

# **Ph.D CIVIL ENGINEERING CURRICULUM & SYLLABI 2024 -2025**

**Department of Civil Engineering  
Faculty of Engineering**



**KARPAGAM ACADEMY OF HIGHER EDUCATION**

(Deemed to be University)

(Established Under Section 3 of UGC Act 1956)

(Accredited with A+ Grade by NAAC in the Second Cycle)

COIMBATORE 641 021, TAMIL NADU - INDIA.

**Regulations**  
for  
**Ph.D., Full Time (FT) / Part Time (PT)**

As per the UGC (Minimum Standards and Procedures for Award of Ph.D., Degree)  
Regulations, 2022

The Regulation will be effective from 7<sup>th</sup> November, 2022  
(The research scholars admitted from January, 2023 onwards will be governed by this regulation)



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## Regulations for Ph.D., Full Time (FT) / Part Time (PT)

### 1.0 Preamble

The Degree of Doctor of Philosophy (Ph.D.,) is awarded to a candidate who has submitted a thesis on the basis of original and independent research work done in any particular discipline or involving more than one discipline (inter-disciplinary), that make a contribution to the advancement of knowledge, which is approved by Board of Examiners as per the requirement.

### 2.0 Eligibility Criteria for admission to the Ph.D., Programme:

- 2.1 A 1-year/2-semester master's degree programme after a 4-year/8-semester bachelor's degree programme or a 2-year/4-semester master's degree programme after a 3-year bachelor's degree programme or qualifications declared equivalent to the master's degree by the corresponding statutory regulatory body, with at least 55% marks in aggregate or its equivalent grade in a point scale wherever grading system is followed

or equivalent qualification from a foreign educational institution accredited by an assessment and accreditation agency which is approved, recognized or authorized by an authority, established or incorporated under a law in its home country or any other statutory authority in that country to assess, accredit or assure quality and standards of the educational institution.

- 2.2 Candidate seeking admission after a 4-year/8-semester bachelor's degree programme should have a minimum of 75% marks in aggregate or its equivalent grade on a point scale wherever the grading system is followed. A relaxation of 5% marks or its equivalent grade may be allowed for those belonging to SC/ST/OBC (non-creamy layer)/Differently-Abled, Economically Weaker Section (EWS) and other categories of candidates as per the decision of the Commission from time to time.

Candidates who have completed the M.Phil. programme with at least 55% marks in aggregate or its equivalent grade in a point scale wherever grading system is followed or equivalent qualification from a foreign educational institution accredited by an assessment and accreditation agency which is approved, recognized or authorized by an authority, established or incorporated under a law in its home country or any other statutory authority in that country to assess, accredit or assure quality and standards of educational institutions, shall be eligible for admission to the Ph.D. programme. A relaxation of 5% marks or its equivalent grade may be allowed for those belonging to SC/ST/OBC (non-creamy layer)/Differently-Abled, Economically Weaker Section (EWS) and other categories of candidates as per the decision of the Commission from time to time

- 2.3 The Part Time research scholars have to report to the guide once in a month till they submit their Synopsis/Thesis.

### **3.0 Admission**

Admission for Ph.D. programme shall be made on half yearly basis viz. January and July. The admission shall be based on the criteria notified by the Institution, keeping in view the guidelines/norms issued by the UGC and other statutory bodies concerned and taking into account the reservation policy of the Central / State Government and the number of vacancies available with each recognized guide of the Department concerned.

### **4.0 Selection Procedure**

4.1 The candidates will be selected for admission to Ph.D., programme based on the performance in the **Entrance Test** and **Interview** conducted to assess the aptitude of the candidate for research, subject to satisfying the eligibility conditions.

The candidates who have qualify for fellowship/scholarship in UGC-NET//UGC-CSIRNET/GATE/CEED and similar National level tests based on an interview. And/or The candidates who have qualified from “Karpagam Academy of Higher Education entrance test” conducted at the level of our Institution. The Entrance Test syllabus shall consist of 50% of research methodology, and 50% shall be subject-specific.

Students who have secured 50% marks in the entrance test are eligible to be called for the interview. A relaxation of 5 % marks will be allowed in the entrance examination for the candidates belonging to SC/ST/OBC/differently-abled category, Economically Weaker Section (EWS), and other categories of candidates as per the decision of the Commission from time to time.

KAHE may decide the number of eligible students to be called for an interview based on the number of Ph.D. seats available.

4.2 The candidates selected for admission to the Ph.D., programme shall be required to submit attested copy of the certificates with 3 passport size recent Photo. The original certificates brought during interview will be returned immediately after verification.

4.3 Provided that for selection of candidates, a weightage of 70% to the entrance test and 30% to the performance in the interview shall be given.

4.4 The Karpagam Academy of Higher Education shall maintain the list of all the Ph.D., registered students on its website year-wise. The list shall include the name of the registered candidate, topic of his/her research, name of his/her supervisor / co-supervisor and date of enrolment /registration.

4.5 Admission of International students in Ph.D., programme is also based on Entrance test and Interview keeping in view the guidelines/norms in this regard issued by statutory/regulatory bodies concerned from time to time.

### **5.0 Eligible Degrees for Ph.D., Registration:**

Master's degree / M.Phil., Degree in the relevant disciplines or 4-Year Bachelor's Degree in the relevant disciplines, approved by Central and State approval authority.

## **6.0 Duration of the Programme**

Ph.D. Programme shall be for a minimum duration of three (3) years, including coursework, and a maximum duration of six (6) years from the date of admission to the Ph.D. programme.

A maximum of an additional two (2) years can be given through a process of re-registration as per the Statute/Ordinance of the Higher Educational Institution concerned; provided, however, that the total period for completion of a Ph.D. programme should not exceed eight (8) years from the date of admission in the Ph.D. programme.

Provided further that, female Ph.D. scholars and Persons with Disabilities (having more than 40% disability) may be allowed an additional relaxation of two (2) years; however, the total period for completion of a Ph.D. programme in such cases should not exceed ten (10) years from the date of admission in the Ph.D. programme.

Female Ph.D. Scholars may be provided Maternity Leave/Child Care Leave for up to 240 days in the entire duration of the Ph.D. programme.

Ph.D. programmes through part-time mode will be permitted, provided all the conditions stipulated in these Regulations are fulfilled.

The Higher Educational Institution concerned shall obtain a “No Objection Certificate” through the candidate for a part-time Ph.D. programme from the appropriate authority in the organization where the candidate is employed, clearly stating that:

- i. The candidate is permitted to pursue studies on a part-time basis.
- ii. His/her official duties permit him/her to devote sufficient time for research.
- iii. If required, he/she will be relieved from the duty to complete the course work.

## **7.0 Conversion from Full Time Ph.D. to Part Time Ph.D. and Vice-versa**

- i. Conversion from Full time to Part time or vice versa is permitted on recommendation of the Research Supervisor
- ii. A conversion fee of ₹2000 has to be paid towards the conversion.

## **8.0 Modification of Topic**

Modification of topic of research by the candidate is permitted. A fee of ₹ 2000 has to be paid for a change of topic of research. The time limit fixed for modification of topic of research in Ph.D., programme is up to final DCM prior to submission of synopsis.

## **9.0 Language**

The Ph.D., Part I course work and Part II synopsis / thesis must be written in English for subjects other than languages.

## **10.0 Eligibility criteria to be a Research Supervisor:**

Permanent faculty members working as Professor/Associate Professor with a Ph.D., and at least five research publications in peer-reviewed or refereed journals and permanent faculty members working as Assistant Professors with a Ph.D., and at least three research publications in peer-reviewed or refereed journals may be recognized as a Research Supervisor in the university where the faculty member is employed. Such recognized

research supervisors cannot supervise research scholars in other institutions, where they can only act as co-supervisors. Ph.D. awarded by a university under the supervision of a faculty member who is not an employee of the university would be in violation of these Regulations.

For Ph.D. scholars working in Central government/ State government research institutions whose degrees are given by Higher Educational Institutions, the scientists in such research institutions who are equivalent to Professor/Associate Professor/Assistant Professor can be recognized as supervisors if they fulfill the above requirements.

Provided that in areas/disciplines where there is no, or only a limited number of peer-reviewed or refereed journals, the Higher Educational Institution may relax the above condition for recognition of a person as Research Supervisor with reasons recorded in writing.

Adjunct Faculty members shall not act as Research Supervisors and can only act as co-supervisors.

However, Co-Supervisor can be allowed in inter-disciplinary areas from other departments of the same institute or from other institutions with the approval of the Doctoral Committee.

In case of interdisciplinary/multidisciplinary research work, if required, a Co-Supervisor from out \side the University may be appointed.

A Research Supervisor who is a Professor, at any given point of time, can guide a maximum of 8 Ph.D., scholars only. An Associate Professor upto a maximum of 6 Ph.D., scholars and an Assistant Professor upto a maximum of 4 Ph.D., scholars.

In case of relocation of a female Ph.D. scholar due to marriage or otherwise, the research data shall be allowed to be transferred to the Higher Educational Institution to which the scholar intends to relocate, provided all the other conditions in these Regulations are followed, and the research work does not pertain to a project sanctioned to the parent Institution/Supervisor by any funding agency. Such scholar shall, however, give due credit to the parent institution and the supervisor for the part of research already undertaken.

Faculty members with less than three years of service before superannuation shall not be allowed to take new research scholars under their supervision. However, such faculty members can continue to supervise Ph.D. Research scholars who are already registered until superannuation and as a co-supervisor after superannuation, but not after attaining the age of 70 years.

#### **11.0 Admission of International students in Ph.D., programme.**

Each supervisor can guide up to two international research scholars on a supernumerary basis over and above the permitted number of Ph.D. scholars as specified.

#### **12.0 Change of Research Supervisor**

Transfer of Ph.D., scholars from one Research supervisor to another Research supervisor shall be permitted under the following conditions:

- i. If the Research Supervisor resigns and leaves the institution.
- ii. If the Research Supervisor expresses unwillingness to guide the candidate
- iii. If the Research Scholar expresses his/her unwillingness to work under a specific Research Supervisor.

- iv. By mutual consent.
- v. A fee of ₹2000 has to be paid towards the change of Research Supervisor, if the change is requested by the Research scholar.

### 13.0 Doctoral Committee (Research Advisory Committee as per UGC)

There shall be a Doctoral Committee (Research Advisory Committee as per UGC) for every Ph.D., scholar to monitor the progress of his/her research work. The Research Supervisors in consultation with Head of the Department shall furnish a panel of minimum five experts with doctoral qualification in their respective research field, from the other Academic Institutions / National Laboratories and established research laboratories. From this list one will be nominated as a external expert for each Ph.D research scholar. The Research Supervisor of the research scholar shall be the convener of the Doctoral Committee. The Co- Supervisor, if applicable, shall also be a member. In the absence of Research Supervisor, the Co-Supervisor can be the convenor of the Doctoral Committee. **The Doctoral Committee Meeting shall be conducted in presence of Ph.D Research Supervisor and the nominated external expert.** If a Doctoral Committee member is away from his/her place of work for a longer period, the Research Supervisor shall request for an alternate member from the Panel of experts submitted.

### 13.1 Functions of Doctoral Committee (Research Advisory Committee as per UGC):

The Research Supervisor of the Ph.D. scholar concerned shall be the Convener of this committee, and this committee shall have the following responsibilities:

- i. To review the research proposal and finalize the topic of research.
- ii. To guide the Ph.D. scholar in developing the study design and methodology of research and identify the course(s) that he/she may have to do.
- iii. To periodically review and assist in the progress of the research work of the Ph.D. scholar.

Each semester, a Ph.D. scholar shall appear before the Doctoral Committee in the Karpagam Academy of Higher Education campus to make a presentation and submit a brief report on the progress of his/her work for evaluation and further guidance. The Doctoral Committee shall submit its recommendations along with a copy of Ph.D. scholar's progress report to The Registrar, Karpagam Academy of Higher Education. A copy of such recommendations shall also be provided to the Ph.D. scholar.

The first Doctoral Committee meeting of a scholar which shall be conducted within one month from the date of registration shall decide the topic of research, work plan and the course work to be undertaken by the scholar. The Doctoral Committee shall also submit a Panel of three Experts from recognized institutes (other than Parent Institution) along with their CV for question paper setting and evaluation relating to Part –I Examinations.

The scholar shall be permitted for pre-submission presentation after recommended by the Final Doctoral Committee Meeting. The synopsis to be submitted only after the successful completion of pre-submission presentation. The time gap between the date of pre-submission and the date of submission of synopsis shall be atleast one month.

**14.0 Submission of Progress Report:**

Progress report is to be submitted every half-year period during the entire duration of Ph.D., programme

**15.0 Course of Study:**

The course of study of Ph.D., programme consists of Part I Course work and Part II Research work.

**15.1 Part I: Course Work**

Course work comprises the following three theory papers.

Paper I : Research Methodology and Pedagogy

Paper II : Research and Publication Ethics

Paper III : Special Paper (Research Area)

15.2 The course work shall be treated as a prerequisite for Ph.D., preparation. The credit assigned to the Ph.D. course work shall be 12 credits.

Paper I on Research Methodology and Pedagogy a minimum of four credits shall be assigned which could cover areas such as quantitative methods, computer applications, research ethics and review of published research in the relevant field, training, field work, etc.

Paper II Research and Publication Ethics and Paper III Special Paper carry 4 credits each. The total number of special papers in each discipline shall be 10. The candidate has to select one among the 10, in consultation with the Research Supervisor.

The Credit requirement for the Ph.D. coursework is a minimum of 12 credits, including a "Research and Publication Ethics" course as notified by UGC vide D.O. No. F.1- 1/2018(Journal/CARE) in 2019 and a research methodology course. The Research Advisory Committee can also recommend UGC recognized online courses as part of the credit requirements for the Ph.D. programme.

Ph.D. scholars, irrespective of discipline, shall be trained in teaching / education / pedagogy / writing related to their chosen Ph.D. subject during their doctoral period. Ph.D. scholars will also be assigned 4-6 hours per week of teaching/research assistantship for conducting tutorial or laboratory work and evaluations.

The Full-Time scholar is required to write all the three courses within six months and for Part time the research scholar has to write within one year, from the date of registration, but has to pass all the courses within a maximum of one and half years (three attempts). If the scholar fails to complete course work within one and half years (three attempts) his/her registration will stand automatically cancelled.

15.3 A Ph.D., scholar has to obtain a minimum of 55% of marks or its equivalent grade in the UGC 10 point scale in the course work in order to be eligible to continue the programme and submit the dissertation/thesis.



The pattern of question paper for course work for Ph.D., programme is given below.

**Pattern of Question Paper** (Common for FASCM /FoE/FoP)(For Course Work in Ph.D, Programme)

**Part – A** (5 X 7 = 35 marks - Answer any FIVE out of Seven)

**Part – B** (5 X 10 = 50 marks - Answer any FIVE out of Ten)

**Part – C** (1 X 15 = 15 marks - Compulsory Question)

#### **15.4. Part II: Research Work**

Upon satisfactory completion of course work and obtaining the marks/grade prescribed, the Ph.D., scholar shall be required to undertake research work. The Ph.D., candidates shall select an original research topic within the chosen area of research specialization. At the end of the minimum period of duration the candidates are eligible to submit the thesis.

#### **16.0 Publication of Articles**

Before sending the articles for publication, the article/manuscript is to be submitted to Scrutiny Committee for language and technical scrutiny with a fee of ₹450 per article. After publication, the candidate has to submit the copy of his/her article to the members of the Doctoral Committee.

#### **16.1 Publication of a minimum of two articles is mandatory for submission of a thesis.**

16.2 Condition for submission of thesis:

It is Mandatory for the Ph.D., Scholars to publish two research articles for submission of his/her of Ph.D., thesis as mentioned below:

- (i) Engineering, Science and Pharmacy: One article should be in SCI / SCIE / Web of Science and another one in Scopus
- (ii) Commerce, Management, Arts: One in Scopus and another one in Peer reviewed / UGC care listed Journals
- (iii) To attend at-least two timeline presentations and two annual research congress

#### **17.0 Pre-Submission Presentation**

The Pre-submission will be permitted only when the research scholar has either published his/her article or it has been accepted for publication provided the date of publication of the article is given in the acceptance letter for publication in an approved Journal. All the published papers by the scholar shall have name of the Research Supervisor and Karpagam Academy of Higher Education. Papers without the name of the Research Supervisor and Karpagam Academy of Higher Education will not be accounted. The Research Scholar should be one among the first two authors in the paper.

Prior to submission of the synopsis, the scholar shall make Pre-submission presentation and it is open to all faculty members and research students, and their feedback and comments if any may suitably be incorporated in the draft synopsis and thesis in consultation with Doctoral Committee. A notification may be issued to all the Departments regarding the same. The report in the prescribed format shall be forwarded

by the Research Supervisor to the Research section on the same day along with the certificate of bonafide research work done.

**18.0. Plagiarism (Turnitin Software):**

18.1 The research scholar has to submit his/her synopsis and thesis for checking plagiarism on payment of prescribed fee. If the percentage of plagiarism is more than 10% the thesis will not be accepted for submission. Same is the case for manuscripts and synopsis.

18.2 Further while submitting for evaluation, the thesis shall have an undertaking from the research scholar and a certificate from the Research Supervisor attesting the originality of the work, vouching that the plagiarism is less than 10% and that the work has not been submitted for the award of any other degree/diploma of the same Institution where the work was carried out, or any other Institution.

18.3 In any case if scholars have committed an act of plagiarism with more than 10%, his/her Thesis / degree shall be withdrawn and his / her registration shall be cancelled and also, he / she shall be debarred to register for any other programme in the Karpagam Academy of Higher Education. Appropriate legal action shall also be initiated.

18.4 Research Supervisor ship of the Supervisor will also be withdrawn.

**19.0. Submission of synopsis**

The research scholar who has successfully completed the course work alone is eligible to submit the synopsis. He/she shall be permitted to submit the synopsis during the last quarter of the eligible minimum period on the recommendation of the Final Doctoral Committee Meeting and after Pre-submission Presentation. The research scholar shall submit five copies of synopsis with a soft copy along with prescribed application through the Research Supervisor to the Controller of Examinations. Synopsis shall be accepted only when the Panel of Examiners is submitted to Controller of Examinations. In case the panel is exhausted, the Vice Chancellor can either call for a fresh panel of examiners from the Research Supervisor or nominate examiner(s).

**19.1 Submission of thesis**

Five copies of thesis with flexible cover along with soft copy (PDF format) shall be prepared in accordance with the format and specifications prescribed. Thesis shall be submitted together with the prescribed application form along with the prescribed fee, within three months from the date of submission of the synopsis.

All the Ph.D., scholars are encouraged to submit their thesis within the stipulated time period. However, for those candidates who have submitted synopsis but unable to submit the thesis within the stipulated period, an extension of three months will be allowed on payment of ₹ 2000/- as extension fee. If the candidate fails to submit within the extension period of three months, he / she has to pay full year fee for all the years till he / she submits the thesis.

**20.0 Evaluation of the Thesis**

- 20.1 The Ph.D. thesis submitted by a Ph.D. scholar shall be evaluated by his/her Research Supervisor and atleast two external examiners who are experts in the field. Such examiner(s) should be academics with a good record of scholarly publications in the field. Wherever possible, one of the external examiners should be chosen from outside India. The viva-voce board shall consist of the Research Supervisor and at least one of the two external examiners and may be conducted offline.
- 20.2 The viva-voce of the Ph.D. scholar to defend the thesis shall be conducted if both the external examiners recommend acceptance of the thesis after incorporating any corrections suggested by them. If one of the external examiners recommends rejection, the Institution concerned shall send the thesis to an alternate external examiner from the approved panel of examiners, and the viva-voce examination shall be held only if the alternate examiner recommends acceptance of the thesis. If the alternate examiner does not recommend acceptance of the thesis, the thesis shall be rejected, and the Ph.D. scholar shall be declared ineligible for the award of a Ph.D.
- 20.3 Each member of the Board shall adjudicate the thesis and shall submit a detailed report as given in the prescribed form on the merits and demerits of the thesis and finally explicitly indicate whether the thesis is Recommended or Recommended for Resubmission or Not Recommended within a period of 6 months.
- 20.4 If the evaluation report from the examiner is not received within 6 Months, another examiner will be appointed from the panel of examiners.
- 20.5 As soon as the reports of evaluation are received from the examiners by Controller of Examinations, they shall be sent to the Research Supervisor (Convener) for consolidation of the reports.
- 20.6 If the examiners insist on corrections to be made in the thesis, the same shall be made before appearing for the Public viva-voce examination, along with a certificate as given below from the Research Supervisor that the corrections have been satisfactorily carried out.

A Ph.D. scholar shall submit the thesis for evaluation, along with (a) an undertaking from the Ph.D. scholar that there is no plagiarism and (b) a certificate from the Research Supervisor attesting to the originality of the thesis and that the thesis has not been submitted for the award of any other degree/diploma to any other Higher Educational Institution.

<p><b>CERTIFICATE</b></p> <p>This is to certify that all corrections, modifications suggested by the examiners of the thesis entitled, “.....”submitted by Mr./Ms ..... have been incorporated and resubmitted. The thesis may be accepted.</p> <p style="text-align: right;"><b>Signature of the Research Supervisor</b></p>
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- 20.7 In case of a thesis, which has not been specifically ‘recommended’ or ‘not recommended’ but revision and resubmission is suggested, the thesis shall be

revised and the thesis duly certified by the Research Supervisor be sent to the same examiner who has suggested the revision for obtaining the recommendation.

- 20.8 The time-limit to resubmit the revised thesis, as per the suggestions for revision and resubmission of thesis by the examiner(s) shall not exceed twelve full months. A candidate shall not ordinarily be permitted to submit the thesis for the degree or to take the public viva-voce examination on more than two occasions.
- 20.9 The viva-voce shall be conducted by the Research Supervisor and atleast by one of the two external examiners, on the critiques given in the evaluation report. It is open to DC Members, all faculty members, research scholars and other interested experts/researchers.
- 20.10 The first notification for Ph.D., viva-voce shall be issued only after the Research Supervisor of the candidate, receives the approval from the authorities to issue the first notice.
- 20.11 15 clear days' notice may be required to be given for issue of the second notification from the date of the first notification. Similarly, 15 clear days are required to be given for conducting the public viva-voce from the date of issue of the second notification.
- 20.12 The Research Supervisor shall fix the date and time of the viva-voce in consultation with the External Examiner and Head of the Department concerned. After conducting the public viva-voce, the Research Supervisor shall convey to the Controller of Examination, the result of such examination endorsed by the External Examiner along with list of participants, recommending for the award of Ph.D.,
- 20.13 A candidate who is not successful in the Public viva-voce may be permitted to undergo the Public viva-voce second time, within a period of three months but not before one month after the first viva-voce.
- 20.14 The entire process of evaluating a Ph. D. thesis, including the declaration of the viva-voce result, within a period of six (6)months from the date of submission of the thesis.

### **21.0 Award of the Degree**

A candidate who has successfully completed the public viva-voce shall be declared to have qualified for the award of Ph.D., degree of Karpagam Academy of Higher Education. Viva voce evaluation of the thesis shall be conducted offline. Prior to actual award of the degree, provisional certificate shall be issued after approval by the Board of Management.

Issuing a Provisional certificate:

Prior to the actual award of the Ph.D. degree, the degree- awarding Higher Educational Institution shall issue a provisional certificate to the effect that the Ph.D. is being awarded in accordance with the provisions of these Regulations.

Award of Ph.D. degrees:

Award of degrees to candidates registered for the Ph.D. programme on or after November,07, 2022 shall be governed by University Grants Commission (Minimum Standards and Procedures for Award of Ph.D. Degree) Regulations, 2022.

**Depository with INFLIBNET:**

Following the successful completion of the evaluation process and before the announcement of the award of the Ph.D. degree(s), the Karpagam Academy of Higher Education shall submit an electronic copy of the Ph.D. thesis to INFLIBNET, for hosting the same so as to make it accessible to all the Higher Educational Institutions and research institutions.

**22.0. Cancellation of Registration**

The registration of a research scholar shall stand cancelled if -

- The research scholar has not paid the prescribed fee within the stipulated time;
- The Full-Time candidate has not completed his course work within one and half years (three attempts) and Part-Time candidates within two years (three attempts)
- The progress report is not submitted consecutively or the progress reports are not satisfactory as decided by the Doctoral Committee;
- The maximum period stipulated for the programme exceeded; and
- The research scholar withdraws from the course voluntarily.

In all the above cases, the fees paid by the research scholar shall be forfeited. However, such candidates may be permitted for fresh registration.

**23.0 Publication of the thesis**

The candidate may publish his/her thesis on the recommendation of the Research Supervisor in the format as given below and after getting permission from the Karpagam Academy of Higher Education. At least ten copies of the published work should be given to the Karpagam Academy of Higher Education at free of cost Permission for publication of the thesis should be obtained within FIVE years of the award of the degree. All the publications arising out of the research work shall have the name of Karpagam Academy of Higher Education. Due credit shall be given to the Institution and Research Supervisor if any patent is filed out of the work undertaken during the period of research.

**[CERTIFICATE]**

This is to certify that the thesis entitled, “.....” submitted by Mr. / Ms. .... does not contain any objectionable material and is a record of original and independent research work done by him/her. Hence the thesis is fit for publication, if the candidate so desires.

**Signature of the Research Supervisor**

**24.0 Conferment of the Degree**

Candidates who qualify for the Ph.D., degree shall be awarded the degree in the discipline in which he/she has registered.

**25. Preparation and Submission of Synopsis and Thesis**

**25.1 Preparation of Synopsis**

Synopsis should outline the research problem, the methodology adopted and the summary of the findings. The synopsis should not exceed 10 pages from the first page to the last page including the List of Publications. The sequence in which the Synopsis should be arranged is as follows:

- i. Cover Page and Title page (as shown in the Annexure I) (Page No.17& Page No.18)
- ii. Text divided into suitable Headings (numbered consecutively)
- iii. References
- iv. List of Publications (those published / accepted for publication in Journals and papers presented in Conferences / Symposia)
- v. Standard A4 size (297mm x 210mm) paper shall be used for preparing the copies.

Top edge: 30 mm

Bottom edge: 30 mm

Left side: 35 mm

Right side : 25 mm

The Synopsis should be prepared on good quality white bond paper preferably not lower than 80 gsm. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 12. All page numbers (Arabic numbers) should be typed without punctuation on the upper right hand corner. Synopsis should be bound using flexible cover of thick white art paper. The cover should be printed in black letters and the text for printing should be identical to what has been prescribed for the title page. References, if any cited in the text of the Synopsis, should be listed at the end of the Synopsis under the heading "REFERENCES" as per the following format:

### References

#### I. References cited from published research papers should be in the following format:

##### a. Single author

Wattenberg, L.W.,2008.Chemoprevention of cancer. *Cancer Research.*, 45:1-8.

##### b. Two authors

Defendi, V. and B. Pearson, 2012. Quantitative estimation of succinic dehydrogenase activity in a single microscopic tissue section. *Journal, Histochemistry, Cytochemistry*, 3: 61-64.

##### c. More than two authors

Kristan K., M. Kotnik, M. Oblak and U.J. Urleb, 2009. New high throughput fluorimetric assay for discovering inhibitors of UDP-N-acetylmuramyl-l-alanine: d-glutamate (MurD)lLigase.*Biomol. Screen*, 14: 412-418.

#### II. References cited from a published book

Vuković-Gačić, B. and D.Simić, 2010. Identification of natural antimutagens with modulating effects on DNA repair, In: *Antimutagenesis and anti-carcinogenesis mechanisms III* (Eds. G.Bronzzeti, H. Hayatsu, S. De Flora, M.D. Waters and D.M. Shankel), Plenum Press, New York,269-277.

#### III. References cited from approved Thesis / Dissertation

Ratnakar, P., 2012. Biochemical studies of *Allium sativum* Linn. (Garlic). Ph.D.,Thesis, DelhiUniversity. P. 87.

## 25.2 Preparation of Thesis

**A. General**

In general, the Thesis shall be presented, in an organized and scholarly fashion, the original research work of the research scholar.

**B. Size of Thesis**

The size of the Thesis should not exceed 250 pages of typed matter reckoned from the first page of Chapter 1 to the last page of the Conclusion Chapter exclusive of tables, photographs, figures, references & appendices.

**C. Sequence of the Contents of the Thesis**

The sequence in which the Thesis material should be arranged is as follows:

- i. Cover Page and Title page (as shown in Annexure II Page 19& Page 20)
- ii. Bonafide Certificate (as shown in Annexure III Page 21)
- iii. Declaration and Certificate from the Research Supervisor and co-Research Supervisor (if any)(as shown in Annexure IV Page 22& V Page 23)
- iv. Acknowledgement
- v. Table of Contents
- vi. List of Symbols and Abbreviations.
- vii. Abstract
- viii. Chapters
- ix. References
- x. Appendices
- xi. List of Publications- only title of the paper with ISSN and other details.

**D. Page Dimensions and Margin**

The dimensions of the final bound Thesis report (5 copies) should be 290 mm x 205mm. Page margins: Tables and Figures should conform to the margin specifications. Large sized figures may be as it is or otherwise reduced to the appropriate size before insertion.

**E. Bonafide Certificate**

The Bonafide Certificate shall be typed in **double line spacing** using Font Style Times New Roman and Font Size 12 as per the format shown in Annexure III. The certificate shall carry the Supervisor's signature and shall be followed by the Supervisor's name, academic designation, department and full address of the institution where the Research Supervisor has guided the research scholar.

**F. Acknowledgement**

It should be brief and should not exceed two pages when typed in double spacing. The scholar's signature shall be made at the bottom right end above his / her name typed in capitals.

**G. Table of Contents**

The Table of contents should list all captions from items v to xi following it. The title page, Bonafide Certificate and Declaration Certificate will not find a place among the items listed in the Table of Contents but the page numbers must be typed in lower case Roman letters in all the pages (excepting No. i on the Title page). One and a half spacing should be adopted for typing the matter under Table of Contents.

## **H. List of Symbols and Abbreviations**

One and a half spacing should be adopted for typing the matter under this head. Standard symbols, abbreviations, etc. should be used. The list should be arranged alphabetically with respect to the contents on the right side.

## **I. Abstract**

Abstract should be an essay type of narration not exceeding four pages outlining the research problem, methodology used for solving it and a summary of the findings. This shall be typed in double line spacing using Font Style Times New Roman and Font Size 12.

## **J. Chapters**

The chapters may be broadly divided into Introduction, Review of Literature, Material and Methods, Results, Discussion, Summary and References.

- a. Each chapter should be given an appropriate title.
- b. Tables and Figures in a chapter should be placed in the immediate vicinity of the reference where they are cited.
- c. Footnotes should be used sparingly. They should be typed single space and placed directly underneath in the very same page which refers to the material they annotate.

## **K. List of References**

The listing of references cited in the text should be typed in single line spacing starting from 4 lines spaces below the heading "REFERENCES". The reference material should be listed in the alphabetical order of the first author of each reference. The name of the author / authors should be immediately followed by the other details and year. The cited references in the Text should be listed "REFERENCES" as per the specified format:

## **L. Appendices**

Appendices are provided to give supplementary information's relevant to the research work done by the candidate.

## **M. List of Publications**

Reprints / Photostat copies of research papers already published / accepted for publication in Journals are to be attached in chronological orders and these pages need not be numbered. The heading "List of Publications" alone must find a place in the Table of Contents without page numbers for this item only.

## **N. Tables and Figures**

"Table" means tabulated numerical data in the body of the Thesis as well as in the appendices. All other non-verbal material used in the body of the Thesis and appendices such as charts, graphs, maps, photographs and diagrams may be designated as Figures.

- a. A Table or Figure including caption should be accommodated within the prescribed margin limits and appear on the page following the page where their first reference is made.
- b. Tables and Figures on half page or less in length may appear on the same page along with the text. However, they should be separated from the text both above and below by triple spacing.



- c. All Tables and Figures should be prepared on the same paper or material used for the preparation of the rest of the Thesis.
- d. Two or more small Tables or Figures may be grouped, if necessary, in a single page.
- e. Wherever possible, the photograph(s) shall be reproduced on a full sheet of photographic paper or colour xerox.
- f. More than one photograph can be included in a page.
- g. Samples of Fabric, Leather, etc., if absolutely necessary may be attached evenly in a page and fixed/pasted suitably and should be treated as Figures.

## **O. Typing Instructions**

### **General**

This section includes additional information for final typing of the Thesis. The impressions on the typed / photo-stated / printed copies should be black in colour.

A sub-heading at the bottom of a page must have at least two full lines below it or else it should be carried over to the next page.

The last word of any page should not be split using a hyphen. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 12. Single spacing should be used for typing:

- (i) Long Tables
- (ii) Long quotations
- (iii) Foot notes
- (iv) Multiline captions
- (v) References

All quotations exceeding one line should be typed in an indented space – the indentation being 15 mm from either side of the margin.

## **P. Page Numbering**

All page numbers (small case Roman numerals or Arabic numbers) should be typed without punctuation on the **upper right hand corner** 20 mm from the top with the last digit of the number in line with the right hand margin. The preliminary pages of the Thesis (such as Title page, Bonafide Certificate, Declaration and Certificate, Table of Contents, Acknowledgement, List of Symbols and Abbreviations and Abstracts) should be numbered in lower case Roman numerals. The Title page will be numbered as (i) but this should not be typed on the page. The page immediately following the Title page shall be numbered as (ii) and it should appear **at the top right hand corner** as already specified. Pages of main text, starting with Chapter 1 should be consecutively numbered using Arabic numerals.

## **Q. Numbering of Chapters, Divisions and Sub-Divisions**

The numbering of chapters, divisions and sub-divisions should be done using Arabic numerals only and further decimal notation should be used for numbering the divisions and sub-divisions within a chapter. For example, sub-division 4 under division 3 belonging to chapter 2 should be numbered as 2.3.4. The caption for the sub-division should immediately follow the number assigned to it.

Every chapter beginning with the first chapter should be serially numbered using Arabic numerals. Appendices, included if any, should also be numbered in an identical manner starting with Appendix 1.

**R. Numbering of Tables and Figures**

Tables and Figures appearing anywhere in the Thesis should bear appropriate numbers. The rule for assigning such numbers is illustrated by an example. Thus, if a Figure in Chapter 3, happens to be the fourth then assign 3.4 to that Figure. Identical rules apply for Tables except that the word Figure is replaced by the word Table. If Figures (or Tables) appear in appendices, then Figure 3 in Appendix 2 will be designated as Figure A 2.3. If a table is to be continued into the next page this may be done, but no line should be drawn underneath an unfinished Table. The top line of the Table continued into the next page should, for example read Table 2.1 (continued) placed centrally and underlined.

**S. Numbering of Equations**

Equations appearing in each Chapter or Appendix should be numbered serially, the numbering should commence afresh for each Chapter or Appendix. Thus, for example, an equation appearing in Chapter 3, if it happens to be the eighth equation in that Chapter should be numbered as (3.8) thus (3.8) While referring to this equation in the body of the Thesis it should be referred to as Equation (3.8).

**T. Binding Specifications**

Thesis should be bound with **black calico cloth** and using flexible cover of thick white art paper. The cover should be printed in black letters and the text for printing should be identical to what has been prescribed for the title page.

Soft copy of the Thesis (PDF format) written in CD (2 Nos.) should be submitted for Karpagam Academy of Higher Education archives.

**Revision of Regulation:**

The Karpagam Academy of Higher Education may from time to time, amend the Regulations based on UGC Regulations if found necessary.

**ANNEXURE I**

**Specimen of Cover Page and Title Page**

<Font Style Times New Roman>

**ANTIOXIDANT ACTIVITY OF INDIAN MEDICINAL PLANTS FROM WESTERN GHATS**

Font Size 18><1.5 line spacing>

**SYNOPSIS**

<Font Size 14>

***Submitted by***

<Font Size 14><Italic>

**RAGHAVENDRA S A**

<Font Size 16>

***in partial fulfilment of the requirements for the award of the degree of***

<Font Size 14><Italic><1.5 line spacing>

**DOCTOR OF PHILOSOPHY**

<Font Size 16>

IN

**BIOTECHNOLOGY**

<Font Size 14>



**DEPARTMENT OF BIOTECHNOLOGY**

**Karpagam Academy of Higher Education**

(Deemed to be University) (Established Under Section 3 of UGC Act, 1956)

(Accredited with A+ Grade by NAAC in the Second Cycle)

Pollachi Main Road, Eachanari Post, Coimbatore – 641 021, Tamil Nadu, India

<Font Size 16><1.5 line spacing>

**December, 2022**

<Font Size 14>

**ANTIOXIDANT ACTIVITY OF INDIAN MEDICINAL PLANTS FROM  
WESTERN GHATS**

**SYNOPSIS**

*Submitted by*

**RAGHAVENDRA S A**

*in partial fulfilment of the requirements for the*

*award of the degree of*

**DOCTOR OF PHILOSOPHY  
IN  
BIOTECHNOLOGY**



**DEPARTMENT OF BIOTECHNOLOGY**

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Pollachi Main Road, Eachanari Post, Coimbatore – 641 021, Tamil Nadu, India

**December, 2022**

**ANNEXURE II**

**Specimen of Cover Page and Title Page**

<Font Style Times New Roman>

**ANTIOXIDANT ACTIVITY OF INDIAN MEDICINAL PLANTS FROM WESTERN  
GHATS**

<Font Size 18><1.5 line spacing>

**THESIS**

<Font Size 14>

***Submitted by***

<Font Size 14><Italic>

**RAGHAVENDRA S A**

<Font Size 16>

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<Font Size 16>

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<Font Size 16><1.5 line spacing>

**December, 2022**

<Font Size 14>

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**RAGHAVENDRA S A**

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Pollachi Main Road, Eachanari Post, Coimbatore – 641 021, Tamil Nadu, India

**December, 2022**

**ANNEXURE III**

**Specimen of Bonafide Certificate**

<Font Style Times New Roman>

**KARPAGAM ACADEMY OF HIGHER EDUCATION  
COIMBATORE-21**

<Font Size 16>

**BONAFIDE CERTIFICATE**

<Font Size 14>

<Font Size 12>

Certified that this Thesis entitled  
“ \_\_\_\_\_ ” is the bonafide  
work of Mr./Ms. \_\_\_\_\_ who carried out the  
research under my supervision. Certified further, that to the best of my knowledge the work  
reported herein does not form part of any other thesis or dissertation on the basis of which a  
degree or award was conferred on an earlier occasion in this or any other scholar.

<<Signature of the Co Supervisor>>  
<<Name>>  
CO SUPERVISOR  
<<Designation & Address >>  
(If applicable)

<<Signature of the Supervisor>>  
<<Name>>  
SUPERVISOR  
<<Designation & Address >>

**ANNEXURE IV**

**Specimen of Declaration**

<Font Style Times New Roman>

**DECLARATION**

<Font Size 16>

<Font Size 12>

I \_\_\_\_\_ hereby declare that the thesis entitled  
“ \_\_\_\_\_ ”  
submitted to the Karpagam Academy of Higher Education, in partial fulfillment of the  
requirements for the award of the Degree of Doctor of Philosophy in  
\_\_\_\_\_ is a record of bonafide and  
independent research work done by me during the period from \_\_\_\_/\_\_\_\_/\_\_\_\_ to \_\_\_\_-  
\_\_\_\_/\_\_\_\_/\_\_\_\_ under the supervision and guidance of  
Dr. \_\_\_\_\_, Department of  
\_\_\_\_\_ at Karpagam Academy of Higher Education, and it has not  
formed the basis for the award of any Degree / Diploma / Associate ship / Fellowship or other  
similar title to any candidate in Karpagam Academy of Higher Education so far.

**Signature of the Research Scholar**



**ANNEXURE V**

**Specimen of Certificate**

<Font Style Times New Roman>

**CERTIFICATE**

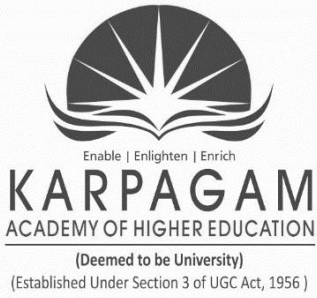
<Font Size 16>

<Font Size 12>

This is to certify that the thesis entitled “\_\_\_\_\_” submitted to the Karpagam Academy of Higher Education, in partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy in \_\_\_\_\_ is a record of bonafide research work done by Mr. / Ms. \_\_\_\_\_ during the period from \_\_\_\_/\_\_\_\_/\_\_\_\_ to \_\_\_\_/\_\_\_\_/\_\_\_\_ of his / her study in the Department of \_\_\_\_\_ at Karpagam Academy of Higher Education, under my supervision and guidance and the thesis has not formed the basis for the award of any Degree / Diploma / Associate ship / Fellowship or other similar title to any candidate of Karpagam Academy of Higher Education so far.

**Countersigned  
Head of the Department**

**Signature of the Research Supervisor**



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Phone: 0422 - 2980011- 14 | Email : info@kahedu.edu.in

*This is a Format only (Neatly typed, aligned and duly signed form to be submitted)*

## FORMAT I

### Progress Report of Research Scholar

(To be submitted once in six months)

1. Programme : Ph.D., FT/PT
2. Subject :
3. Name & Regn.No. of the Research scholar:
4. Title of Ph.D., Research work :
5. Report No./Month/Year :

No.	Month	Year

6. Brief report about the work carried

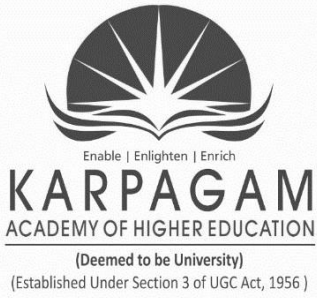
out by the Research scholar :

- a. Article/s published \_\_\_\_\_ No's (Attach copies)
- b. Seminars/Conferences attended \_\_\_\_\_ (Attach certificate copies)
- c. Course work: Completed / Not Completed (Attach copy of Mark sheet)
- d. Course fee: Paid till \_\_\_\_\_(copies of receipts)

7. Research Guide's Comment :

Signature of the Research Scholar  
(with Name & address)  
Mobile No.:  
E-mail id:

Signature of the Research Supervisor  
(with Name & address)  
Mobile No.:  
E-mail id:



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## FORMAT II

### Request for Pre-submission presentation

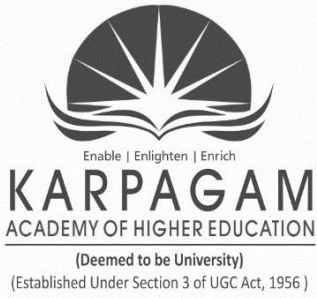
#### Check list

1. Name of the research scholar with Registration Number :
2. Name of the Research Supervisor :  
Designation :  
Department :
3. (a) Whether the minimum period completed? : Yes/No (Refer Registration Communication)  
(b) If extension obtained, attach particulars :
4. Whether course fee paid for all the years : Yes/No (Attach No Dues Certificate)
5. Title of Ph.D. Research work :
6. Details of the Part I Course work :  
(Enclose necessary documents)
7. Number of DC Meetings attended (Annually 2) :
8. Total No. of 6 months performance reports submitted : 6/8/10/12
9. (a) No. of Time-line presentations attended :  
(b) No. of Annual Research Congress attended :
10. (a) Minimum No. of Research articles to be published : 2 as per KAHE regulation  
(b) No of articles published by the scholar :  
(Attach photocopies of reprints)
11. Whether submission of thesis is recommended  
at the Final Doctoral Committee Meeting and  
date of DCM :
12. Communication skill\* : Good/Satisfactory/Need improvement  
(To be judged based on the DC Meeting,  
Time line Presentation and  
Annual Research Congress) (Tick whichever is applicable)

**Signature of the Research Scholar  
Supervisor**

**Signature of the Research**

\*The Guide/HOD shall give specific remarks about the communication skill of the scholar. At the time of Pre-submission Presentation, if it is found that the Communication skill of the scholar is less than average, the period of submission may be extended for one more year and the scholar shall be advised to improve his/her Communication skill and may be presented again.



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## FORMAT III

KAHE / RS / Rx /Ph.D./Dept./ Pre-Sub / xxxx / 2022/

Date: \_\_\_\_\_

### Pre-Submission presentation of the Ph.D. research - Notification

I am by direction to inform you that a Pre-submission Presentation of the Ph.D., thesis is arranged for the candidate \_\_\_\_\_ working under the supervision of \_\_\_\_\_, Designation, Department of \_\_\_\_\_, Karpagam Academy of Higher Education, Coimbatore – 641 021.

**Ph.D. Thesis Title:** “ \_\_\_\_\_ ”.

All members of faculty, experts and all interested persons are requested to attend the aforesaid Pre-submission Presentation.

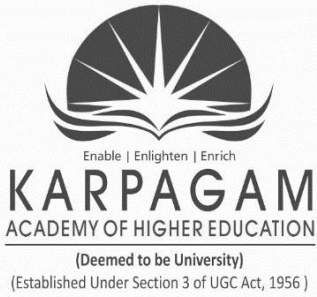
Venue :  
Date :  
Time :

**Registrar**

**To**

All Head of the Department of \_\_\_\_\_, requested to make necessary arrangement to conduct the programme.

Kindly circulate to Dean / Director / Research Supervisor / Research Scholars



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**FORMAT - IV**

DEPARTMENT OF \_\_\_\_\_  
**Pre-submission Presentation Report**

- |   |   |
|---|---|
|   | Date:   |
| 1. Name of the Research Scholar   | :   |
| 2. Register Number of the Research Scholar  | :   |
| 3. Ph.D., programme in  | :   |
| 4. Department   | :   |
| 5. Name of the Research Supervisor  | :   |
| Designation   | :   |
| Department  | :   |
| 6. Presentation date & Venue  | :   |
| 7. No. of articles published by the scholar   | :   |
| 8. Number of members present in<br>the presentation (enclose the<br>attendance sheet)                     | :   |
| 9. A report on the Question & Answer Session<br>(in the enclosed format)                                  | :   |
| 10. Comments of the Supervisor  | :   |
| (a) On the composition of the Thesis chapters   | : Adequate/Needs to be revised.   |
| (b) On the Communication skill*<br>(additional sheets may be used)  | : Good/Satisfactory/Needs improvement<br>(Tick whichever is applicable)       |
| 11. After the Pre-submission<br>Presentation whether the scholar<br>may be permitted to submit the Thesis | : Permitted/Extended for one year<br>(Strike out whichever is not applicable) |

**Signature:**

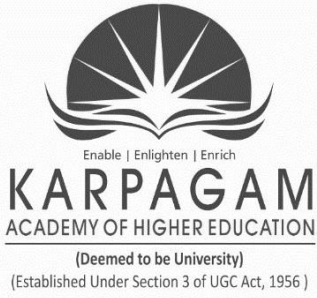
**Research Scholar**

**Research Supervisor**

**HOD**

**Dean**

\*(At the time of Pre-submission Presentation, if it is found that the Communication skill of the scholar is less than average and needs improvement, the period of submission may be extended for one more year and the scholar shall be advised to improve his/her Communication skill and may be presented again.)



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**FORMAT – IV Annexure**

**Pre-submission Presentation: A brief report on the Question & Answer Session**

Answers should be brief and relevant to the question. If needed, additional sheets may be used

**Topic of the Research work:**

**Q1.**

**Answer:**

**Q2.**

**Answer:**

**Q3.**

**Answer:**

**Q4.**

**Answer:**

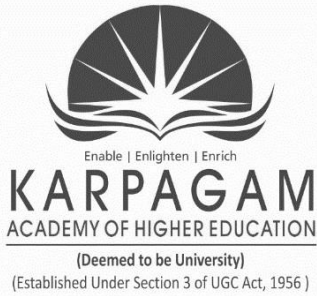
**Q5:**

**Answer:**

**Signature of**

**Research Scholar**

**Research Supervisor**



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**FORMAT V**

## **Pre-submission presentation**

### **Certificate**

**Name & Reg. No. of the research scholar :**

**Subject :**

**Date of Presentation :**

Certified that the above research scholar under my guidance has presented his/her research work during Pre-submission Presentation and his/her presentation is \_\_\_\_\_ . All the suggestions made by the participants are taken into consideration and important suggestions will be included in the thesis entitled:

“ \_\_\_\_\_ ”.

**Place :**

**Date :**

**Signature of the Research Supervisor  
(Name & Address)**

**Counter Signed:**

**HOD  
(Name & Seal)**



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*This is a Format only (Neatly typed, aligned and duly signed form to be submitted)*

**FORMAT - VI**

## Submission of Ph.D., Thesis: Check List

1. Name of the research scholar with Registration Number :
2. Name of the Research Supervisor :  
Designation :  
Department :
3. (a) Whether the minimum period completed? : Yes/No (Refer Registration Communication)
4. (b) If extension obtained, attach particulars :
5. Whether course fee paid for all the years : Yes/No (Attach No Dues Certificate)
6. Title of Ph.D. Research work :
7. Details of the Part I Course work :
8. (Enclose necessary documents)
9. Number of DC Meetings attended (Annually 2) :
10. Total No. of 6 months performance reports submitted : 6/8/10/12  
(a) No. of Time-line presentations attended :  
(b) No. of Annual Research Congress attended :
11. (a) Minimum No. of Research articles to be published : 2 as per KAHE regulation  
(b) No of articles published by the scholar :
12. Whether submission of thesis is recommended at the Final Doctoral Committee Meeting and date of DCM :
13. Date of Pre-Submission Presentation made :  
(Attach a certificate from the supervisor duly countersigned by the HOD)
14. Probable date of submission of Synopsis :
15. Expected date of submission of Thesis :

**Signature of:**

**Research Scholar**

**Research Supervisor**

**HOD**

**For Office of the Research use:**

1	2	3	4	5	6	7	8	9	10	11	12	13	14
---	---	---	---	---	---	---	---	---	----	----	----	----	----

Recommendation for submission: **Recommended / Not recommended**

**Addl. Director, Research**

**Director, Research**





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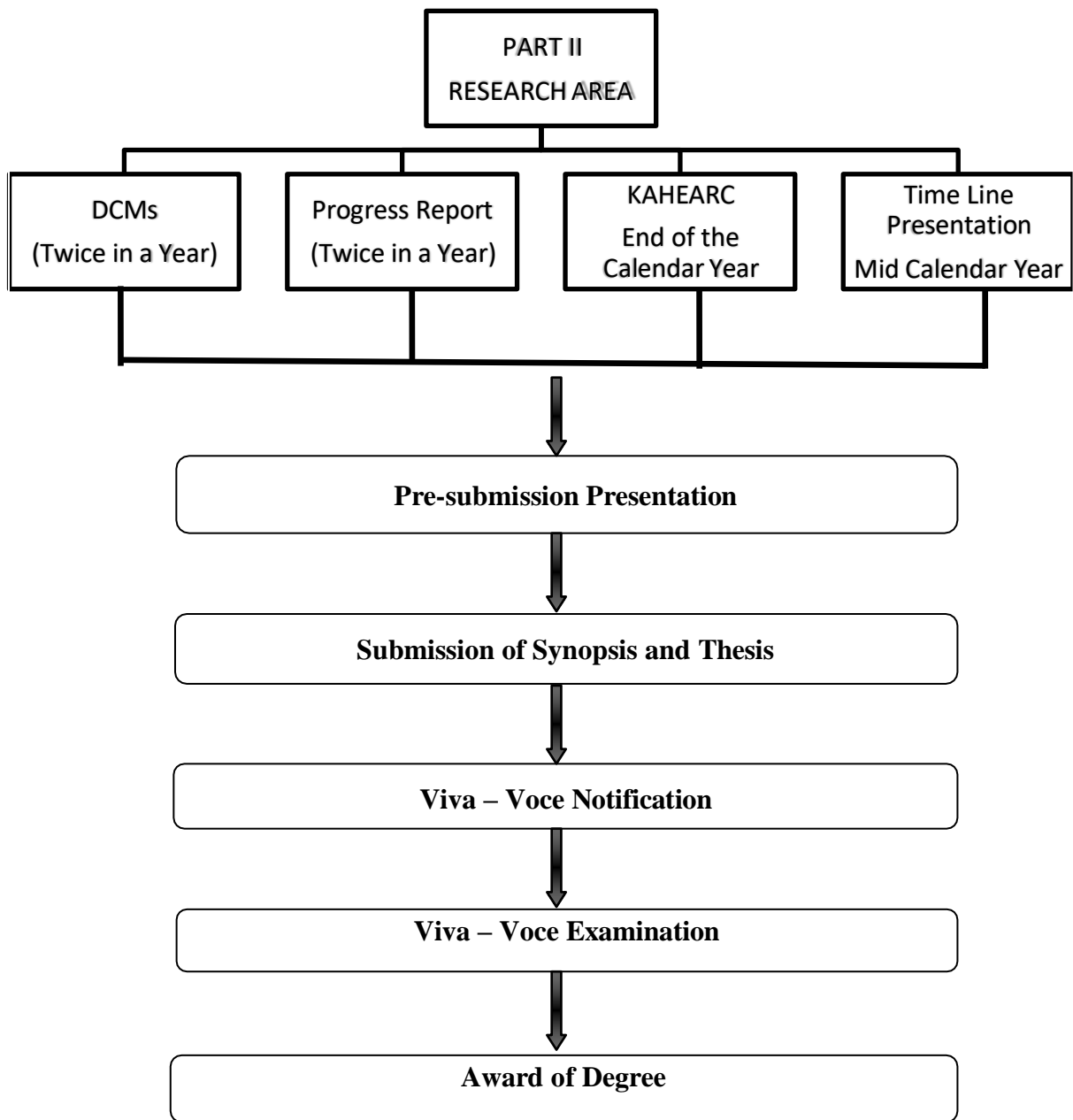
## Certificate of Plagiarism

Certified that the thesis entitled “\_\_\_\_\_” for  
the award of Ph.D., degree has undergone Plagiarism check through Turnitin software and the  
level of plagiarism is \_\_\_\_\_.

Signature of the Research Scholar

Signature of the Research Supervisor

Professor in- charge for Plagiarism Test



## Publications terminology

### 1. Impact Factor

The Impact Factor of an academic journal is a measure which reflects the average number of citations to recent articles published in that Journal.

- It is a measure of the relative importance of a journal in a given field.
- It was devised by **Mr. Eugene Garfield**, the founder of the **Institute for Scientific Information**.
- Impact factor is calculated yearly starting from 1975 for those journals which are indexed in the **Journal Citation Reports**.
- Normally, the impact factor for 2021 is published in 2022.
- It is a journal metric and not to be used to assess an individual researcher or research institution.

### Calculation

Example: If a Journal has an impact factor of 3 in the year 2022; it means that each paper published in that journal during the years 2020 and 2021 had received an average of 3 citations in 2022.

Let A= The number of times that articles published in that journal in and 2021, were cited by articles in indexed journals during 2022.

B= The total number of “citable items” (usually, articles, reviews and proceedings) published in that journal in 2020 and 2021.

Then, Impact factor (in 2022) =  $\frac{A}{B}$

### 2. HIndex

The h-index is an index that attempts to measure both the productivity and impact of the published work of a scientist or scholar. The index is based on the set of the scientist's most cited papers and the number of citations that they have received in other publications. The index can also be applied to the productivity and impact of a group of scientists, such as a department or university or country, as well as a scholarly journal. The index was suggested by Jorge E. Hirsch, a physicist at UCSD (University of California, San Diego), as a tool for determining theoretical physicists' relative quality and is sometimes called the Hirsch index or Hirsch number. The h-index serves as an alternative to more traditional journal impact factor metrics in the evaluation of the impact of the work of a particular researcher.

### 3. Scopus

**Scopus**, officially named **SciVerse Scopus**, is a bibliographic database containing abstracts and citations for academic journal articles. It covers nearly 20,500 titles from over 5,000 international publishers, of which 19,500 are peer-reviewed journals in the scientific, technical, medical, and social sciences (including arts and humanities). It is owned by **Elsevier** and is available online by subscription. Since Elsevier is the owner of Scopus, and is also one of the main international publishers of scientific journals, Elsevier established the independent and international Scopus Content Selection and Advisory Board to prevent a potential conflict of interest in the choice of the periodicals to be included in the database and to maintain an open and transparent content coverage policy. The board consists of scientists and subject librarians from all scientific disciplines and geographical areas, whose interest is to access any relevant information regardless of the publishers.

**SciVerse**

**SciVerse** is a platform for accessing scientific information from certain databases and the web. It is published by **Elsevier**. It provides access to 2,500 journals and 11,000 books with about 500 thousand additions each year.

"**SciVerse**" globally indexes articles, books, theses, abstracts, patents and sifts through web results, from publishers, universities and professional organizations.

**4. International Standard Serial Number**

An **International Standard Serial Number (ISSN)** is a unique eight-digit number used to identify a print or electronic periodical publication. Periodicals published in both print and electronic form may have two ISSNs, a **print ISSN (p-ISSN)** and an **electronic ISSN (e-ISSN or eISSN)**. The ISSN system was first drafted as an ISO international standard in 1971 and published as ISO 3297 in 1975. The ISO subcommittee is responsible for the standard.

**Code format**

The format of the ISSN is an eight-digit number, divided by a hyphen into two four-digit numbers. The last digit, which may be 0–9 or an X, is a check digit. The ISSN of the journal *Hearing Research*, for example, is 0378-5955, the check digit is 5.

**Code assignment**

ISSN codes are assigned by a network of ISSN National Centres, usually located at national libraries and coordinated by the ISSN International Centre based in Paris. The International Centre is an intergovernmental organization created in 1974 through an agreement between UNESCO and the French government. The International Centre maintains a database of all ISSNs assigned worldwide, the ISSN Register.

**Availability**

The ISSN Register is not freely available for interrogation on the web but is available by subscription. There are several routes to the identification and verification of ISSN codes for the general public.

- the print version of a periodical typically will include the ISSN code as part of the publication information
- most periodical websites contain ISSN code information
- derivative lists of publications will often contain ISSN codes; these can be found through on-line searches with the ISSN code itself or periodical title.

**5. Peer Review**

**Peer review** is the evaluation of work by one or more people of similar competence to the producers of the work (peers). It constitutes a form of self-regulation by qualified members of a profession within the relevant field. Peer review methods are employed to maintain standards of quality, improve performance, and provide credibility. In academia peer review is often used to determine an academic paper's suitability for publication.

**Professional peer review**

Professional peer review focuses on the performance of professionals, with a view of improving quality, upholding standards, or providing certification. Professional peer review activity is widespread in the field of health care, where it is best termed as **Clinical peer review**.

## Scholarly peer review

Scholarly peer review (also known as **refereeing**) is the process of subjecting an author's scholarly work, research, or ideas to the scrutiny of others who are experts in the same field, before a paper describing this work is published in a journal. The work may be accepted, considered acceptable with revisions, or rejected. Peer review requires a community of experts in a given (and often narrowly defined) field, who are qualified and able to perform impartial review

### 6. Web of Science

Single research destination to explore the citation universe across subjects and around the world. Web of Science provides access to the most reliable, integrated, multidisciplinary research connected through linked content citation metrics from multiple sources within a single interface. Since Web of Science adheres to a strict evaluation process, one can be assured only the most influential, relevant, and credible information is included - allowing to uncover next big idea faster.

### 7. Science Citation Index

- The Science Citation Index (SCI) is a citation index originally produced by the Institute for Scientific Information (ISI) and created by Eugene Garfield and was officially launched in 1964. The larger version (Science Citation Index Expanded) covers more than 8,500 notable and significant journals, across 150 disciplines, from 1900 to the present. These are alternatively described as the world's leading journals of Science and Technology, because of a rigorous selection process.
- The index is made available online through different platforms, such as the Web of Science and SciSearch.

### 8. International Standard Book Number

The **International Standard Book Number (ISBN)** is a unique numeric commercial book identifier based upon the 9-digit **Standard Book Numbering (SBN)** code created by Gordon Foster, Emeritus Professor of Statistics at Trinity College, Dublin, for the booksellers and stationers. The 10-digit ISBN format was developed by the International Organization for Standardization (ISO) and was published in 1970 as International Standard ISO. ISO has appointed the International ISBN Agency as the registration authority for ISBN worldwide and the ISBN Standard is developed under the control of ISO Technical Committee.

#### ISBN issuance

International Standard Book Numbers issuance is country-specific, in that ISBNs are issued by the ISBN Registration Agency that is responsible for that country or territory. The ranges of ISBNs assigned to any particular country are based on the publishing profile of the country concerned.

**DEPARTMENT OF CIVIL ENGINEERING**  
**FACULTY OF ENGINEERING**  
**RESEARCH PROGRAM – Ph.D in Civil Engineering**  
**2024-2025 Batch and onwards**

<b>Subject Code</b>	<b>Paper I</b>	<b>Instructi on Hours / week</b>	<b>Credits</b>	<b>Maximum Marks (100)</b>			
24RCE101	Paper- I: Research Methodology and Pedagogy	4	4	100			
24RCE201	Paper- II: Research Publication Ethics	4	4	100			
24RCE301	Paper- III: Advanced Environmental Engineering						
24RCE302	Paper- III: Slope Stability And Land Slides						
24RCE303	Paper- III: Structural Dynamics and Earthquake Engineering						
24RCE304	Paper- III: Theoretical Soil Mechanics						
24RCE305	Paper- III: Soil Dynamics And Machine Foundations						
24RCE306	Paper- III: Soil Structure Interaction						
24RCE307	Paper- III: Rock Mechanics In Engineering Practice						
24RCE308	Paper- III: Reinforced Soil Structures						
24RCE309	Paper- III: Earthquake Analysis And Design of Structures						
24RCE310	Paper- III: Experimental Stress Analysis						
24RCE311	Paper- III: Repair and Rehabilitation of Irrigation Structures						
24RCE312	Paper- III: Advanced Concrete Technology						
24RCE313	Paper- III: Prefabricated Structures				4	4	100
24RCE314	Paper- III: High Performance Concrete						
24RCE315	Paper- III: Ground Improvement Techniques						
24RCE316	Paper- III: Geopolymer Cement and Concrete						
24RCE317	Paper- III: Pavement Engineering						
24RCE318	Paper- III: Sustainable Solid Waste collection and Management						
24RCE319	Paper- III: Remote Sensing / Spatial Information Technology						
24RCE320	Paper- III: Groundwater modeling and Management						
24RCE321	Paper- III: Advanced Treatment Techniques for industrial Wastewater						
24RCE322	Paper- III: Environmental Policies and Legislations						
24RCE323	Paper- III: Construction Project Management						
24RCE324	Paper- III: Traffic Engineering and Management						
<b>Program Total</b>		<b>12</b>	<b>12</b>	<b>300</b>			

24RCE101

Research Methodology and Pedagogy

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVES**

1. To impart knowledge in the concept of problem identification and research methodology
2. To familiarize with basic of research and the research process
3. To demonstrate the different types of research and its applicability
4. To comprehend the knowledge of social research
5. To exhibit in sampling design and sampling techniques
6. To enrich the knowledge in writing a good research report.

**COURSE OUTCOMES**

1. Read, interpret, and critically evaluate social research.
2. Identify, explain, and apply the basic concepts of research, such as variables, operationalization, sampling, reliability, and validity.
3. Recognize the ethical issues involved in research, and practice ethical research standards.
4. Identify and explain the difference between quantitative, qualitative, and mixed methods research and what types of research questions can be answered with each method.
5. Use theory and previous research to create research questions and hypotheses and to identify and analyze the appropriate method and variables needed for research questions.
6. Use a variety of research methods through hands-on experience.

**UNIT I - HIGHER EDUCATION AN INTRODUCTION**

Historical perspectives, the objectives of higher education, role of higher education-social focus, curricular focus, administrative focus, drivers of change in higher education-globalization, changing demographics, structuring of employment, technological change, demand of accountability, consumerism,. Expectations by employers, rate of knowledge growth, campus demographics, concern for community. Restructuring and new patterns of decision making.

**UNIT II - RESEARCH PROCESSES AND METHODOLOGY**

Introduction to Research – Research strategies – Ethics – Code of conduct for Research – Health and Safety – IPR – Research Events – Networks – Outreach Activities – Best Research practices – Quality assurance for Research – Career Management for Researchers – Research seminars – Journal critiques -.

**UNIT III - EFFECTIVE RESEARCH SKILLS**

Data collection – Modeling – Simulation – Analysis – Prototyping – Presentation Skills – Data Presentation Skills – Research Writing skills (For Articles, Reports, Journals and Thesis) – Creative Skills – Effective Interview Skills – Team Building Skills – Communication and Interpersonal Skills – knowledge Transfer skills – Vivo voce – Teaching and Information Skills – Effective use of Library – Survey Skills – Planning and Control Methods – Statistical Tools – Patents and Copyrights – Advanced Research Techniques and Tools.

**UNIT IV - TECHNIQUES OF TEACHING AND EVALUATION**

Large group techniques – lecture, seminar, symposium, panel discussion-project approaches and workshop.Small Group techniques-group discussion simulation, role playing-Buzz techniques,

brain storming, case discussion and assignment...system approach in education. Individualized techniques-CAI Keller plan – PSI and programmed learning-methods of evaluation-self evaluation and student evaluation in higher education, question banking, diagnostic testing and remedial teaching.

## **UNIT V - ESSENTIALS FOR EFFECTIVE COMMUNICATION IN ENGLISH**

Improving Vocabulary stock-general and technical vocabulary-British and American vocabulary-homophones & homonyms, idioms and phrases-Different grammatical functions of the same word-Grammar-Tenses, Voice, reported speech, Modals, spoken English structures, formal and informal-letters, project reports, descriptions, circulars, synopsis and summary writing. Listening skills for competitive exams-Reading skills-skimming and scanning – Reading journals, magazines and newspapers for comprehension.Practical use of English – conversation, seminars, individual speeches and group discussions. Reference skills-Using dictionary, thesaurus and encyclopedia effectively. Error shooting for better use of English.

### **Suggested Readings**

1. Alley, Michael, ‘The Craft of Scientific Writing’, 3<sup>rd</sup> Edition, Springer (1996).
2. Alley, Michael, ‘The Craft of Scientific Presentations’, Springer(2003).

### **Reference Books**

1. Hubbuch, Susan M., Writing Research Papers Across the Curriculum, 5<sup>th</sup> Edition, Thompson(2005).
2. Vedanayagam.E.G, Teaching technology for college teachers New Delhi - Sterling publishers (Pvt) Ltd, (1989).
3. Kumar.K.H., Educational technology, New Delhi- New age international (Pvt) Ltd( 1997).
4. Tony Bates.A.N,Technology e-learning and distance education, New York, Rout ledge (2005).
5. Aggarwal. J.C., Essential of educational technology; Teaching Learning innovations in education-New Delhi- Vikas publishing house (p) Ltd. (1995)
6. Crow & Crow, Educational Psychology”, Erusia Publishing House New Delhi, (1998).
7. M. Ashraf Rizvi., Effective technical communication, TataMcGraw Hill Co.Ltd, (2005).

### **Websites:**

[www.english4engineer.com](http://www.english4engineer.com)

[www.learn4good.com/language/engineer](http://www.learn4good.com/language/engineer)



24RCE201

Research Publication Ethics

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives**

- To understand the philosophy of science and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications.
- To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools.
- To familiarize participants with basic of research and the research process.
- To enable the participants in conducting research work and formulating research synopsis and report.
- To familiarize participants with Statistical packages such as SPSS/EXCEL.
- To impart knowledge for enabling students to develop data analytics skills and meaningful interpretation to the data sets so as to solve the business/Research problem.

**Course Outcomes**

- Able to describe and apply theories and methods in ethics and research ethics
- To acquire an overview of important issues in research ethics, like responsibility for research, ethical vetting, and scientific misconduct.
- Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
- Have basic knowledge on qualitative research techniques
- Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis
- Have basic awareness of data analysis-and hypothesis testing procedures

**UNIT I –PHILISOPHY AND ETHICS**

Introduction to Philisophy: Definition, Nature and scope, concept, branches – Ethics: Definition, moral philosophy, nature of moral judgements and reactions.

**UNIT II–SCIENTIFIC CONDUCT**

Ethics with respect to science and research – Intellectual honesty and research integrity – Scientific misconduct: Falsification – Fabrication and Plagiarism (FFP) – Redundant publications : duplicate and overlapping publications – salami slicing – Selecting reporting and misrepresentation of date.

**UNIT III - Publication Ethics**

Publication Ethics: Definition, Introduction and importance – Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. – Conflicts of interest – Publication Misconduct:definition, concept, problems that lead to unethical behavior and vice versa, type – Violation of publication ethics, authorship and contributorship – identification of publication misconduct, complaints and appeals – Predatory publishers and journals.

**UNIT IV–PUBLICATION MISCONDUCT**

Group Discussions : Subject specific ethical issues, FFP, authorship – Conflicts of interest – Complaints and appeals: examples and fraud from india and abroad.

Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.

## **UNIT V–DATABASES AND RESEARCH METRICS**

Database: Indexing database – Citation database: Web of Science, Scopus, etc

Research metrics: Impact Factor of Journal as per journal Citation report, SNIP, SJR, IPP, Cite Score – metrics: h- index, g index, i10 index, altmetrics.

## **UNIT VI – DEVELOPMENT OF E- CONTENT & IPR**

Integrated Library management System (ILMS): e- journals – e-books – e- shodhsindu – shodhganga – Database – e- content Development – Learning management System (LMS) – e-PG – Pathshala – CEC (UG) SWAYAM – MOOCs -NPTEL -NMEICT.

IPR: patent – Copyrights – Trademark – Geographical Indication.

### **PRACTICE:**

Open Access Publishing

Open access publications and initiatives – SHERPA / RoMEO online resource to check publisher copyright & Self – archiving policies – Software tool to identify predatory publications developed by SPPU – Journal finder / Journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

24RCE301

Advanced Environmental Engineering

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. To provide the engineering graduates with technical expertise in Environmental Engineering which will enable them to have a career and professional accomplishment in the public or private sector.
2. To address the complexities of real-life environmental engineering problems related to water supply, sewerage, sewage treatment, waste management industrial pollution prevention and control.
3. To Identify and develop processes and technologies to meet desired environmental protection needs of society
4. To formulate solutions that are technically sound, economically feasible, and socially acceptable.
5. To design systems, processes, and equipment for control and remediation of water, air, and soil quality environment within realistic constraints of economic affordability and social acceptability
6. Have a knowledge of contemporary environmental issues and an ability to engage in life-long learning

**Course Outcomes:**

1. The students are expected to be able to identify, formulate, and solve environmental engineering problems using the techniques, skills, and modern engineering tools necessary for environmental engineering practice.
2. Assess the potential environmental impacts of development projects and design mitigation measures.
3. Have basic knowledge about environment protection and operation of pollution control devices.
4. Design and conduct experiments, as well as interpret data and communicate effectively.
5. Function in multi-disciplinary teams and understand the ethical and professional responsibility.
6. Find professional level employment as Environmental Engineers or pursue higher studies

**UNIT I - SOLID WASTE TREATMENT AND DISPOSAL**

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes - Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – closure of landfills – landfill remediation.

**UNIT II - INDUSTRIAL WASTEWATER TREATMENT**

Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors -

Chemical oxidation – Ozonation – carbon adsorption – Photo-catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.- Treatability studies.

### **UNIT III - AIR QUALITY MONITORING AND CONTROL TECHNIQUES:**

Air pollutants: Sources, classification, Combustion Processes, pollutant emission, Effectson Health, vegetation, materials, atmosphere, Reactions of pollutants Scales of APstudies, effects as per scales, Air sampling, pollution measurement methods, Ambient airquality and emission standards, Air pollution indices, Air Act, legislation and regulations,Removal of gaseous pollutants. Particulate emission control; bioscrubers, biofilters,Indoor air quality.

### **UNIT IV- SURFACE WATER HYDROLOGY HYDROLOGIC PROCESSES**

Rainfall – Rain gauges – Adequacy of network – Spatial and temporal distribution – frequency and intensity / duration analysis – Consistency – missing data – Abstractions – Infiltration – Evaporation – Interception – Process, estimation and measurement – Depression and detention storages.

### **RUNOFF ESTIMATION**

Components – Factors affecting runoff – Catchment characteristics – Flow measurements – Stream gauging – Floats, current meters – Venturi, Cut-throat and Parshall flumes – Rating curves – Aquatic Doppler velocity meter – Estimation – SCS and storage table methods – Empirical equations – Rainfall – Runoff models – TANK model – Tank clustered catchments.

### **UNIT V - REMOTE SENSING**

Remote Sensing, GIS and GPS Techniques and their applications in Environmental Studies.Softwares in Environmental Engineering.Pollutant Transport Mechanisms and Modelling, Hazardous Waste Management, Waste Minimization Techniques, Environmental Risk Management

### **Suggested Readings**

1. Manual on water supply and Treatment ",CPHEEO, Ministry of Urban Development, GOI, New Delhi (1999).
2. Manual on Sewerage and Sewage Development ",CPHEEO, Ministry of Urban Development, GOI, New Delhi (1993).
3. B.A. Hauser, " Practical Hydraulics Hand Book ", Lewis Publishers, New York, (1991).
4. M.J. Hammer, " Water and Wastewater Technology ", Regents/Prentice Hall, New Jersey.
5. Franzini, J., Freyberg, D., Linsley, R., and G. Tchobanoglous, "WaterResources Engineering". McGraw Hill (1991).
6. Reed, S.C. and Crites, R.W.,"Natural Systems for Waste Management and Treatment".McGraw Hill, ( 1996).
7. Guyer, H.H., "Industrial Processes and Waste Stream Management".WileyInterscience (1998).
8. Bishop, P.,"Pollution Prevention: Fundamentals and Practice". McGraw Hill, (2000).
9. American Water Works Association, "Water Treatment Plant Design", (3rd Ed.).McGraw-Hill, (1997).
10. Kawamura, S., "Integrated Design and Operation of Water Treatment Facilities".Wiley and Sons (2000).

**Course Objectives:**

1. Understand the engineering properties soil and rock to estimate their strength characteristics for slope stability analysis
2. Describe the different methods of slope stability analysis
3. Evaluate the infinite slopes based on the stability analysis
4. Describe the nature of landslides on various soils for stability analysis
5. Evaluate the behavior of slopes using instrumentation techniques
6. Applications of field observation techniques for understanding the landslides formation on soils

**Course Outcomes:**

1. Understand the various slope failures and causes of Failures
2. Describe the different methods of slope stability analysis
3. Analysis of non-uniform slopes with various methods
4. Analysis and design of the landslide detection and the stability of slopes on various soils
5. Understand the basic concepts and analysis of field observations and slope stabilization
6. Applications of various techniques in landslide detection and monitoring techniques and understand the role of landslides in the earth system

**UNIT I - Stability of Slopes**

Introduction – Importance – General characteristics - Types of failures – Causes of failures – Purpose of stability computation – Investigation of failures – Procedure – Case studies.

**UNIT II - Stability Analysis**

Stability analysis – Method of slices – Friction circle method – Soils with cohesion – Soils with cohesion and angle of internal friction. Critical states for design for embankments – Stability computations – Evaluation of pore water pressure.

**UNIT III - Irregular Slopes**

Non-uniform soils – Janbu's analysis – Taylor's analysis – Bishop's analysis – Total stress and effective stress approaches – composite surfaces of sliding – Block sliding.

**UNIT IV - Land Slides**

General Characteristics -sources – Stability of Hill side slopes – Open cuts – Engineering problems involving the stability of slopes – Cuts in sand – Cuts in loess – Homogeneous and soft clay slopes – Sudden spreading of clay slopes – Clay flows - Clays containing pockets and sand masses – Slides in stiff clay slopes on shale – Slopes on weathered rock; talus slopes, slopes on over consolidated clays – Slides along coastal areas and tropically weathered residual soils – long term stability of clay slopes.

**UNIT V - Field Observations and Slope Stabilization**

Field instrumentation – Observation studies during construction – Post construction, piezometers – Settlement plates – Inclinator – Case histories.

Compaction of new embankments – Compaction of natural masses of soil and existing fills  
– Compaction of deep deposits of sand – Vibroflotation – Compaction of compressible soils –  
Drainage as a means of stabilization – Use of Geotextiles – Soil nailing.

### **Suggested Readings**

1. Chowdhury, D.F., “Slope analysis”, Prentice Hall, (1988).
2. Winterkorn, H.F. and Fang, H.Y., “Foundation Engineering” Handbook, Von NostrandReinhol, (1994).
3. Bramhead, E.N., “The Stability of Slopes”, Blacky Academic and Professionals Publications, Glasgow, (1986).
4. Anderson, M.G., and Richards, K.S., “Slope Stability”, John Wiley,(1987).

**COURSE OBJECTIVE:**

1. To introduce the basics of Earthquake Engineering
2. To introduce the engineering seismology, building geometrics & characteristics, structural irregularities,
3. To introduce tips on earthquake engineering - do's and don'ts
4. To introduce cyclic loading behaviour of RC, steel and pre-stressed concrete elements
5. To discuss code provisions and their application on different types of structures
6. To apply codal provisions on different types of structures

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Apply the basics of Earthquake Engineering
2. Demonstrate the dynamics of structural system under earthquake load
3. Analyze the influence of the structural / geometrical design in building characteristics
4. Demonstrate the cyclic loading behaviour of RC steel and pre-stressed concrete elements
5. Apply codal provisions on different types of structures.
6. Cyclic loading behaviour of RC, steel and pre-stressed concrete elements

**UNIT I Theory of Vibrations**

Difference between static loading and dynamic loading – Degree of freedom – idealisation of structure as single degree of freedom system – Formulation of Equations of motion of SDOF system – D'Alemberts principles – effect of damping – free and forced vibration of damped and undamped structures – Response to harmonic and periodic forces.

**UNIT II Multiple Degree of Freedom System**

Two degree of freedom system – modes of vibrations – formulation of equations of motion of multi degree of freedom (MDOF) system – Eigen values and Eigen vectors – Response to free and forced vibrations – damped and undamped MDOF system – Modal superposition methods.

**UNIT III Elements of Seismology**

Elements of Engineering Seismology – Causes of Earthquake – Plate Tectonic theory – Elastic rebound Theory – Characteristic of earthquake – Estimation of earthquake parameters – Magnitude and intensity of earthquakes – Spectral Acceleration.

## **UNIT IV Response of Structures to Earthquake**

Effect of earthquake on different type of structures – Behaviour of Reinforced Cement Concrete, Steel and Prestressed Concrete Structure under earthquake loading – Pinching effect – Bouchinger Effects – Evaluation of earthquake forces as per IS:1893 – 2002 – Response Spectra – Lessons learnt from past earthquakes.

## **UNIT V Design Methodology**

Causes of damage – Planning considerations / Architectural concepts as per IS:4326 – 1993 – Guidelines for Earthquake resistant design – Earthquake resistant design for masonry and Reinforced Cement Concrete buildings – Later load analysis – Design and detailing as per IS:13920 – 1993.

### **Suggested Readings**

1. Chopra, A.K., “Dynamics of Structures – Theory and Applications to Earthquake Engineering”, 4th Edition, Pearson Education, (2002).
2. Agarwal. P and Shrikhande. M., “Earthquake Resistant Design of Structures”, Prentice Hall of India Pvt. Ltd, (2007).
3. Biggs, J.M., “Introduction to Structural Dynamics”, McGraw Hill Book Co., New York, (1964).
4. Dowrick, D.J., “Earthquake Resistant Design”, John Wiley & Sons, London, (2009).
5. Paz, M. and Leigh., “Structural Dynamics – Theory & Computation”, 4th Edition, CBS Publishers & Distributors, Shahdara, Delhi, (2006).



**Course Objectives:**

1. Describe the engineering behaviour of soil and rock for understanding the slope stability analysis
2. Acquire the basic knowledge on different methods of slope stability analysis
3. Describe the equilibrium analysis to understand the stress-strain behaviour in infinite slopes
4. Describe the various theories and mechanism for estimating the engineering behavior of soils
5. Evaluate the behavior of porous media in different soil conditions for slope stability analysis
6. Applications of basic concepts and field testing techniques to estimate the problems associated with geotechnical engineering structures

**Course Outcomes:**

1. Understand the theory of elasticity and equation of equilibrium and compatibility in soil mechanics
2. Describe the stresses and displacement in soil with fundamental solutions
3. Understand the stress – strain relationship using limit equilibrium analysis
4. Ability to apply theory of elasticity / plasticity / rheological modeling to analyse and obtain solution to challenges involving engineering behavior of soils
5. Analysis of flow through porous media in different soil conditions
6. Application of various principles and theories to analyze the problems related to soil mechanics

**UNIT I - Theory of Elasticity**

Introduction – Material behaviour – Idealistic behaviour – Elastic, viscous and plastic – Elasticity and stability problems, concept of stress and strain – Plane stress, plane strain and axisymmetric problems – Equation of equilibrium and compatibility – Stress functions.

**UNIT II - Stresses and Displacements (Elastic Solutions)**

Stresses in elastic half-space medium by external loads – Fundamental solutions – Boussinesq, Flamant, Kelvin and Mindlin solution – Applications of fundamental solutions – Anisotropic and non-homogeneous linear continuum – Influence charts – Elastic displacement.

**UNIT III - Limit Equilibrium Analysis**

Limit equilibrium analysis – Perfectly plastic material – Stress – strain relationship – Stress and displacement field calculations – Slip line solutions for undrained and drained loading.

**UNIT IV - Limit Analysis**

Limit analysis – Principles of virtual work – Theorems of plastic collapse – Mechanism for plane plastic collapse – Simple solutions for drained and undrained loading – Stability of slopes, cuts and retaining structures. Centrifuge model – Principles and scale effects, practical considerations.

**UNIT V - Flow Through Porous Media**

Flow through porous media – Darcy's law – General equation of flow – Steady state condition – Solution by flow net – Fully saturated conditions – Flownet in anisotropic soils – construction of flownet for different cases.

## **Suggested Readings**

1. Aysen, A., “Soil Mechanics: Basic concepts and Engineering Application”, A.A.Balkema Publishers, (2002).
2. Ulrich Smolte, YK, “Geotechnical Engineering Handbook (Vol. 1)”, Ernst & Sohn, (2002).
3. Aysen, A., “Problem Solving in Soil Mechanics”, A.A.Balkema Publisher, (2003).
4. Davis, R.O., and Selvadurai, A.P.S., Elasticity and Geomechanics, Cambridge University Press, (1996).
5. Taylor, R.N., “Geotechnical Centrifuge Technology”, Blackie Academic and Professional, (1995).
6. Wai-Fah Chen, and Liu, X.L., “Limit Analysis in Soil Mechanics, Elsevier Science Ltd., (1991).
7. Muni Budhu, “Soil Mechanics and Foundations”, John Wiley and Sons, Inc, Network, (2000).
8. Atkinson, J.H., “Foundations and Slopes”, McGraw Hill, (1981).
9. Harr, M.E., “Foundations of Theoretical Soil Mechanics, McGraw Hill, (1966).
10. Cedergren, H.R., “Seepage Drainage and Flow nets”, John Wiley (1997).

**Course Objectives:**

1. Acquire the basic knowledge on vibration theories for dynamic analysis of foundations
2. Understand the basic concepts on dynamic properties of soil using various field and laboratory testings
3. Describe the types of machine foundations to understand the applicability of various vibration theories
4. "Describe the modes of vibration in foundation systems and to understand the importance of designing
5. machine foundation for reciprocating and impact machines."
6. Evaluate the vibration isolation techniques using springs and damping materials
7. Acquire the ability to design machine foundations with different vibration theories

**Course Outcomes:**

1. Understand the fundamental concepts of theory of vibration and the various terminology encompassed to study the behavior of soils due to the effects of dynamic loads.
2. Describe the dynamic soil properties & their determination by field and laboratory tests.
3. Understand the general principles of analysis and design of machine foundation.
4. Analyze and design the foundations for machineries of reciprocating, impact and rotary type.
5. Analyze the active and passive isolation problems for machine foundation.
6. Application of various principles and analyze various problems related to machine foundation.

**UNIT I - Theory of Vibration**

Introduction – Nature of dynamic loads – Basic definitions – Simple harmonic motion – Fundamentals of vibration – Single degree and multi degree of freedom systems – Free vibrations of spring – Mass systems – Forced vibrations – Resonance – Viscous damping – Principles of vibrations measuring systems – Effect of transient and pulsating loads.

**UNIT II - Dynamic Soil Properties**

Dynamic stress – Strain characteristics – Principles of measuring dynamic properties – Laboratory techniques – Field tests – Block vibration test – Factors affecting dynamic properties – Typical values. Mechanism of liquefaction – Influencing factors – Evaluation of liquefaction potential – Analysis from SPT test – Dynamic bearing capacity – Dynamic earth pressure.

**UNIT III - Machine Foundations**

Introduction – Types of machine foundations – General requirements for design of machine foundations – Design approach for machine foundation – Vibration analysis – Elastic Half – Space theory – Mass-spring-dashpot model – Permissible amplitudes – Permissible bearing pressures.

**UNIT IV - Design of Machine Foundation**

Evaluation of design parameters – Types of Machines and foundations – General requirements – their importance - Analysis and design of block type and framed type machine foundations – Modes of vibration of a rigid foundation – Foundations for reciprocating machines,

impact machines, Two – Cylinder vertical compressor, Double-acting steam hammer – Codal recommendations.

Empirical approach - Barken's method – Bulb of pressure concept – Pauw's analogy – Vibration table studies.

### **UNIT V - Vibration Isolation**

Vibration isolation – Types of isolation – Transmissibility – Passive and active isolation – Methods of isolation – Use of springs and damping materials – Properties of isolating materials – Vibration control of existing machine foundation.

#### **Suggested Readings**

1. KameswaraRao, N.S.V., “Dynamics soil tests and applications”, Wheeler Publishing, New Delhi, (2000).
2. Prakash, S and Puri, V.K., “ Foundations for machines”, McGraw Hill, (1987).
3. Moore, P.J., “Analysis and Design of Foundations for Vibrations”, Oxford and IBH, (1985).
4. Vaidyanathan, C.V., and Srinivasalu, P., Handbook of Machine Foundations, McGraw Hill, (1995).
5. KameswaraRao, “Vibration Analysis and Foundation Dynamics”, Wheeler Publishing, New Delhi, (1998).
6. Swami Saran, “Soil Dynamics and Machine Foundation”, Galgotia publications Pvt. Ltd. New Delhi, (2010).
7. Das B.M., “Principles of Soil Dynamics”, McGraw Hill, (1992).
8. Krammer S.L., “Geotechnical Earthquake Engineering”, Prentice Hall, International series, Pearson Education (Singapore) Pvt Ltd, (2004).

**Course Objectives:**

1. Explain the effects of soil flexibility in the response of the structure
2. Analyse the structure with soil structure interaction effects to obtain the realistic response
3. Describe the numerical analysis of plates on elastic medium
4. Analyse the structure with soil structure interaction effects to obtain the realistic response in pile and pile-raft system
5. Analyse the structure with soil structure interaction effects to obtain the realistic response in laterally pile and pile-raft system
6. "Acquire the ability to design the geotechnical engineering structures using the concept of soil structure interaction"

**Course Outcomes:**

1. Understand the various soil response models applicable to soil-foundation interaction analysis.
2. Analyze the beams on elastic foundation and its applications
3. Analyze the plates on elastic medium and its applications
4. Assess the elastic solutions for problems of pile and pile-raft system.
5. Assess the elastic solutions for problems of laterally pile and pile-raft system
6. Application of various principles and evaluate the soil stiffness and damping ratio

**UNIT I - Soil - Foundation Interaction**

Introduction to soil – Foundation interaction problems, Soil behaviour, Foundation behaviour, Interface, behaviour, Scope of soil-foundation interaction analysis, soil response models. Winkler, Elastic continuum, Two parameter elastic models, Elastic – plastic behaviour, Time dependent behaviour.

**UNIT II - Beams on Elastic Foundation - Soil Models**

Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness – Analysis through application packages.

**UNIT III - Plate on Elastic Medium**

Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions, Analysis of braced cuts – Application packages.

**UNIT IV - Elastic Analysis of Pile**

Elastic analysis of single pile, Theoretical solutions for settlement and load distribution, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap – Pile raft – Application packages.

**UNIT V - Laterally Loaded Pile**

Load deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Interaction analysis, pile raft system, solutions through influence charts - Application packages.

## **Suggested Readings**

1. Saran, S., “Analysis and design of substructures:”, Taylor & Francis Publishers, (2006).
2. Hemsley, J.A., “Elastic Analysis of Raft Foundations”, Thomas Telford, (1998).
3. Poulos, H.G., and Davis, E.H., “Pile Foundation Analysis and Design”, John Wiley, (2008).
4. Murthy, V.N.S., “Advanced Foundation Engineering”, CBS Publishers, New Delhi, (2007).
5. McCarthy, D.F., “Essentials of Soil Mechanics and Foundations: Basic Geotechnics”, Sixth Edition, Prentice Hall, (2002).
6. Scott, R.F., “Foundation Analysis”, Prentice Hall, (1981).
7. ACI 336, “Suggested Analysis and Design Procedures for Combined Footings and Mats”, American Concrete Institute, Delhi, (1988).

24RCE307

Rock Mechanics In Engineering Practice

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. Describe the various properties and behaviour of various geological formation
2. Describe the various theories and concepts on strength criteria of rocks
3. Acquire the basic knowledge on the design of geotechnical engineering structures using case studies
4. Describe the slope stability analysis for critical slopes and apply the concept of factor of safety
5. Acquire the knowledge on the effect of reinforcements in the remedial measures of slope stability
6. Application of basic concepts of rock mechanics for designing the geotechnical engineering structures

**Course Outcomes:**

1. Understand the various distribution, geological characters and civil engineering significance of major rock formations of India
2. "Describe the strength criteria of rocks and behaviour of rock under hydrostatic and deviatoric loadings "
3. Analyze the design aspects and stress measurements in rocks
4. Assess the stability analysis of rock slopes and various remedial measures for critical slopes
5. Assess the reinforcement techniques in stability of rocks
6. Apply the geological knowledge in civil engineering planning and development based on the properties of rocks

**UNIT I - Classification of Rocks**

Rocks of peninsular India and the Himalayas – Index properties and classification of rock masses, competent and incompetent rock – Value of RMR and ratings in field estimations.

**UNIT II - Strength Criteria of Rocks**

Behaviour of rock under hydrostatic compression and deviatoric loading – Modes of rock failure – Planes of weakness and joint characteristics – Joint testing, Mohr – Coulomb failure criterion and tension cut-off, Hoek and Brown Strength criteria for rocks with discontinuity sets.

**UNIT III - Design Aspects in Rocks**

Insitu stresses and their measurements, flat jack - Over and under coring methods – stress around underground excavations – Design aspects of openings in rocks – Case studies.

**UNIT IV - Slope Stability of Rocks**

Rock slopes – Role of discontinuities in slope failure, slope analysis and factor of safety – Remedial measures for critical slopes – Case studies.

**UNIT V - Reinforcement of Rocks**

Reinforcement of fractured and jointed rocks – Shotcreting – Bolting – Anchoring – Installation methods – Case studies.

## **Suggested Readings**

1. Goodman, R.E., “Introduction to Rock Mechanics”, John Wiley and Sons,(1989).
2. Hool, E and Bray, J., “Rock Slope Engineering, Institute of Mining and Metallurgy”, U.K. (1981).
3. Hoek, E and Brown, E.T., “Underground Excavations in Rock, Institute of Mining and Metallurgy”, U.K. (1981).
4. Bazant, Z.P.,“ Mechanics of Geomaterials Rocks, Concrete and Soil”, John Wiley and Sons, Chichester, (1985).
5. Wittke, W., “Rock Mechanics: Theory and Applications with Case Histories”, Springer-Verlag, Berlin, (1990).



24RCE308

Reinforced Soil Structures

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. Describe the behaviour and performance of soil - reinforcement interactions using various concepts and mechanisms of reinforced soil
2. Acquire the basic knowledge on the materials properties of different soil reinforcements
3. Describe the design concepts and applications of soil reinforcements
4. Describe the need for geosynthetics in the design of drainage and landfill program
5. Acquire the basic concepts from the case studies on the soil nailing techniques
6. Acquire the ability to analyze and design the geotechnical engineering structures using soil reinforcement techniques

**Course Outcomes:**

1. Understand the various principles and mechanisms of reinforced soil techniques in different soils
2. Describe the materials used in reinforced soil structures and its laboratory testing
3. Assess the design principles of reinforced soil of various structures
4. Assess the use of geosynthetics in drainage requirements and landfill designs program
5. Describe the soil nailing concepts and various case histories
6. Apply the principles of soil reinforcement in engineering constructions

**UNIT I - Principles and Mechanisms**

Historical background – Initial and recent developments – Principles – Concepts and mechanisms of reinforced soil – Factors affecting behaviour and performance of soil – Reinforcement interactions.

**UNIT II - Materials and Material Properties**

Materials used in reinforced soil structures- Fill materials, reinforcing materials, metal strips, Geotextile, Geogrids, Geomembranes, Geocomposites, Geojutes, Geof foam, natural fibres, coir Geotextiles – Bamboo – Timber – Facing elements – Properties – Methods of testing – Advantages and disadvantages – Preservation methods.

**UNIT III - Design Principles and Applications**

Design aspects of reinforced soil – Soil reinforcement function – Separator, Filtration, Drainage, Barrier function – Design and applications of reinforced soil of various structures – Retaining walls – Foundations - Embankments and slopes.

**UNIT IV - Geosynthetics and Applications**

Introduction – Historical background – Applications - Design criteria – Geosynthetics in roads – Design – Giroud and Noiray approach – Geosynthetics in landfills – Geosynthetic clay liner – Design of landfills – Construction of landfills using geosynthetics-Barrier walls- Reinforced Soil retaining walls- Reinforced soil slopes.

**UNIT V - Soil Nailing and Case Histories**

Soil nailing – Introduction – Overview – Soil – Nail interaction – Behaviour – Design procedure – Behaviour in seismic conditions.

Performance studies of reinforced dams, embankments, Pavements, Railroads, Foundations - Case studies.

## Suggested Readings

1. Jewell, R.A., “ Soil Reinforcement with Geotextile”, CIRIA, London, (1996).
2. John, N.W.M., “ Geotextiles”, John Blackie and Sons Ltd., London, (1987).
3. Jones, C.J.F.P., “Earth Reinforcement and Soil Structures”, Earthworks, London, (1982).
4. Koerner, R.M., “Designing with Geosynthetics”, (Third Edition), Prentice Hall, (1997).
5. Proc. Conference on polymer and Reinforcement, Thomas Telford Co., London, 1984.
6. Gray, D.H., and Sotir, R.B., “Biotechnical and Soil Engineering Slope Stabilization”, A Practical Guide for Erosion Control, John Wiley & Son Inc., New York, (1996).
7. RamanathaAyyar, T.S., Ramachandran Nair, C.G. and Balakrishna Nair, N., “Comprehensive reference book on Coir Geotextile”, Centre for Development for Coir Technology, (2002).

**COURSE OBJECTIVES:**

1. To develop the equation of motion for vibratory systems and solving for the free and forced response.
2. To Create simple models for engineering structures.
3. To understand the dynamic analysis result for design analysis and research purposes.
4. To understand Structural dynamics theory to Earthquake analysis response and design of structure.
5. To gain the Knowledge of mathematics science and engineering to create mathematical modeling
6. To Analyse the different system with distributed load

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Apply Knowledge of mathematics, science and engineering by developing the equation of motion for vibratory systems and solving for the free and forced response.
2. Create simple models for engineering structures using knowledge of structural dynamic
3. Intercept dynamic analysis result for design analysis and research purposes.
4. Apply Structural dynamics theory to Earthquake analysis response and design of structure.
5. Apply Knowledge of mathematics science and engineering to create mathematical modeling
6. Analyze the different system with distributed load

**UNIT I - EARTHQUAKES AND GROUND MOTION**

Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation.

**UNIT II - EFFECTS OF EARTHQUAKE ON STRUCTURES**

Dynamics of Structures (SDOFS/ MDOFS), Response Spectra - Evaluation of Earthquake Forces as per codal provisions - Effect of Earthquake on Different Types of Structures - Lessons Learnt from Past Earthquakes

**UNIT III - EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES**

Structural Systems - Types of Buildings - Causes of damage - Planning Considerations - Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Masonry Buildings - Design consideration – Guidelines.

**UNIT IV - EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES**

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis – Capacity based Design and detailing – Rigid Frames – Shear walls.

## **UNIT V - VIBRATION CONTROL TECHNIQUES**

Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- Case Studies, Important structures.

### **Suggested Readings**

1. Bruce A Bolt, “Earthquakes” W H Freeman and Company, New York, (2004).
2. C. A. Brebbia,”Earthquake Resistant Engineering Structures VIII”,WIT Press, (2011).
3. Mohiuddin Ali Khan, “Earthquake-Resistant Structures: Design, Build and Retrofit”, ElsevierScience& Technology, (2012).
4. Pankaj Agarwal and Manish Shrikhande,“Earthquake Resistant Design of Structures”, Prentice Hall of India, (2009).
5. Paulay,T and Priestley, M.J.N.,“Seismic Design of Reinforced Concrete and Masonrybuildings”, John Wiley and Sons, (1992).
6. S K Duggal,“Earthquake Resistant Design of Structures”, Oxford University Press, (2007).

24RCE310

Experimental Stress Analysis

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVES:**

1. To measure the strain under static and dynamic loads.
2. To describe the mechanical, optical, pneumatic and electrical strain gauges
3. To create awareness about the fixing of gauges and temperature effects.
4. To analysis of measuring circuits and strains of different strain gauge rosettes.
5. To describe the measurements by using transducers and excitors.
6. To study about the fundamentals of Non-Destructive Testing.

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Explain the measurement of strain under static and dynamic loads.
2. Describe the Mechanical, optical, pneumatic and electrical strain gauges for strain measurement.
3. Create awareness about the fixing of gauges and temperature effects in bonded gauges and measure of stress in stress gauges.
4. Analysis of measuring circuits and strains of different strain gauge rosettes.
5. Describe the measurements by using transducers and excitors
6. Understand about the fundamentals of Non-Destructive Testing.

**UNIT I - MEASUREMENTS & EXTENSOMETER**

Principles of measurements, Accuracy, Sensitivity and range of measurements. Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.

**UNIT II- ELECTRICAL RESISTANCE STRAIN GAUGES**

Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

**UNIT III- PHOTOELASTICITY**

Two dimensional photo elasticity, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photo elasticity.

**UNIT IV - BRITTLE COATING AND MOIRE METHODS**

Introduction to Moire techniques, brittle coating methods and holography.

**UNIT V - NON – DESTRUCTIVE TESTING**

Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique.

## **Suggested Readings**

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., “Experimental Stress Analysis”, Tata McGraw-Hill, New Delhi, (1984).

## **References**

1. Dally, J.W., and Riley, W.F., “Experimental Stress Analysis”, McGraw-Hill Inc., New York, 2005, IV edition, (2005).
2. Hetenyi, M., “Hand book of Experimental Stress Analysis”, John Wiley and Sons Inc., New York, (1972).
3. Pollock A.A., “Acoustic Emission in Acoustics and Vibration Progress”, Ed. Stephens R.W.B., Chapman and Hall, (1993).

**COURSE OBJECTIVES**

1. To enable the students for a successful career as water management professionals.
2. To create a potential among students in the area of irrigation management with specific enrichment to synthesis of data and their analysis.
3. To expose the students the need for an interdisciplinary approach in irrigation water management and providing a platform to work in an interdisciplinary team.
4. To provide students an ability to understand the applications of mathematical and scientific concepts to analyse intricate technical, social and environmental problems in irrigation water management and finding solutions for them.
5. To promote student awareness for a life-long learning process and inculcate professional ethics and codes of professional practice in water management.
6. To know about the Modernisation of Irrigation Systems

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Understand the concepts of soil-water-plant relationship as well as to expose them to the principles and practices of crop production.
2. Exposure to ground water, hydraulics of ground water related to drainage, drainage concepts, planning, design and management of drainage related irrigation system management
3. Understand the various principles of irrigation management and to analyse the different types of irrigation systems and their performances based on service-oriented approach.
4. To gain insight on local and global perceptions and approaches to participatory water resource management and to learn from successes and failures in the context of both rural and urban communities of water management.
5. Exposure on the use of economic concepts in irrigation development and to impart knowledge on economic planning so as to enable viable allocation of resources in the irrigation sector.
6. Understand about the Modernisation of Irrigation Systems

**UNIT I - IRRIGATION SYSTEMS**

Historical evolution of irrigation systems in India; its importance to agricultural production. Irrigation system classification – Nature of system modernization and rehabilitation. Distinction between rehabilitation and modernization; Rehabilitation and modernization objectives – Theory and Practice.

**UNIT II - SYSTEM MAINTENANCE**

Maintenance: essential, catch up, preventive and normal – Diagnostic analysis of flow, seepage and other parameters through Participatory Rural Appraisal, Rapid Rural Appraisal and Walkthrough Survey – Development and maintenance programme – Kudimaramath – Turnover – WUA.

### **UNIT III - DIAGNOSTIC ANALYSIS OF IRRIGATION SYSTEMS**

System performance: history of inflow, cropping pattern, system alterations, distribution performance – Operational constraints – Management constraints – Resources constraints.

### **UNIT IV- REHABILITATION**

Baseline survey – Deferred maintenance – Causes – Criteria used for taking rehabilitation programmes –Service Delivery Concepts- Software and hardware improvements – Prioritization – Role of water users' association – Monitoring and evaluation.

### **UNIT V - CASE STUDIES**

Rehabilitation and modernization programmes – PeriyarVaigai Project – Walawe Project – Tank Modernization Project – Water Resources Consolidation Project. IAM WARM Project - DRIP - Case study of Rehabilitation using Water Delivery Concept.

### **Suggested Readings**

1. CWR,Baseline Survey of Irrigation Commands, Centre for Water Resources, Anna University, Chennai, (2000).
2. IIMI and WALMI, “The Case of MahiKadana”, WALMI, Gujarat, India, (1994),.
3. CSU, “Diagnostic Analysis of Irrigation Systems Volume 2: Evaluation Techniques. Water Management Synthesis Project”, Colorado State University, USA, (1984).
4. WAPCOS, Technical Report No. 19-A, “Handbook for Improving Irrigation System Maintenance Projects”, WAPCOS, New Delhi, (1989).
5. CWR, “Tank Modernization Project EEC Assistance: Monitoring and Evaluation. Final Reports”, Centre for Water Resources, Anna University, Chennai, (2000).
6. CWR, “Planning and Mobilization of Farmers Organization and Turnover”, Tamil Nadu Water Resources Consolidation Project. CWR and OM, Anna University, Chennai, (1997).



24RCE312

Advanced Concrete Technology

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVES:**

1. To know about the constituent materials of concrete and mix design principles.
2. To understand the concept of special concrete.
3. To study about the tests for durability of concrete
4. To study about recommendations of IS 456-2000 for quality control of concrete
5. To know about the concreting under special circumstances
6. To know about the tests for hardened concrete.

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Identify the constituent materials of concrete and mix design principles.
2. Describe the concept of special concrete.
3. Demonstrate the tests for durability of concrete
4. Categorize the quality control of concrete as per IS 456-2000 code
5. Develop the concreting under special circumstances
6. Will gain the knowledge of tests for hardened concrete.

**UNIT I- INTRODUCTION**

Concrete: Past, Present and Future- Constituent Materials --Strength of Concrete -Dimensional Stability of Concrete- Chemical and Mineral Admixtures-Properties of Fresh and hardened Concrete - Principles of Concrete Mix Design-Methods of Concrete mix design.

**UNIT II - SPECIAL CONCRETES**

Lightweight and Heavy Weight Concrete-High Strength Concrete-High Performance Concrete-Polymers in Concrete-Steel fiber Reinforced Concrete-Ferrocement Concrete-Vaccum Concrete-Shotcrete-Ready Mixed Concrete-SIFCON.

**UNIT III - DURABILITY OF CONCRETE**

Permeability-chemical attack-sulphate attack-Quality of water-marine conditions- Thermal properties of concrete-fire resistance-methods of making durable concrete - Mass Concrete-Formwork-Structural Concrete Block Masonry -Quality Control of Concrete Construction.

**UNIT IV - FORMWORK AND QUALITY CONTROL**

Formwork Materials and Systems-Specifications-Design-Recommendations of IS 456-2000 on Quality- Statistical Parameters and Variability-Errors in Concrete Constructions-Quality Management.

**UNIT V - CONCRETING UNDER SPECIAL CIRCUMSTANCES**

Underground Construction-Concreting in Marine Environment-Under water Construction-Hot weather and Cold weather concreting.

**Tests on Concrete** :Evaluation of Strength of existing structures-investigation Techniques-Tests on Hardened Concrete-Non Destructive Testing-Semi destructive testing techniques-Tests on fresh Concrete-Load Test on Structural Components.

### **Suggested Readings**

- 1.Neville, A.M., Properties of Concrete, Pitman Publishing Limited, London.
2. ShettyM.S.ConcreteTechnology,S.Chand and Company Ltd,.New Delhi, (2003).
3. Gambir,M.L., “Concrete Technology”, Tata McGraw Hill, Publishing,Co,Ltd,NewDelhi, (2004).
4. Krishnaraju.N, “Design of Concrete mixes”, Sehgal Educational Consultants Pvt.Ltd.,Faridabad.
5. IS:456-2000,Indian Standards Code of Practice for Plain and Reinforced Concrete
6. IS: 10262, “Recommended Guidelines for Concrete Mix Design”,1982.
7. Santhakumar,A.R., Concrete Technology, Oxford University Press, New Delhi.

**COURSE OBJECTIVES:**

1. To know about the modular coordination and production process of prefabricates
2. To understand the concept of Long wall and cross-wall large panel buildings.
3. To study about the design of large panels and stair cases
4. To study about the design of shear walls
5. To know about the design of industrial sheds and roof trusses.
6. To know about the hand book-based design of prefabricates.

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Identify the modular coordination and production process of prefabricates
2. Describe the long wall and cross-wall large panel buildings.
3. Design the large panels and stair cases
4. Design the shear walls
5. Design the industrial sheds and roof trusses.
6. Will gain the knowledge of hand book-based design of prefabricates.

**UNIT I - DESIGN PRINCIPLES**

General Civil Engineering requirements, specific requirements for planning and layout of prefabricates plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and codal provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls.

**UNIT II - REINFORCED CONCRETE**

Prefabricated structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column and column to column.

**UNIT III - FLOORS , STAIRS AND ROOFS**

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.

**UNIT IV -WALLS**

Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.

## **UNIT V - INDUSTRIAL BUILDINGS AND SHELL ROOFS**

Components of single-storey industrial sheds with crane gantry systems, R.C. Roof Trusses, Roof Panels, corbels and columns, wind bracing design. Cylindrical, Folded plate and hyper-prefabricated shells, Erection and jointing, joint design, hand book based design.

### **Suggested Readings**

1. B.Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam, London, New York, (2011).
2. Koncz.T., Manual of Precast Concrete Construction, Vol.I II and III, Bauverlag, GMBH, (1971).
3. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precast Concrete, Netherland BetorVerlag, (1978).
4. LassloMokk, Prefabricated Concrete for Industrial and Public Sectors, AkademiaiKiado, Budapest, (1964).
5. Murashev.V., Sigalov.E., and Bailov.V., Design of Reinforced Concrete Structures, CBS publishers and distributors, New Delhi, (2003).
6. Gerostiza. C.Z., Hendrikson, C. and Rehat D.R., Knowledge Based Process Planning for Construction and Manufacturing, Academic Press, Inc, (1994).

24RCE314

High Performance Concrete

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVES:**

1. To know about the characteristics of concrete
2. To know about the design of concrete mixtures
3. To understand the concept micro & macroscopic behavior and theories of HPC
4. To study about the design of Fibre reinforced concrete as per ACI 318-99
5. To study about the design of shear walls
6. To know about the hand book-based design of prefabricates.

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Identify the modular coordination and production process of prefabricates
2. Show competency in design of advanced reinforced concrete structures.
3. Develop competence for applying of structures. Design the shear walls
4. Design the industrial sheds and roof trusses.
5. Will gain the knowledge of hand book-based design of prefabricates.
6. Understand the hand book-based design of prefabricates.

**UNIT I – PERFORMANCE CHARACTERISTICS OF CONCRETE**

General performance characteristics – cement effect on concrete strength – Portland cement and other hydraulic cement characteristics and content – performance comparison of various cements in concrete – water/cement ratio, aggregate and admixtures – permeability effects on performance of concrete – air voids and permeability – diffusion, sorptivity – freezing, thawing effect – concrete in cold weather –air entraining agents- ACI recommendations –hot weather concreting

**UNIT II – ADMIXTURES AND DESIGN MIXTURES OF HPC**

Mineral admixtures – chemical admixtures – strength requirements – selection of materials and proportions – flow chart for mixtures – mixture design – high performance light weight aggregates production, properties and proportioning – mixing and placement – creep, shrinkage and durability – thermal expansion ,conductivity and carbonation – offshore arctic environment – design of concrete mixtures – long term effects

**UNIT III- CHARACTERISTICS, MICRO & MACRO MECHANICS**

Concrete properties – mature elastic strength expressions – workability and cohesiveness, permeability, volumetric stability – ductility and energy absorption, constructability- bond to parent concrete – abrasion and fire resistance – micro & macroscopic behavior and theories – classical failure, crack propagation and failure mechanics theory – shear friction theory – confinement

**UNIT IV – FRC & FRPC AND CODE OVER VIEW**

FRC historical development, general characters and mixture proportioning – mechanical properties and mechanics of fiber reinforcement – plastic composites – GFRP & CFRP sheets –fire resistance – structural element designs as per ACI 318-99 – performance control for long term durability –

constituent materials , corrosion inhibitors – water, mixture proportioning – constructability, serviceability, quality control and quality assurance

#### **UNIT V – ECONOMICS OF HPC & HPC in 21<sup>st</sup> CENTURY**

Construction needs – design and rehabilitation considerations – monitoring and cost evaluation – expectations and conclusions - principal factors affecting cost –advantages using HPC- cost studies and comparisons

#### **Suggested Readings**

1. Edward G. Nawy, Fundamentals of high-performance concrete ,2<sup>nd</sup> edition John Wiley & Sons, Australia.
2. Pierre- Claude Aitcin E.& F.N Spon High performance concrete Technology and Engineering ,London.
3. Yves Malier –E & FN Spon High performance concrete from material to structure, London.
4. V.M.Malhotra, High performance concrete performance and quality of concrete structures, Proceedings of the 3<sup>rd</sup> international conference, (2002).

24RCE315

Ground Improvement Techniques

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVE:**

1. At the end of the course student is expected to identify the problematic soil and suitable suggest remedial measures
2. To understand the different problematic soils and effect of ground improvement techniques.
3. To describe the seepage analysis and suitable dewatering systems for the particular soil conditions.
4. To express the concept of compaction efforts on ground improvement and their installation and working principles.
5. Describe the load transfer mechanism and effect of geo textiles reinforcements in ground improvement.
6. Describe the various stabilization methods for the different types of problematic soils.

**COURSE OUTCOMES:**

1. Student will be in a position to identify and evaluate the deficiencies if any in the deposits of a project area.
2. Capable of providing alternate methods to improve its character suitable to the project, so that the structures built will be stable and serve.
3. Describe the dewatering systems for different soil conditions and their effect.
4. Express the working principles of different compaction methods on improving weak deposits.
5. Express the design of geo textiles reinforcements for ground improvement.
6. Express the soil stabilization methods for the problematic soils.

**UNIT I - DEWATERING**

Introduction - Scope and necessity of ground improvement in Geotechnical engineering basic concepts and philosophy. Drainage - Ground Water lowering by well points, deep wells, vacuum and electro-osmotic methods. Stabilization by thermal and freezing techniques.

**UNIT II - COMPACTION AND SAND DRAINS**

Insitu compaction of granular and cohesive soils, Shallow and Deep compaction methods - sand piles – concept, design, factors influencing compaction. Blasting and dynamic consolidation – Preloading with sand drains, fabric drains, wick drains etc. – Theories of sand drain – design and relative merits of above methods.

**UNIT III - STONE COLUMN, LIME PILES AND SOIL NAILING**

Stone column, lime piles – Functions – Methods of installation – design, estimation of load carrying capacity and settlement. Root piles and soil nailing - methods of installation – Design and Applications – case studies.

**UNIT IV - EARTH REINFORCEMENT**

Earth reinforcement – Principles and basic mechanism of reinforced earth, simple design, Synthetic and natural fibre based Geotextiles and their applications. Filtration, drainage, separation, erosion control – case studies.

## **UNIT V - GROUTING**

Grouting – Types of grout – Suspension and solution grouts – Basic requirements of grout. Grouting equipment – injection methods - jet grouting – grout monitoring – Electro – chemical stabilization – Stabilization with cement, lime etc. – Stabilization of expansive clays.

### **Suggested Readings**

1. P. Purushothama Raj, Ground Improvement Technique, Laxmi Publications (P) Ltd (2005).
2. NiharRanjanPatra : Ground Improvement Techniques ; Vikas Publishing house (2005).
3. RamanathaAyyar, T.S., Ramachandran Nair, C.L. and Balakrishnan Nair, N., Comprehensive Reference book on Coir Geotextiles, Centre for development of Coir Technology, (2002).
4. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall, (1997).
5. Jewell, R.A., Soil Reinforcement with Geotextiles, CIRIA, London, (1996).
6. Jones, J.E.P., Earth Reinforcement and Soil Structure, Butterworths, (1985).
7. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, (2001).
8. Moseley, M.D., Ground Treatment, Blackie Academic and Professional, (1998).
9. Das, B.M, Principles of Foundation Engineering, Fourth Edition, PWS Publishing, (1999).
10. Koerner, R.M. and Welsh, J.P, Construction and Geotechnical Engineering using Synthetic Fabrics, John Wiley, (1990).
11. Hehn, R.W, Practical Guide to Grouting of Underground Structures, ASCE, (1996).
12. Shroff, A.V, Grouting Technology in Tunneling and Dam, Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi, (1999).



24RCE316

Geopolymer Cement and Concrete

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVES:**

1. To familiarize with the basic chemistry, structure, and reactions of geopolymer formation and its reaction products
2. To understand the fundamentals of Geopolymer composites (resins, pastes, mortars, concretes) and their characterization using different advanced analytical tools
3. To study the characteristic properties of Geopolymer composites such as strength, durability, waste utilization, safe disposal of hazardous effluents and heavy metal encapsulations
4. To identify and evaluate various geopolymer systems for commercially viable practical applications in various fields such as infrastructure, nuclear, constructions, buildings, precast systems, strengthening/retrofitting operations, and thermal/fire resistances
5. To analyse the Geopolymer composites with reference to ecology, economy, sustainability and environmental friendliness
6. To gain about toxic waste management

**COURSE OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand the concepts of basic chemistry, structure, and reactions of geopolymer formation and its reaction products
2. Understand the fundamentals of Geopolymer composites and their characterization
3. characteristic properties of Geopolymer composites such as strength, durability, waste utilization, safe disposal of hazardous effluents and heavy metal encapsulations
4. Identify and evaluate various geopolymer systems for commercially viable practical applications.
5. Analyse the Geopolymer composites with reference to ecology, economy, sustainability and environmental friendliness
6. Will gain the knowledge about toxic waste management

**UNIT I - POLYMERS AND GEOPOLYMERS**

Introduction - The mineral polymer concept: silicones and geopolymers - Macromolecular structure of natural silicates and alumino silicates - Scientific Tools, X-rays, FTIR, NMR – Poly (siloxonate) and polysilicate, soluble silicate, Si:Al=1:0 - Chemistry of (Na,K)-oligo-sialates: hydrous alumino-silicate gels and zeolites - Kaolinite / Hydrosodalite based geopolymer, poly(sialate) with Si:Al=1:1 - MetakaolinMK-750 based geopolymer, poly(sialate-siloxo) with Si:Al=2:1- Chemical mechanism: formation of ortho-sialate (OH)<sub>3</sub>-Si-O-Al- (OH)<sub>3</sub> –

**UNIT II - GEOPOLYMERS AND TOXIC WASTE MANAGEMENT**

Calcium based geopolymer, (Ca, K, Na)-sialate, Si:Al=1, 2, 3 - Silica-based geopolymer, sialate link and siloxo link in poly(siloxonate) Si:Al>5 - Fly ash-based geopolymer - Phosphate-based geopolymers - Organic-mineral geopolymer - Containment with barriers - Waste encapsulation

requires MK-750-based geopolymers - Heavy metals in mine tailings - The use of geopolymers for paint sludge disposal - Treatment of arsenic-bearing wastes - Uranium mining waste treatment - Geopolymers in other toxic-radioactive waste management applications

### **UNIT III - PROPERTIES AND APPLICATIONS**

Physical properties of condensed geopolymers - Chemical Properties of condensed geopolymers - Long-term durability, archaeological analogues, geological analogues - Quality control - Development of user-friendly systems – Castablegeopolymer, industrial and decorative applications - Geopolymer – fiber composites - Foamed geopolymer - Geopolymers in ceramic processing

### **UNIT IV - GEOPOLYMER CEMENT**

The manufacture of geopolymer cements - Greenhouse CO<sub>2</sub> mitigation fosters the development of geopolymer cements - Additional Raw-Materials from industrial wastes - Additional Raw-Materials from industrial wastes - Replacement of (Na,K) soluble silicates with synthetic lavas

### **UNIT V - GEOPOLYMER CONCRETE**

Geopolymer concrete - Mixture proportions of fly ash-based geopolymer concrete - Mixing, casting, and compaction of fly ash-based geopolymer concrete - Curing of fly ash-based geopolymer concrete - Design of fly ash-based geopolymer concrete mixtures - Short-term properties of fly ash-based geopolymer concrete - Long-term properties of fly ash-based geopolymer concrete - Reinforced geopolymer concrete beams and columns - Better than Portland cement concrete

### **Suggested Readings**

1. J L Provis J S J van Deventer , “Geopolymers”, 1st Edition, Woodhead Publishing,(2009).
2. Joseph Davidovits Geopolymer Chemistry and Applications, Institute Géopolymère , 16 rue Galilée , France, (2011).
3. Advanced concrete technology by Zongjin li , John – Wily & sons , New Jersey
4. Innovative Material for concrete construction – ACES workshop by Michael N.Fardis, Springer Publications, London, New York

24RCE317

Pavement Engineering

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVES:**

1. To understand the importance of transportation and characteristics of road transport
2. To know about the history of highway development, surveys and classification of roads
3. To study about the geometric design of highways
4. To study about traffic characteristics and design of intersections
5. To know about the pavement materials and design
6. To design flexible and rigid pavements as per IRC.

**COURSE OUTCOMES**

On completion of the course, the students will be able to:

1. Carry out surveys involved in planning and highway alignment.
2. Design cross section elements, sight distance, horizontal and vertical alignment.
3. Implement traffic studies, traffic regulations and control, and intersection design.
4. Determine the characteristics of pavement materials.
5. Design flexible and rigid pavements as per IRC.
6. Will gain the knowledge of horizontal and vertical curves

**UNIT I - BASIC CONCEPTS**

Pavements types – Historical developments - Approaches to pavement design –vehicle and traffic considerations – behaviour of road materials under repeated loading – Stresses and deflections in layered systems.

**UNIT II - FLEXIBLE PAVEMENT**

Factors affecting flexible pavements – material characterization for analytical pavement design – CBR and stabilometer tests – Resilient modulus – Fatigue subsystem – failure criteria for bituminous pavements – IRC design guidelines.

**UNIT III - RIGID PAVEMENT**

Factors affecting rigid pavements - Design procedures for rigid pavement – IRC guidelines – Airfield pavements. Highway pavements – CRC pavements.

**UNIT IV - PAVEMENT EVALUATION AND REHABILITATION**

Pavement evaluation and rehabilitation, condition and evaluation surveys causes and types of distress – in flexible and rigid pavements – PSI models – Serviceability index of rural roads – Overlay design, pavements maintenance management and construction.

**UNIT V - STABILIZATION OF SOILS FOR ROAD CONSTRUCTIONS**

The need for a stabilized soil – Design criteria and choice of stabilizers – Testing and field control – Stabilisation in India for rural roads – Use of Geosynthetics in road construction - Case studies.

## Suggested Readings

1. Wright, P.H, Highway Engineers, John Wiley & Sons, Inc., New York, (1996).
2. Khanna S.K and Justo C.E.G, Highway Engineering, Eighth Edition, New Chand and Brothers, Roorkee, (2001).
3. Yoder R.J and WitchakM.W, Principles of Pavement Design, John Wiley, (2000).
4. Croney, D, Design and Performance of Road Pavements, HMO Stationary Office, (1979).
5. Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, (2001).
6. Guidelines for the Design of Flexible Pavements, IRC:37 - 2001, The Indian roads Congress, New Delhi.
7. Guideline for the Design of Rigid Pavements for Highways, IRC:58-1998, The Indian Roads Congress, New Delhi.
8. O' Flaherty, C.A, Highway Engineering (Vol. 2), Edward Arnold Cp, (1978).
9. Bell. P.S, Developments in Highway Engineering, Applied Sciences publishers, (1978).

24RCE318

Sustainable Solid Waste collection and Management 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. To gain a brief knowledge on different hazardous waste and its disposal methods.
2. To provide students with the necessary background and knowledge about the various sources.
3. To know the on-site/off-site processing of the Solid waste management and the disposal methods.
4. To characterize the waste and its sources with various test available for checking the quality.
5. To impart knowledge and skills in various components of Municipal Solid Waste Management.
6. To gain the knowledge of processing and conversion technologies.

**Course Outcomes:**

1. Brief knowledge on different hazardous waste and its disposal methods.
2. The necessary background and knowledge about the various sources.
3. The on-site/off-site processing of the Solid waste management and the disposal methods.
4. Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of materials and energy from waste.
5. Have an overview of the Indian and international waste management regulations and guidelines for the design, construction, operation and management of waste treatment facilities.
6. Ways of operation of collection, transfer, treatment, management and disposal of wastes as per Solid Waste Management Rules, 2016.

**UNIT I- INTRODUCTION**

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management – Elements of integrated waste management and roles of stakeholders - Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, lead acid batteries, plastics and fly ash.

**UNIT II - WASTE CHARACTERISATION AND SOURCE REDUCTION**

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes – Recycling and reuse – Waste exchange.

**UNIT III - STORAGE, COLLECTION AND TRANSPORT OF WASTES**

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport

**UNIT IV- WASTE PROCESSING TECHNOLOGIES**

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes

## **UNIT V - WASTE DISPOSAL**

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – closure of landfills – landfill remediation.

### **Suggested Readings**

1. M. N. Rao, Razia Sultana, “ Solid and Hazardous Waste Management” Second Edition, BS Publications, ( 2020).
2. S. Bhatia , “Solid and Hazardous Waste Management”, BS Publications,(2007)
3. M. N. Rao & Razia Sultana, “Solid and Hazardous Waste Management”, Second Edition, BS Publications (2020).
4. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, McGraw- Hill International edition, New York, (1993).
5. CPHEEO, “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, (2000).

**COURSE OBJECTIVE:**

1. To gain a sound fundamental understanding of the GIS and remote sensing technologies
2. To understand the basic principles underlying the GIS/model-based management of water resources and environment.
3. To become familiar with the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
4. Different types of remotely sensed images and data available for water resource applications.
5. To apply the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
6. To develop a project report and can develop Water Resource Information Systems (WRIS) for regional and basin scale.

**COURSE OUTCOMES**

By the end of this course the students will be able to

1. Develop fundamental understanding of the GIS and remote sensing technologies
2. Understand the basic principles underlying the GIS based management of water resources and environment.
3. Apply the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
4. Understand the types of remotely sensed images and data available for water resource applications.
5. Develop a project report and can develop Water Resource Information Systems (WRIS) for regional and basin scale.
6. Understand the basic principles underlying the GIS/model-based management of water resources and environment.

**UNIT I -FUNDAMENTALS OF REMOTE SENSING**

Introduction to remote sensing – Principles of Electro – Magnetic Radiation – Energy / Matter interaction with Atmosphere and land surface – spectral reflectance of earth Materials and vegetation – Data products

**UNIT II - AERIAL PHOTOGRAPHY AND SATELLITE REMOTE SENSING**

Aerial Photography – photogrammetry And Visual Image Interpretation –Various Satellites in orbit and their sensors – Resolutions - Multispectral Remote Sensing System (MSS) and design – VISIBLE – NIR remote sensing – Thermal IR Radiation Properties, systems and application – Microwave and LIDAR remote sensing – Principles and applications

**UNIT II - DATA ANALYSIS AND GIS**

Data Analysis – Visual interpretation and digital image processing – Classification -Introduction to GIS, concepts and base structure , various GIS software.

#### **UNIT IV - REMOTE SENSING AND GIS APPLICATIONS**

Application of Remote sensing and GIS – Management and Monitoring of Land, air ,Water and pollution studies – conservation of resources – coastal zone management – Limitations

#### **UNIT V - LABORATORY PRACTICES**

Data sources - Visual interpretation - digital image processing –Introduction to ENVI image processing software – GIS / Data Analysis in ARC GIS.

#### **Suggested Readings**

1. Anji Reddy , “Remote Sensing and Geographical Information system “, B S Publications, (2001).
2. M.G. Srinivas, “Remote sensing applications”, Narosa publishing House, (2001).
3. A M. Chandra and S.k .Ghosh, “Remote Sensing and Geographical Information System”, Narosa Publishing House, (2006).
4. Lintz, J. and Simonet, Remote Sensing of Environment, Addison Wesle Publishing Company, (1994).
5. Burroughs, P.A, Principles of Geographical Information system , Oxford University Press, (1998).
6. Thomas M Lillesand, Rupert W. Kiefer & Jonathan W. Chipman “Remote sensing and Image Interpretation” John Wiley Sons, (2004).



24RCE320

Groundwater Modeling And Management

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**COURSE OBJECTIVE:**

1. These courses are introduced to the students to understand the basic concept of mathematical modelling
2. To know about the process simulation techniques of environmental disturbances
3. To know about modeling concept and transport phenomena.
4. To understand ground water prospecting.
5. To understand the contaminant transport model in environment.
6. To gain the knowledge about the ground water flow model.

**Course Outcomes:**

At the end of this course students can

1. Understand the basic concept of mathematical modelling
2. Know about the process simulation techniques of environmental disturbances with groundwater domains.
3. Concept of modeling concept and transport phenomena.
4. Understand ground water flow model.
5. Understand the ground water prospecting understand the contaminant transport model in environment.
6. Know the importance of Subsurface mass transport through the vadose zone.

**UNIT I - GROUNDWATER PROSPECTING**

Investigation and evaluation – Geophysical methods- Electrical Resistivity methods – Interpretation of data – Seismic method – Subsurface investigation – Test drilling – Resistivity logging – Application of remote sensing techniques.

**UNIT II - GROUNDWATER FLOW MODEL**

Physical models – Analog models – Mathematical modeling – Unsaturated flow models Numerical modeling of groundwater flow – Finite Differential equations - Finite difference solution – Successive over Relaxation, Alternating direction implicit procedure – Crank Nicolson equation – Iterative methods -Direct methods - Inverse problem – Finite element method

**UNIT III - CONTAMINANT TRANSPORT MODEL**

Contaminant transport theory – Advection, dispersion equation – Longitudinal and transverse dispersivity – Hydrodynamic dispersion – Analytical models – Numerical simulation of solute transport – Solution methods - Sorption model – Subsurface mass transport through the vadose zone - Density driven flow - Heat transport.

**UNIT IV - MODEL DEVELOPMENT**

Data requirements – Conceptual model design : Conceptualization of aquifer system – Parameters, Input-output stresses, Initial and Boundary conditions - Model design and execution : Grid design, Setting boundaries, Time discretization and Transient simulation – Model calibration : steady state and unsteady state – sensitivity analysis – Model validation and prediction – Uncertainty in the model prediction

**UNIT V - GROUNDWATER MANAGEMENT MODEL**

Optimal groundwater development – Indian GEC norms – Conjunctive use models Modeling multilayer groundwater flow system -Modeling contaminant migration – Modeling fracture flow

system – Artificial recharge feasibility through modeling – Simulation of movements of solutes in unsaturated zone – Stochastic modeling of groundwater flow - Groundwater contamination, restoration and management

### **Suggested Readings**

1. Anderson M.P., and Woessner W.W, Applied Groundwater Modelling : Simulation of flow and advective transport, Academic Press, Inc, (2000).
2. Fetter C.W, Contaminant Hydrogeology, Prentice Hall, (2008).
3. Rushton K.R, Groundwater Hydrology:Conceptual and Computational Models, Wiley, (2003).
4. Elango L. and Jayakumar, R., Modelling in Hydrology, Allied Publishers Ltd, (2001).
5. Remson I., Hornberger G.M. and MoltzF.J, Numerical Methods in Subsurface Hydrology, Wiley, New York, (2007).
6. Robert Willis and William W.G.Yenth, Groundwater System Planning and Management, Prentice Hall, Englewood Cliffs, (1987).
7. M. Thangarajan, Vijay P. Singh,Groundwater Assessment, Modeling, and Management, CRC Press Custom Publishing, (2016).

24RCE321 Advanced Treatment Techniques for industrial Wastewater

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. To learn various process engineering, unit operations of Mining, Metallurgical, Thermal Power, Cement and Petroleum Industries.
2. Provides a fundamental understanding of the design, operational principles and practical applications of modern instrumental methods employed in chemical analysis of environmental samples.
3. To have a basic knowledge about Source reduction techniques.
4. To understand the concept of wastewater reuse and residual management
5. To understand detailly about Disposal on water and land
6. To gain the knowledge about the pollution prevention of assessment.

**Course Outcomes:**

At the end of this course students can

1. Understanding the environmental aspects and impacts of each unit operations of the polluting industries.
2. The students will be able to understand and orient themselves with the industry before they undergo summer training, internship, interview or job.
3. The students will be able to conceive and prepare Environmental Management Plan of these industries.
4. Develop critical thinking skills in the areas of instrument selection, method development and data interpretation.
5. Knowledge in various case studies about various industries.
6. Able to get a detailed Regulatory requirement for treatment of industrial wastewater.

**UNIT I - INTRODUCTION**

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management

**UNIT II - INDUSTRIAL POLLUTION PREVENTION**

Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Pollution Prevention of Assessment - Material balance - Evaluation of Pollution prevention options –Cost benefit analysis – pay back period - Waste minimization Circles

**UNIT III - INDUSTRIAL WASTEWATER TREATMENT**

Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – carbon adsorption – Photo-catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.- Treatability studies.

#### **UNIT IV - WASTEWATER REUSE AND RESIDUAL MANAGEMENT**

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse, Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

#### **UNIT V - CASE STUDIES**

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries.

#### **Suggested Readings**

1. Eckenfelder, W.W, Industrial Water Pollution Control, Mc-Graw Hill, (2000).
2. Nelson Leonard Nemerow, Industrial waste treatment contemporary practice and vision for the future, Elsevier, Singapore, (2007).
3. Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, (2001).
4. Paul L. Bishop, Pollution Prevention: - Fundamentals and Practice, Mc-Graw Hill International, Boston, (2000).
5. Dezotti, Márcia, Lippel, Geraldo, Bassin, João Paulo- Advanced Biological Processes for Wastewater Treatment, Springer International Publishing, (2018).
6. Mogens Henze, Poul Harremoës, Erik Arvin, Jes La Cour Jansen, “Wastewater Treatment” Springer-Verlag Berlin Heidelberg, (2017).

24RCE322

Environmental Policies and Legislations

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. Understating the environmental laws, acts, standard for environmental compliance.
2. Understating the EIA and its methodologies for Industries and Regulators.
3. To learn methodologies of Environmental Management System through Appellate Authority – Penalties for violation of consent conditions
4. To learn the implementation of Environmental Management System through Environmental Audits.
5. Insight of regulatory framework related to hazardous waste management.
6. To have a knowledge about the air act, water act and environmental act.

**Course Outcomes:**

At the end of this course students can learn the

1. Concepts and applications of Environmental Laws and EIA in real world situations
2. Environmental management system and various auditing processes.
3. Prepare the statutory Environmental Statement for various industries.
4. Serve and guide the industrial sector as good corporate citizens.
5. Understanding the principles of regulatory framework for the treatment and disposal of hazardous wastes.
6. Knowledge about the Concept of absolute liability.

**UNIT I - INTRODUCTION**

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration – Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework (SPCB/CPCB/MoEF)

**UNIT II - WATER (P&CP) ACT, 1974**

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

**UNIT III - AIR (P&CP) ACT, 1981**

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

#### **UNIT IV- ENVIRONMENT (PROTECTION) ACT 1986**

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Siting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

#### **UNIT V- OTHER TOPICS**

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

#### **Suggested Readings**

1. CPCB,“Pollution Control acts, Rules and Notifications issued there under “Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, (1997).
2. Shyam Divan and Armin Roseneranz,“Environmental law and policy in India “Oxford University Press, New Delhi, (2001).
3. Pollution control Legislations volume I &II issued by Tamil Nadu Pollution Control Board.

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. To study the various management techniques for successful completion of construction
2. To study the effect of management for project organization
3. To understand a design of construction process.
4. To understand about the labour, material and equipment utilization
5. To learn about the application of cost indices and cost estimation in the construction
6. To gain the knowledge about the Estimation of operating cost

**Course Outcomes:**

At the end of this course students can

1. Understanding the various management techniques and Role of Project Managers
2. The students will be able to understand modern trends in project management
3. The students will be able to Design and Construction as an Integrated System
4. Develop critical thinking skills in the areas of problems in construction management, Choice of Equipment and Standard Production Rates
5. Knowledge in various Construction Processes Queues and Resource Bottlenecks.
6. Able to get a detailed knowledge in resource utilisation and cost estimation.

**UNIT I THE OWNERS' PERSPECTIVE** - Introduction - Project Life Cycle - Types of Construction - Selection of Professional Services - Construction Contractors - Financing of Constructed Facilities - Legal and Regulatory Requirements - Changing Environment of the Construction Industry - Role of Project Managers.

**UNIT II ORGANIZING FOR PROJECT MANAGEMENT** - Project Management – modern trends - Strategic Planning - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence - Professional Construction Management - Owner-Builder Operation - Turnkey Operation -Leadership and Motivation for the Project Team.

**UNIT III - DESIGN AND CONSTRUCTION PROCESS** - Design and Construction as an Integrated System - Innovation and Technological Feasibility - Innovation and Economic Feasibility - Design Methodology - Functional Design - Construction Site Environment.

**UNIT IV - LABOUR, MATERIAL AND EQUIPMENT UTILIZATION** - historical Perspective - Labour Productivity - Factors Affecting Job-Site Productivity - Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management. - Construction Equipment - Choice of Equipment and Standard Production Rates - Construction Processes Queues and Resource Bottlenecks.

**UNIT V - COST ESTIMATION** - Costs Associated with Constructed Facilities - Approaches to Cost Estimation - Type of Construction Cost Estimates - Effects of Scale on Construction Cost - Unit Cost Method of Estimation - Methods for Allocation of Joint Costs - Historical Cost Data - Cost Indices - Applications of Cost Indices to Estimating - Estimate Based on Engineer's List of Quantities - Estimation of Operating Costs.

## REFERENCE BOOKS:

1. Prasanna Chandra " Project Planning,Analysis, Selection, Implementation and review" Tata Mcgraw Hill ,1999
2. Chitkara, K.K Construction Project Management: Planning Scheduling and control Tata McGraw-Hill Publishing Company, New Delhi- 1998
3. Frederick E. Gould, Construction Project Management, Went worth Institute of Technology,Vary E. Joyce, Massachusetts Institute of Technology, 2000
4. Choudhury, S Project Management, Tata McGraw-Hill Publishing company New Delhi 1988.
5. Sengutha,B., Guha,H., " Construction Management and Planning ", TataMcGraw Hill,2001



Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**Course Objectives:**

1. To have an overall knowledge of the traffic components and assess the traffic characteristics and related problems.
2. To develop a strong knowledge base of traffic planning and its management in any transportation area.
3. To provide knowledge of traffic control devices and its techniques in transportation interaction.
4. To understand the concept of wastewater reuse and residual management
5. To understand the geometric design of intersections
6. To gain the knowledge about the Traffic Management.

**Course Outcomes:**

At the end of this course students can

1. The students will gain knowledge in the fundamentals components of traffic engineering and its features.
2. The students will get a vast understanding on various traffic enforcements rules and regulations.
3. The students will get aware in the field of transportation and its utility in solving the traffic problems.
  1. Understanding in geometric design of intersections
  2. Able to understand about the Traffic Management System.

**UNIT I - INTRODUCTION**

Significance and scope, Characteristics of Vehicles and Road Users, Skid Resistance and Braking Efficiency (Problems), Components of Traffic Engineering- Road, Traffic and Land Use Characteristics

**UNIT II - TRAFFIC SURVEYS AND ANALYSIS**

Surveys and Analysis - Volume, Capacity, Speed and Delays, Origin and Destination, Parking, Pedestrian Studies, Accident Studies and Safety Level of Services- Problems

**UNIT III - TRAFFIC CONTROL**

Traffic signs, Road markings, Design of Traffic signals and Signal co-ordination (Problems), Traffic control aids and Street furniture, Street Lighting, Computer applications in Signal design

**UNIT IV - GEOMETRIC DESIGN OF INTERSECTIONS**

Conflicts at Intersections, Classification of Intersections at Grade, - Chanallised and Unchanallised Intersection - Grade Separators (Concepts only), Principles of Intersection Design, Elements of Intersection Design, Chanallisation and Rotary design (Problems), Grade Separators

## UNIT V - TRAFFIC MANAGEMENT

Traffic Management- Traffic System Management (TSM) and Travel Demand Management (TDM), Traffic Forecasting techniques, Restrictions on turning movements, One-way Streets, Traffic Segregation, Traffic Calming, Tidal flow operations, Exclusive Bus Lanes - Introduction to Intelligence Transport System (ITS)

### REFERENCES:

1. Indian Roads Congress (IRC) specifications: Guidelines and special publications on Traffic Planning and Management.
2. Guidelines of Ministry of Road Transport and Highways, Government of India.
3. SubhashC.Saxena,( 2009), A Course in Traffic Planning and Design, DhanpatRai Publications, New Delhi.
4. Khanna K and Justo C E G(2001), Highway Engineering, *Khanna Publishers, Roorkee.*
5. KadiyaliL(2000), *Traffic Engineering and Transport Planning.Khanna Technical Publications, Delhi.*