> <li>7. C. F. Gerald &amp; O. Patrick, Wheatley Applied Numerical Analysis, Addison Wesley, 1994.</li> <li>8. O. C. Zienkiewicz, The Finite Element Methods, Tata McGraw Hill Publishing Co., 1971.</li> <li>9. C. S. Desai &amp; J. F. Abel, Introduction to Finite Element Method, Van Nostrand Reinhold, New York, 1972.</li> </ol>	
<b>Faculty</b>	Abha Mittal, P.K. Yadav, Manojit Samanta and D. Ghosh	

ENG-CBRI-1-1120	Concrete Technology	L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p>Developments of concrete, Concrete mix proportioning: Principles and methods, Concrete manufacturing and its placement, Ready mixed concrete, Concrete with admixtures, Rheological properties, Short and long term engineering properties, Microstructural evolutions, Statistical analysis of results, High strength and high performance concretes: Proportioning, Behavior, Applications and Codal aspects, Concrete at elevated temperatures and under cryogenic conditions, Durability of concrete under various exposure condition, Alkali-silica reactions, Corrosion of steel in concrete, Protective measures High volume fly ash concrete, Fibre reinforced concrete, Self compacting concrete, Pervious concrete, Geo-polymer concrete, Recycled aggregate concrete, Light weight aggregate concrete, Sustainable &amp; durable construction, Quality control and quality assurance during production/construction.</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. A. M. Neville, Properties of concrete, John Wiley &amp; Sons Inc, 5th Edition, 2012.</li> <li>2. P. K. Mehta &amp; P. J. M. Monteiro, Concrete: Microstructure, properties and Materials, McGraw- Hi", 2005.</li> <li>3. A. M. Neville &amp; J. J. Brooks, Concrete Technology, 4th Impression, Pearsons Education Ltd, 2009.</li> <li>4. J. P. Broomfield, Corrosion of steel in concrete: Understanding, investigation and repair, Taylor Francis, London, UK, 2007.</li> </ol>	
<b>Faculty</b>	S.K. Singh, S.R. Karade and K.S. Kulkarni	

<b>ENG-CBRI- 1-1124</b>		<b>Industrialized Building Systems</b>	<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	Classification of prefabricated and industrialized building systems, Advantages and disadvantages of IBS, Industrialization for sustainable construction; Modular Coordination, standardization, rationalization, systematization and codal provisions. Building Systems: criteria of selection, sub structural systems, horizontal, vertical, open and closed systems. Strategies for Industrialization: user-friendly building components, production strategies and emerging concepts of prefabrication, generic forms of construction, facade technologies and jointing techniques, Case studies.		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. F. S. Merritt &amp; J. Ambrose, Building Engineering and Systems Design, Van Nostrand Reinhold, New York, 1990.</li> <li>2. A. S. G. Bruggeling &amp; G. F. Huyghe, Prefabrication with Concrete, A A Balkema, 1991.</li> <li>3. F. (Eph.) BUUGER, Design of Precast Concrete Structures, John Wiley &amp; Sons, 1988.</li> <li>4. K. S. Elliott, Multi Storey Precast Concrete Framed Structures, Blackwell Science Ltd, 1996.</li> <li>5. Prestressed Concrete Institute (PCI), Chicago, Manual on Design and Typical Details of Connections for Precast and Prestressed Concrete, second edition, (1988).</li> <li>6. National Building Code - 2005.</li> <li>7. IS Codes on Modular Coordination.</li> </ol>		
<b>Faculty</b>	Ashok Kumar, Ajay Chaurasia and K.S. Kulkarni		

<b>ENG-CBRI- 1-1126</b>		<b>Repair, Rehabilitation &amp; Retrofitting of Structures</b>	<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Condition Assessment: Appraisal of structures, Types of distresses- causes &amp; effects, Distress diagnosis, Irregularities &amp; inconsistencies in construction, In-place strength assessment, Evaluation of buildings based on demand-capacity method.</p> <p>Innovative Repair Materials: Selection criteria, salient properties, Testing &amp; evaluation of repair materials &amp; systems.</p> <p>Rehabilitation and strengthening techniques: Strategies, Philosophy and design of strengthening, Surface preparation, Grouting, Sprayed concrete, Steel jacketing, Micro-concreting, FRP wrapping etc., Introduction to performance based strengthening strategies, Seismic retrofitting.</p> <p>Codal provisions, Quality Assurance and Control, Case studies of buildings and heritage structures</p>		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. H.V.S. GangaRao, Navendra Taly &amp; P.V. Vijay "Reinforced Concrete Design with FRP composites", 1<sup>st</sup> edition, 2007, CRC Press, Tylor &amp; Francis group, USA.</li> <li>2. A. Chakrabarti, D. Menon &amp; A Sengupta, "Hand book on Retrofitting of Structures-Principles &amp; Applications, 1<sup>st</sup> edition,2010, Narosa Publishing House, New Delhi</li> <li>3. J.H. Bungey, S. G. Millard &amp; M. G. Grantham, Testing of concrete in Structures, 4<sup>th</sup> edition, Taylor &amp; Francis, London &amp; New York, 2006.</li> <li>4. Gajanan M. Sabnis, Avanti C. Shroff &amp; Lawrence F. Kahn "Seismic Rehabilitation of Concrete Structure", 1996, SP-160, American Concrete Institute, Michigan, USA.</li> <li>5. "Repair and strengthening of concrete structure", FIP ,Thomas Telford, London</li> <li>6. R.Holland "Appraisal &amp; Repair of Reinforced Concrete", ,The Gromwell Press, Thomas Telford Ltd., London</li> <li>7. Nader Ghafoori "Innovation in Repair Techniques in Concrete Structures", ASCE publication.</li> </ol>		
<b>Faculty</b>	S.K. Singh, Ajay Chaurasia and R. Siva Chidambaram		

ENG- CBRI- 1-1128		Environmental Impact Assessment	L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p>Introduction, Sustainable development, Environmental impact of infrastructural projects, Planning and Management of impacts studies.</p> <p>Impact assessment of infrastructural development on air, surface &amp; sub-surface water, soil, noise, etc., Assessment methods and techniques, Prediction technique for quality of environment attributes. Control measures, Preparation of environmental management plan: carrying capacity and assimilation capacity studies for sustainable development</p> <p>Environmental quality standards: Regulations, Legislations, Environmental Clearance Process, Salient features of EIA notification. Case studies.</p>		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. David C.Wooten &amp; J.G.Ran Environmental Impact Analysis Hand Books Pub. McGraw – Hill (1979).</li> <li>2. Canter L.W., Environmental Impact Assessment, McGraw-Hill, 1997</li> <li>3. Betty Bowers Marriott, Environmental Impact Assessment A Practical Guide McGraw-Hill Professional, 1997</li> <li>4. Peter Morris &amp; Riki Therivel, Methods of Environmental Impact Assessment, Routledge, 2001.</li> <li>5. Denver Tolliver, Highway Impact Assessment, Greenwood Publishing Group, 1993</li> <li>6. R.K.Jain, L.V.G.S. Stacey, H.E. Balbach, Environmental Assessment McGraw-Hill Professional, 2001.</li> <li>7. Relevant IRC &amp; CPCB Code of Practices / Guidelines</li> <li>8. CPCB (2006) Pollution Control Acts, Rules and Notifications issued there under Pollution Control Law Series' PCLS/02/2006 Central Pollution Control Board, Delhi.</li> </ol>		
<b>Faculty</b>	A.K. Minocha & Purnima Parida		

ENG- CBRI- 1-1130		Sustainable Design and Energy Efficient Building Systems	L-T-P-C 3-0-0-3
<b>Syllabus</b>	<p>Introduction to sustainable and energy efficient building systems, Sustainable design principles, Low carbon building technologies, Climate factors for buildings design, Thermal comfort and insulation, Passive energy building design, Green building rating systems, Energy Conservation Building Code, Application of performance assessment tools, Low energy building materials, Heat repellent, Insulating materials, Heat transfer through building elements.</p> <p>Case Studies: Integrated design process, Green design projects.</p> <p><b>Solar Energy Applications:</b> Introduction of sun and solar radiations, overview of solar thermal applications, Liquid flat-plate collectors, Solar air heaters, Concentrating collectors, Testing procedures, Thermal energy storage: sensible heat storage, latent heat storage and thermo-chemical heat storage, other methods to utilization of solar energy: photovoltaic conversion, solar chimney, solar pond, etc.</p> <p><b>Instrumentation:</b> Sensor and Transducer Fundamentals: Transducer terminology, Design and performance characteristics, criteria for transducer selection, Case Studies – Transducers principles of representative cases with emphasis on special “Electronic Conditioning requirements” of different type of sensors-- Resistive transducer; Inductive transducers; capacitive transducers; piezoelectric transducer; semiconductor and other sensing structures.</p>		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Godfrey Boyle, Renewable Energy, Oxford University Press, 2004, Reprint 2010.</li> <li>2. Sharma I C, The Climatic Data Handbook, Tata Mc Graw Hill Pub. Co. Ltd., 1993.</li> <li>3. Givoni B, Man Climate &amp; Architecture, Elsevier, 1969</li> <li>4. Gupta C P, Prakesh Rajendra, Engineering Heat Transfer, Nem Chand &amp; Brothers -Roorkee, 1979</li> <li>5. Renewable Energy Resources, Second Edition, John Twidell &amp; Tony Weir, Taylor &amp; Francis-2008</li> <li>6. Non-Conventional Energy Resources, B.H. Khan, TMH, 2<sup>nd</sup> Edition-2009</li> <li>7. Wind and Solar Systems by Mukund Patel, CRC Press, 2011.</li> <li>8. Measurements – E. O. Doebelin</li> </ol>		
<b>Faculty</b>	Ashok Kumar, T. Alam, Anuj Kumar, and C.S. Meena		

<b>ENG-CBRI- 1-1132                      Construction, Planning &amp; Management</b>		<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Introduction to Building Projects, Modes of public: private participation, Innovative approaches for fiscal mobilization and financing. Project formulation, appraisal &amp; evaluation, Feasibility studies and preparation of detailed project reports (DPRs). Planning - Fundamentals for construction planning, project life cycle. Project Management Issues: planning, monitoring, scheduling, application of Information technology tools, project proposal, project completion, compliance and closure. Tender documents &amp; selection process, contract correspondence, formulation of claims, variations &amp; extensions, dispute resolution, reconciliation and arbitration. Case studies: Urban housing and other building projects.</p> <p>Construction project management: Network scheduling, critical path method (CPM), project evaluation and review technique (PERT), planning and scheduling of activity network, cost - time trade off, linear programming, PERT / Cost accounting. Scheduling with limited resources, resource planning, resource allocation, project schedule compression, generalized activity network.</p> <p>Estimation of project cost, earned value analysis, monitoring project progress, project appraisal and selection, recent trends in project management.</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. R. Barry, The Construction of Buildings: Parts 1-4, Orient Longman lid.</li> <li>2. H. Roy &amp; B. Sengupta, Construction Management.</li> <li>3. A. B. Badiru, STEP Project Management: Guide for science, technology and engineering projects, CPC press, Taylor and Francis Group, USA, 2009.</li> <li>4. World Bank, Procurement documents related infrastructure projects, <a href="http://www.worldbank.org">www.worldbank.org</a>.</li> </ol>	
<b>Faculty</b>	Ashok Kumar & K.S. Kulkarni	

<b>ENG- CBRI- 1-1134                      Fire Protection Engineering</b>		<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Introduction to fire safety engineering, Heat transfer mechanisms in fire and built up of untenability conditions, Flames / fire plumes, Burning behavior of materials, Active fire protection: Portable fire extinguishers, Water mist fire extinguishment system, Fire hydrant and hose reel systems, Automatic sprinkler system, Fixed fire suppression flooding system, Detection and automatic alarm system, Passive fire protection: Structural fire protection, Compartmentation of building' &amp; fire spread, Containment of fire spread, Regulations of fire safety measures and techniques, Case studies.</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. J. W. Lyone, The chemistry &amp; uses of fire retardants, Wiley Inter science, 1970.</li> <li>2. T. H. Harmathy, Fire Resistant Designs.</li> <li>3. J. L. Bryan &amp; Macmillan, Fire Suppression &amp; Detection System, 1993.</li> <li>4. G. Cox, Combustion Fundamentals of Fire, Academic Press, 1995.</li> <li>5. D. D. Drysdale, Introduction to Fire Dynamics, Wiley Publications, 2011.</li> <li>6. C. A. Wilkie &amp; A. B. Morgan, Fire retardency of polymeric materials, CRC Press, Taylor &amp; Francis Groups, Boca Raton, USA, 2010.</li> </ol>	
<b>Faculty</b>	Suvir Singh, RS Chimote, Rajiv Kumar and B.A Gedam	



<b>ENG- CBRI- 1-1136 Environmental Engineering &amp; Management</b>		<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Water and wastewater: Quality Parameters and Standards, Wastewater treatment plant:            Industrial wastewater: characteristics, treatment levels and available technologies, Reactor Tanks: Mixed Tanks, Plug Flow, Dispersed Flow, Tanks-In-Series, Residence Time Distribution, Sedimentation-Flocculation, Filtration, Chemical Treatment, Biological treatment, Activated Sludge Treatment, Sanitation infrastructures: sanitation and hygiene-related diseases, Decentralized &amp; Centralized household water treatment</p> <p>Air Quality and Modelling: Sources and classification of air pollutants, indoor and outdoor air pollutants, Characteristics of various air pollutant particulates, Meteorology: influence of solar radiation and wind fields, lapse rate and stability conditions, characteristics of stack plumes, Dispersion and deposition modeling of atmospheric pollutants: Eddy and Gaussian diffusion models, techniques, health and nuisance/aesthetic, Monitoring, Control of particulates: collection mechanisms and efficiencies</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. H. S. Peavy &amp; D. R. Rowe, Environmental Engineering, McGraw Hill, 1985.</li> <li>2. S. K. Garg, Environmental Engineering, Khanna Publishers, 2005.</li> <li>3. Metcalf &amp; Eddy, Wastewater engineering, treatment, disposal and reuse, McGraw Hill, 1979.</li> <li>4. A. C. Stern, Air Pollution, Vol I to VIII, Academic Press, 1986.</li> <li>5. M. N. Rao &amp; H. V. N. Rao, Air pollution, Tata McGraw hill, 1989.</li> <li>6. A. D. Bhide &amp; B. B. Sudresan, Solid waste management in developing countries, New Delhi: Indian National Scientific Documentation Centre, 1983.</li> </ol>	
<b>Faculty</b>	Soumitra Maiti & Purnima Parida	

<b>ENG- CBRI- 1-1140 Ground Improvement Techniques</b>		<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Soft, expansive, loose cohesion less &amp; organic soils, need of ground improvement, engineering properties, principles of treatments, Improvement techniques: preloading, vertical drain, stone column, compaction, chemical stabilization, ground freezing, electro osmosis, blasting, vibrofloatation, determination of swell pressure, consequence of swelling, improvement of expansive soils, foundation techniques on expansive soil, soil reinforcement theory, type of soil reinforcements, mechanism of reinforced soil, Soil- reinforcement interactions, different types of soil reinforcements, application of reinforced soil, soil nailing, soil anchors, design of reinforced earth wall, reinforced soil for foundation, quality control in expansive soil</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. P. P. Raj, Ground Improvement Techniques, Laxmi publication (p) Ltd., New Delhi, 2005.</li> <li>2. R. K. Katti, Behavior of Saturated Expansive Soil &amp; Control Methods, A.A. Balkema publishers, 2002.</li> <li>3. M. P. Moseley &amp; K. Krisch, Ground Improvement, Spon Press, Taylor and Francis Group, 1992.</li> <li>4. E. W. Brand &amp; R. P. Brener, Soft Clay Engineering, Elsevier Scientific Publishing Company, 1981.</li> <li>5. K. Terzaghi, R. B. Peck &amp; Mesri, Soil Mechanics in Engineering Practices, A Wiley Inter science Publication, 1996.</li> </ol>	
<b>Faculty</b>	Pradeep Kumar, Manojit Samanta and S. Ganeshkumar	

<b>ENG- CBRI- 1-1144</b>		<b>Deep Excavation</b>	<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Introduction to the analysis and design of excavation, Excavation methods and lateral supporting systems: retaining walls, strutting systems, factors influencing on the selection of the retaining strut system, case history. Lateral earth pressure: Rankine's and Coulomb's earth pressure theory, earth pressure for design of excavation. Stability analysis: free and fixed earth support method, shear failure of strutted walls, push in, basal heave, upheaval, sand boiling.</p> <p>Stress and deformation analysis of excavation: simplified method, beam on elastic foundation method, finite element method. Design of excavation supporting systems: design methods and factor of safety, structural components in braced excavations, strut systems, anchor systems, tests of anchors.</p>		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Y. O. Chang, Deep Excavation Theory and Practice, Taylor &amp; Francis Group, London, UK, 2006.</li> <li>2. R. D. Holtz &amp; W. D. Kovacs, An Introduction to Geotechnical Engineering, Prentice - Hall, Inc., Englewood Cliffs, NJ, 1981.</li> <li>3. Soil Mechanics in Engineering Practice, John Wiley &amp; Sons, New York, 1967.</li> <li>4. R. B. Peck, W. E. Hanson &amp; T. H. Thornburn, Foundation Engineering, John Wiley &amp; Sons, New York, 1977.</li> <li>5. M. R. Hausman, Engineering Principles of Ground Modification, McGraw - Hill Publishing Company, New York, 1990.</li> <li>6. J. E. Bowles, Foundation Analysis and Design, 4th Ed., McGraw - Hill Book Company, New York, USA, 1988.</li> </ol>		
<b>Faculty</b>	Manojit Samanta		

<b>ENG-CBRI-2-1104</b>		<b>Health Monitoring of Building Structures</b>	<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Introduction to health monitoring systems of buildings, Use of sensors, Data acquisition techniques, Data Processing, Fast Fourier Transform and Inverse Fourier transform, Diagnostic techniques, Damage detection techniques - Modal curvature, Cumulative Damage Factor, Wavelet Transform, Wireless sensor network, Numerical modeling, Rehabilitation techniques, Case histories.</p>		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. V. Giurgiutiu, Structural health monitoring with piezoelectric wafer active sensors, Elsevier publications, 2008.</li> <li>2. D. E. Adams, Health monitoring of structural materials and components, Wiley, 2007.</li> <li>3. F. Kuo-chang, Structural health monitoring from system interpretation to autonomous systems, Technomic publication, 2000.</li> </ol>		
<b>Faculty</b>	Ajay Chaurasia and S.K. Panigrahi		

<b>ENG-CBRI-2-1106</b>		<b>Tall Buildings &amp; Structures</b>	<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	Introduction to Tall building systems, Analysis Methodology of tall building frames, Different types of loads, Lateral load analysis, multi bay frames; Shear walls, types, analysis, Coupled frames, Frame with shear wall; Principles of 3-D analysis of tall buildings; Perforated cores, types, Analysis ,Pure torsion, bending and warping of cores; Floor systems: Analysis; Elastic and inelastic stability of frames and shear walls; Analysis for Thermal Stresses; Other Tall structures.  Creep & Shrinkage effects on tall buildings, P - Delta analysis.		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Daniel Schodek &amp; Martin Bechthold, Structures, Prentice Hall; 7 edition,2013</li> <li>2. B. S. Taranath, Tall Buildings - Steel, Concrete, and Composite Design of Tall Buildings, TMH publications, 1997.</li> <li>3. S.N. Manohar, Tall Chimneys: Design and Construction, Tata McGraw-Hili Pub. Co.1985</li> <li>4. Timoshangeo &amp; Gere, Theory of Elastic Stability, TMH publications, 1961.</li> <li>5. B. S. Smith &amp; A. Coull, Tall Building Structure, Analysis &amp; Design, John Wiley &amp; Sons, 1991.</li> <li>6. M. Fintal, Handbook of Concrete Structures, CBS Publishers &amp; Distributors, 2004.</li> <li>7. Advances in Tall Buildings, CBS Publisher &amp; Distributors, Delhi, 1986.</li> </ol>		
<b>Faculty</b>	A.K. Mittal, Siddarth Behera and D. Ghosh		

<b>ENG-CBRI- 2-1108</b>		<b>Behaviour of Metal Structures</b>	<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	Introduction - Stability of frames, plates - Lateral buckling of beam - Compression Members - Combined bending and axial-combined bending & torsion; Buckling of thin elements - Torsional buckling of thin walled structures and open sections - Column - Strength curves - Buckling and post-buckling strength of plate elements with special reference to Codal provisions - Behaviour of light gauge steel structures; Prestressing in steel structures, Types of Connections- Welded, Bolted, Screwed, Rupture Failure of Connections. Introduction to Impact in metal structures- Behaviour of materials (steel, CFST) subjected to low velocity impact.		
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. C. G. Salmon, J. E. Johnson &amp; F. A. Malhas, Behaviour of Steel Structures, Prentice Hall,, 2008.</li> <li>2. S. P. Timoshenko &amp; J. M. Gere, Theory of Elastic Stability, Dover Publications, 2009.</li> <li>3. A. Kumar, Elastic Stability.</li> <li>4. Yu, Design of Light gauge Structures.</li> <li>5. K. Mukhanov, Design of Metal Structures, University Press of the Pacific, 2002.</li> <li>6. D.E. Blodgeth, Design of Welded Structures, The James F. Lincoln Arc Welding Foundation, 1996.</li> <li>7. D. Dubina, V. Ungureanum &amp; R. Landolfo, Design of Cold-Formed Steel Structures, Pub: European Convention for Constructional Steelwork, 2013.</li> <li>8.W. W. Yu &amp; R. A. LaBoube, Cold-formed Steel Design, Wiley Publishers, 2010.</li> </ol>		
<b>Faculty</b>	A.K. Mittal, Siddharth Behera and Mickey Dalbehera		

ENG-CBRI- 1-1150 <b>Subsurface Investigation &amp; Geo-hazards</b>		<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<p>Introduction to geohazards; different types of hazards: natural disasters, landslides, earthquakes, flash flood etc.</p> <p>Engineering geophysics, Engineering properties of soils and rocks: Characteristics of important engineering problems – landslides, tunnels, cavities, roads etc., identification of dam sites and other engineering construction problems Near surface geophysics - application in archeological problems.</p> <p>Seismic Method: Elementary principle of reflection and refraction methods, seismic exploration theory and geometry of seismic waves, seismic sources and equipment, field method and seismic data interpretation,</p> <p>Electrical Method: Elements of IP and resistivity methods, Wenner and Schlumberger configurations. Methods of resistivity profiling and sounding, and 2D, 3D data interpretation. Basic principles of electromagnetic and GPR methods.</p>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. An Introduction to Applied and Environmental Geophysics, John M. Reynolds, ISBN: 978-0-471-48535-3</li> <li>2. Applied Geophysics by <u>W. M. Telford</u> , <u>L. P. Geldart</u> , <u>R. E. Sheriff</u>, Cambridge University Press</li> <li>3. Archaeogeophysics, Editors: El-Qady, Gad, Metwaly, Mohamed (Eds.) Published by Springer. Series: <u>Natural Science in Archaeology</u></li> </ol>	
<b>Faculty</b>	P K S Chauhan D.P. Kanungo and Abha Mittal	

ENG-CBRI- 1-1106 <b>Laboratory - II</b>		<b>L-T-P-C 0-0-4-2</b>
<b>Structural Engineering &amp; Fire Engineering</b>		
<b>Syllabus</b>	<p><b>Structural Engineering:</b> Characterisation of raw materials of concrete, Concrete mix proportioning of grade M30 &amp; M60, casting &amp; testing of cubes, cylinders and prisms, non-destructive tests such as rebound hammer, ultrasonic pulse velocity, rebar locator, impact echo, corrosion tests, vibration monitoring etc; casting and testing of reinforced concrete beams under static &amp; dynamic loading conditions, testing of FRP strengthened beams.</p> <p><b>Fire Engineering:</b> Fire propagation index, Surface spread of flame test, Ignitability test at various irradiances levels, Non-combustibility test, Specific optical density of smoke, Toxicity index, Limiting oxygen index test, Cone calorimeter test: Rate of burning of polymeric building materials.</p>	
<b>Faculty</b>	S.K. Singh, Harpal Singh and Subash Gurram	

Core Courses

**SEMESTER III**

<b>ENG-CBRI- 1-1121 Building Information Modelling and Construction Management</b>		<b>L-T-P-C 3-0-0-3</b>
<b>Syllabus</b>	<ul style="list-style-type: none"><li>• Information technology development in building construction</li><li>• Principles and advantages of IT in construction</li><li>• Introduction to BIM fundamentals and its applications</li><li>• BIM and Pre-construction, and construction</li><li>• Modelling building elements: Exterior and interior walls, footings, columns, floors beams, roofs, stairs and ramps, doors, windows and other elements.</li><li>• Working with BIM models:<ul style="list-style-type: none"><li>a. Estimating &amp; material takeoff</li><li>b. 3D/4D/5D scanning and modelling</li></ul></li><li>• Project Planning of a construction process and Delivery Methods</li><li>• Designing for Prefabrication and Coordinating Construction</li><li>• Controlling Schedules - Critical Path Method (CPM) and PERT</li><li>• Material Management</li><li>• BIM project lifecycle and other integrated aspects (Facility management, HVAC, MEP etc.)</li></ul>	
<b>Faculty</b>	K.S. Kulkarni, Ashok Kumar and A.P. Chaurasia	

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**PhD programme:** for details of the PhD programme, refer to the PhD brochure  
(website: [www.cbri.res.in](http://www.cbri.res.in))

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