

# Ph.D Programme in Chemistry

## Curriculum & Syllabus 2024-2025



**DEPARTMENT OF CHEMISTRY**  
FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

### **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

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**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 outside 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  
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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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**December, 2022**

<Font Size 14>

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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**

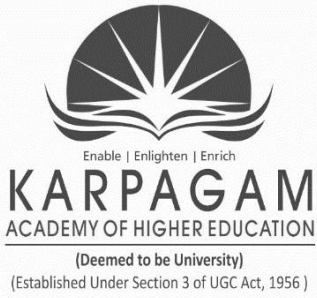
<Font Size 16>

<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

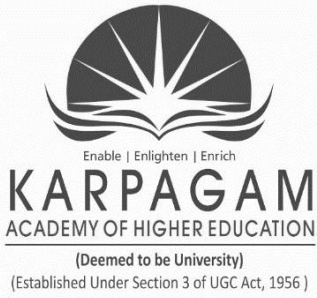
#### Check list

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, (Tick whichever is applicable)  
Time line Presentation and  
Annual Research Congress)

**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:**

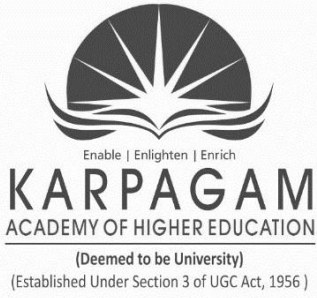
**Research Scholar**

**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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---

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

**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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**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:**

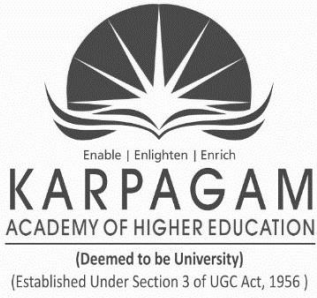
1	2	3	4	5	6	7	8	9	10	11	12	13	14
---	---	---	---	---	---	---	---	---	----	----	----	----	----

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

**Addl. Director, Research**

**Director, Research**





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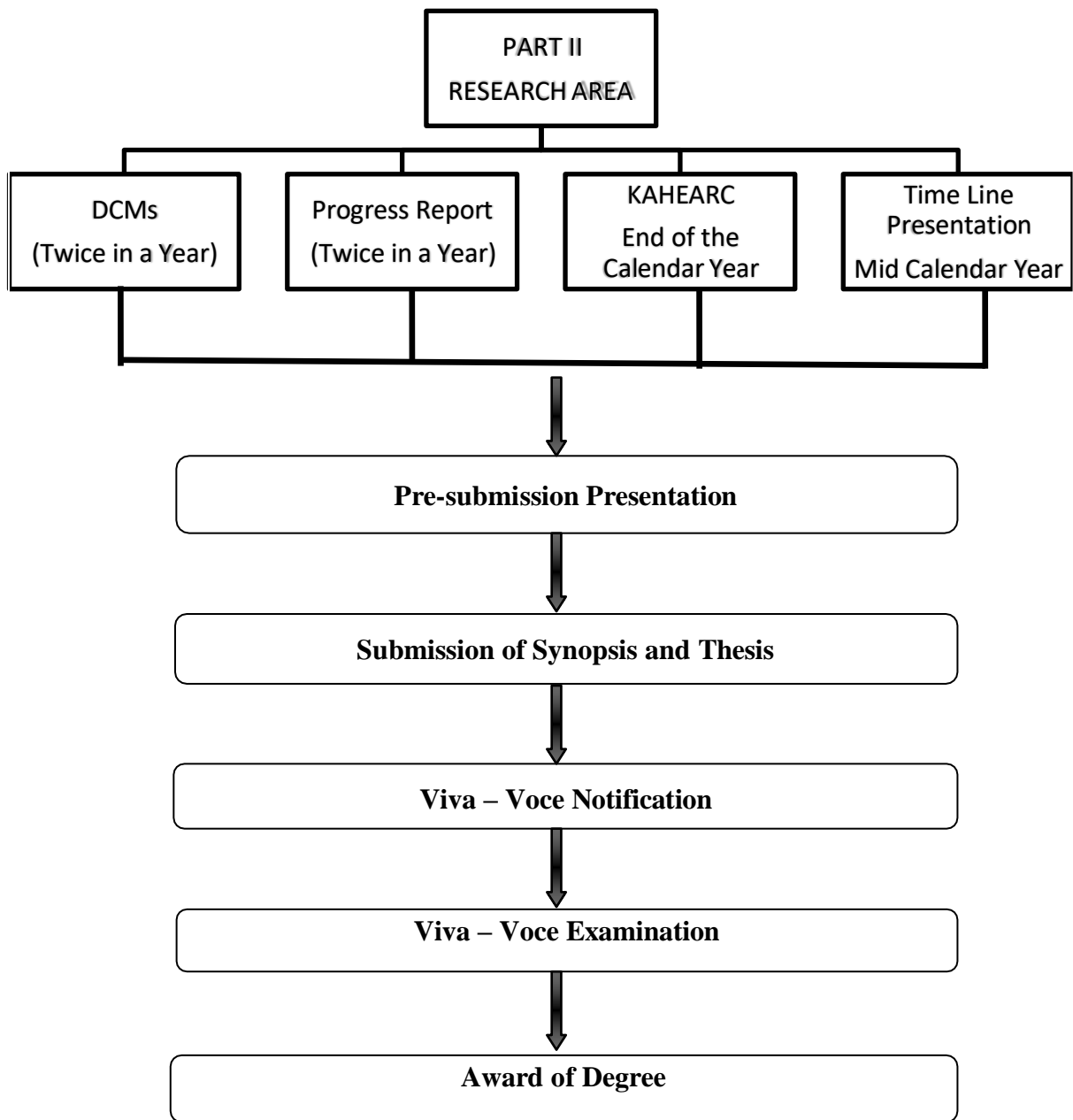
## Certificate of Plagiarism

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 CHEMISTRY****FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT****RESEARCH PROGRAM – Ph.D in Chemistry****(2024–2025 Batch and onwards)**

<b>Course Code</b>	<b>Name of the Course</b>	<b>Instruction hours / week</b>	<b>Credits</b>	<b>Maximum Marks (100)</b>	<b>Page No.</b>
<b>Paper-I</b>					
24RCH101	Research Methodology and Pedagogy	4	4	100	1
<b>Paper-II</b>					
24RCH201	Research and Publication Ethics	4	4	100	4
<b>Paper-III</b>					
24RCH301	Organic Chemistry	4	4	100	6
24RCH302	Nanochemistry				9
24RCH303	Electrochemistry				11
24RCH304	Environmental Chemistry				13
24RCH305	Organometallic Chemistry of Transition Metals				15
24RCH306	Polymer Chemistry				18
<b>Program Total</b>		<b>12</b>	<b>12</b>	<b>300</b>	

**COURSE OBJECTIVES:**

To make the learners to:

- Understand the fundamentals of research methodology.
- Analyze chemical data accurately by understanding errors, applying statistical tests, and employing effective sampling techniques
- Systematically define research problems, design studies, and develop plans for data collection and publication
- Know the principles and applications of various spectroscopic and chromatographic techniques for the quantitative analysis of chemical substances
- Enhance teaching effectiveness in higher education through diverse pedagogical methods, instructional design, and innovative evaluation techniques

**COURSE OUTCOMES (COs):**

Learners able to:

1. Demonstrate a strong understanding of the key principles and techniques in research methodology
2. Analyze chemical data by identifying errors, applying appropriate statistical tests, and sampling methods.
3. Define research problems and create comprehensive research designs, including plans for data collection and publication.
4. Gain the knowledge of the principles and applications of various spectroscopic and chromatographic techniques
5. Improve their teaching effectiveness in higher education by applying diverse pedagogical methods, instructional design principles, and innovative evaluation strategies.

**UNIT I**

Research Methodology-Objectives of Research - Types of Research - Criteria for good Research. Defining the Research Problem - Research Design. Dissertation writing- Guidelines for review of literature - Materials and methods, results and discussion. Interpretation of results, presentation of results, summary, presentation of references and appendix.

Use of Computers in Research – Data base Operations like creation–updating– indexing/sorting and searching of data, data entries and analysis, graphical applications.

**UNIT II**

**Data Analysis:** Errors in chemical analysis - classification of errors – determination of accuracy of methods - improving accuracy of analysis - significant figures - mean, standard deviation-comparison of results: “t” test, “f” test, and “chi” square test – rejection of results-presentation of data.

Sampling – introduction – definitions - theory of sampling-techniques of sampling - statistical

criteria of good sampling and required size - stratified sampling vs random sampling – minimisation of variance in stratified sampling – transmission and storage of samples.

### UNIT III

**Definition of problem:** Necessity of defining problem, Technique involved in defining a problem. Surveying the available literature. Building up of own literature collection, citation techniques.

**Research Design:** Subject of study; Place of study; Reason of such study; Type of data required; Method of data collection; Periods of study; Style of data presentation.

**Developing a research plan:** Research objective; Information's required for solving the problem; Different methods used to solve a problem.

**Publication of Journal Articles:** Concept, types of journals, components of a journal article, preparation of the manuscript, from manuscript to publication and online submission.

**Submission of Research Proposals:** Leading funding agencies in India, Submission of research project proposals with prescribed formats.

### UNIT IV

#### **Flame emission and atomic absorption spectroscopy and Fluorometric Analysis:**

Types of atomic spectroscopy – emission methods - absorption methods - fluorescence methods - applications of atomic emission spectroscopy – flames and flame spectra. Fluorescence and phosphorescence –application of fluorometric analysis.

#### **HPLC and Gas Chromatography:**

Theory of chromatography - detectors - Application of gas/mass analysis. Principles of high performance liquid chromatography - gradient elution, isocratic elution, sampling detectors for liquid chromatography - quantitative analysis by HPLC.

### UNIT V

#### **Pedagogical Methods in Higher Education:**

Objectives and roll of higher education – Important characteristics of an effective Lecture – Quality teaching and learning – Lecture preparation – Characteristics of instructional design – Methods of teaching and learning : Large group – Technique – Lecture, Seminar, Symposium, Team Teaching, Project, Small group Technique – Simulation, role playing Demonstration, Brain storing, case discussion, and assignment, Methods of evaluation – Self evaluation, student evaluation, Diagnostic testing and remedial teaching – Question banking – Electronic media in education: - 'e' learning researches – web based learning

### SUGGESTED READINGS:

1. Dick, J. D. (1973). *Analytical Chemistry*. New York: McGraw Hill.
2. Dyer, J.R. (1965). *Applications of Absorption Spectroscopy of Organic Compounds*. New Jersey: Prentice-Hall, Englewood Cliffs.
3. Khopkar, S.M. (1998). *Basic Concepts of Analytical Chemistry*. New Delhi: New Age International,
4. Sharma, B. K. (2005). *Instrumental Methods of Chemical Analysis* (24<sup>th</sup> Revised Edition). Meerut: GOEL Publishing House.
5. Skoog, D.A., West, D.M. James Holler, F. & Crouch, S.R. (2014). *Fundamentals of*



- Analytical Chemistry* (IX Edition). United Kingdom: Brookes/Cole Publishers.
6. Willard, H.H., Merritt, Jr, L. L. Dean, J. A & Jr. F. A. Settle. (1988). *Instrumental Methods of Analysis* (XII Edition). Florence: Wadsworth Publishing Company.
  7. Vedanayagam, E.G. (1989). *Teaching Technology for College Teachers*. New Delhi: Sterling Publishers (P) Ltd.
  8. Rajasekar, S. (2005). *Computer Education and Educational Computing*. Hyderabad: Neelkamal Publications.
  9. Kumar, K.L. (1997). *Educational Technologies*. New Delhi: New Age International.

**24RCH201 RESEARCH AND PUBLICATION ETHICS****Paper II  
4H-4C****Instruction Hours/week: L:4****Marks: 100****End Semester Exam: 3 Hours****COURSE OBJECTIVES (CO):**

To make the learners to:

- Know about the basic of philosophy of science and ethics, research integrity, publication ethics
- Know about the hands-on sessions are designed to identify misconduct and predatory publications.
- Learn indexing and citation databases, open access publication, research and p metrics and plagiarism tools introduced in the course.
- Understand the concept of Group discussions.
- Learn the impact factor of journal as per Journal Citation Report.
- Identify the concept development of e- content.

**COURSE OUTCOMES (COs):**

Learners able to:

1. Attain mastery in basic concept and moral philosophy of research process.
2. Understand selective reporting and misrepresentation of date.
3. Identify violation of publication ethics, authorship and contributing and appeals.
4. Summarize the philosopher who developed the terms of ethics and their arguments about on ethics.
5. Know about the indexing database and impact factor of journals.
6. Understand the concepts of Learning Management system.

**UNIT I****Philosophy and Ethics:**

Introduction to Philosophy: Definition, nature and scope, concept, branches - Ethics: Definition, moral philosophy, nature of moral judgments 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 - Selective 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 contributor ship - 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 & IP:**

Integrated Library Management System (ILMS) : e-journals – e-books – e-shodhsindushodhganga – 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.

#### **SUGGESTED READINGS:**

1. Ray, P.P. (2022). *A Guide to Research and Publication Ethics A Text Book As per UGC Guidelines for UG, PG, MPhil and PhD*. New Delhi: New Delhi Publishers.
2. Oliver, P. (2003). *The Student's Guide to Research Ethics*. Philadelphia: Open University Press Maidenhead.
3. Zwart, H. (2010). *Tales of Research Misconduct*. Switzerland: Springer International Publishing AG.
4. Research Impact, <https://guides.osu.edu/c.php?g=608754&p=4224917>.
5. Pinder, D., & Elkins, D. (2015). *E-Learning Fundamentals: A Practical Guide*. United Kingdom: ATD Press.
6. Rushby, N., & Surry, D. (2016). *Wiley Handbook of Learning Technology* (I Edition). Wiley Education.

**COURSE OBJECTIVES (CO):**

To make the learners to:

- Understand fundamental concepts of molecular and frontier orbitals, pericyclic reactions, electrocyclic reactions and cycloadditions.
- Know the various reagents and compounds essential for organic synthesis and transformation processes.
- Understand fundamental concepts of stereoselective, stereospecific, and regiospecific reaction.
- Understand the theory and principles underlying various chromatographic techniques.
- Analyze UV, IR, NMR, and mass spectral data to deduce the structures of simple organic molecules.

**COURSE OUTCOMES (COs):**

Learners able to:

1. Demonstrate a thorough understanding of molecular and frontier orbitals, as well as pericyclic, electrocyclic, and cycloaddition reactions.
2. Identify and utilize various reagents and compounds essential for organic synthesis and transformation processes.
3. Distinguish between stereoselective, stereospecific, and regiospecific reactions, applying this knowledge to design targeted synthetic pathways.
4. Articulate the theory and principles of various chromatographic techniques for compound separation and analysis.
5. Competently analyze UV, IR, NMR, and mass spectral data to deduce the structures of simple organic molecules.

**UNIT I****Theory of Concerted Reactions:**

Definitions - molecular orbitals – frontier orbitals – frontier orbital approach – correlation diagrams – the aromatic transition state concept – general rule for pericyclic reactions.

Electrocyclic Reactions:

Definition – thermal electrocyclic reactions – photochemical electrocyclic reactions – metal catalysed electrocyclic reactions.

Cycloadditions:

Introduction – selection rules for thermal polyene cyclo additions – Diels – Alder reaction – The retro diels – alder reaction – 1,3 Dipolar cycloadditions – Retro 1,3 – dipolar additions.

**UNIT II****Modern reagents in Organic synthesis:**

Sodium cyanoborohydride – osmium tetraoxide – lithium dimethyl copper – thallium trifluoro acetate – sodium hydrogen telluride – silver hexa fluorantimonate – Thiobenzoyl chloride –

trichloro silane- vanadium oxytrifluoro – phosphonitrile chloride – ruthenium tetraoxide – barium magnaganate – benzene selenic acid – benzene selenyl bromide/chloride, aluminium chloride/phosphoryl chloride.

### UNIT III

#### **Stereochemistry, Conformational Analysis & Retrosynthetic analysis:**

Stereoselective, stereospecific and regiospecific reactions – stereoselectivity in carbonyl addition- Cram's rule – configuration – conformation – torsional strain – Vander waals strain – gauche interaction – allylic strain – conformation analysis of acyclic molecules.

Retrosynthetic Analysis of Simple Organic compounds:

Retrosynthetic analysis of mono & difunctional open chain target molecules and monocyclic target molecules.

### UNIT IV

#### **Chromatography:**

Theory, Instrumentation & application in the chemical analysis of column, paper, thinlayer, ion-exchange, Gas chromatography (GC) and High Pressure Liquid Chromatography (HPLC).

Natural products:

Extraction, Isolation and structural elucidation (using spectroscopic methods) of terpenes, steroids, alkaloids and phenolic compounds.

### UNIT V

#### **Problem solving:**

Solving the structure of simple organic molecules on the basis of UV, IR, NMR & Mass spectral data. (restricted to organic compound compounds having 12 carbon atoms).

#### **SUGGESTED READINGS:**

1. Tewari, N. (2011). *Advanced Organic Reaction Mechanism* (III Edition). Kolkata: Books and Allied (P) Ltd.
2. Sanyal, S. N. (2014). *Reactions, Rearrangements and Reagents* (IV Edition). New Delhi: Bharathi Bhawan (Publishers and Distributors).
3. Ramesh, P. (2005). *Basic Principles of Organic Stereochemistry* (I Edition). Madurai: Meenu Publications.
4. Nasipuri, D. (2014). *Stereochemistry of Organic Compounds: Principles and Applications* (III Edition). New Delhi: New Age International (P) Ltd.
5. Warren, S., & Wyatt, P. (2008). *Organic Synthesis: The Disconnection Approach* (II Edition). John Wiley & Sons Ltd., Chichester.
6. Chatwal, G. R. (2015). *Organic Chemistry of Natural Products Vol. II*. New Delhi: Himalaya Publishing House.
7. Finar, I. L. (2013). *Organic Chemistry Vol. II: Stereochemistry and the Chemistry of Natural Products* (V Edition). New Delhi: Pearson Education, Ltd.
8. Chatwal, G. R. (2015). *Organic Chemistry of Natural Products. Vol. I*. New Delhi: Himalaya Publishing House.

9. Jag Mohan. (2018). *Organic Spectroscopy: Principles and Applications* (II Edition). New Delhi: Narose Publishing House.
10. Kemp, W. (2017). *Organic Spectroscopy* (III Edition). New York: Palgrave Macmillan.
11. Sharma, Y. R. (2017). *Elementary Organic Spectroscopy: Principles and Chemical Applications* (Revised Edition). New Delhi: S. Chand & Company Limited.
12. Silverstein, R. M., Webster, F. X., & Kiemle, D. (2014). *Spectroscopy of Organic Compounds* (VIII Edition). New York: John Wiley & Sons.
13. Sharma., B. K. (2012). *Instrumental Methods of Chemical Analysis* (28<sup>th</sup> Edition) Meerut: Krishna Prakashan Media (p) Ltd.
14. Usharani, S. (2002). *Analytical Chemistry*. Chennai: MacMillan India Ltd.
15. Sharma, B. K. (2019). *Instrumental Methods of Chemical Analysis* (27<sup>th</sup> Edition). Meerut: Krishna Prakashan Media (P) Ltd.
16. Feiser, M. (1986) *Feiser & Feiser's Reagents for Organic Synthesis* Vols. I – XII. John Wiley & Sons Inc.

**COURSE OBJECTIVES (CO):**

To make the learners to:

- Understand the fundamental concepts and introduction to nanomaterials and their unique properties.
- Understand and apply various synthesis techniques for nanomaterials, including chemical precipitation, sol-gel synthesis and reduction methods.
- Understand the structural classification of metal nanoparticles, explore size control and its impact on optical, electronic, and magnetic properties.
- Know the principles and applications of various characterization techniques, including X-ray diffraction, small angle X-ray scattering etc.
- Explore the properties, applications, and functionalization of fullerenes and carbon nanotubes.

**COURSE OUTCOMES (COs):**

Learners able to:

1. Demonstrate a solid understanding of the fundamental concepts of nanomaterials and their unique properties.
2. Apply various synthesis techniques for nanomaterials, such as chemical precipitation, sol-gel synthesis, and reduction methods.
3. Explore the structural classification of metal nanoparticles and understand how size control influences their optical, electronic, and magnetic properties.
4. Articulate the principles and applications of various characterization techniques.
5. Investigate the properties and applications of fullerenes and carbon nanotubes, gaining insights into their functionalization.

**UNIT I****Size and Shape of Nanomaterials:**

Introduction to nanomaterials, Properties of materials & nanomaterials, role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state.

**UNIT II****Chemical Routes for Synthesis of Nanomaterials:**

Chemical precipitation and co-precipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, melle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; Photochemical synthesis, Synthesis in supercritical fluids.

### **UNIT III**

#### **Nanostructures:**

Zero-, One-, Two- and Three- dimensional structure, Size control of metal Nanoparticles and their properties: Optical, Electronic, Magnetic properties; Surface plasmon Resonance, Change of bandgap; Application: catalysis, electronic devices.

### **UNIT IV**

#### **Structural Characterization:**

X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

### **UNIT V**

#### **Carbon nanostructures:**

Introduction. Fullerenes, C<sub>60</sub>, C<sub>80</sub> and C<sub>240</sub> nanostructures. Properties & applications (mechanical, optical and electrical). Functionalization of carbon nanotubes, reactivity of carbon nanotubes. Nanosensors: Temperature sensors, smoke sensors, sensors for aerospace and defence. Accelerometer, pressure sensor, night vision system, nano tweezers, nano-cutting tools, integration of sensor with actuators and electronic circuitry biosensors.

#### **SUGGESTED READINGS:**

1. Pradeep, T. (2007). *Nano: The Essentials*. New Delhi: Tata McGraw-Hill.
2. Cao, G. (2004). *Nanostructures and Nanomaterials–Synthesis, Properties and Applications*. London: Imperial College Press.
3. Rao, C. N. R., Muller, A & Cheetham, A. K. (2004). *The Chemistry of Nanomaterials*, Volume 1, Weinheim: Wiley –VCH Verlag GmbH & Co.
4. Ozin, G.A., Arsenault, A.C. Cademartiri, L., & Mirkin, C.A. (2008). *Nanochemistry: A Chemical Approach to Nanomaterials* (II Edition). RSC Publishing.
5. Egerton, R.F. (2005). *Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AFM*. New York: Springer New York.



**COURSE OBJECTIVES (CO):**

To make the learners to:

- Understand the fundamentals of corrosion, classification, electrochemical and thermodynamic principles.
- Explore the significance of electrode kinetics, including graphical presentation of kinetic data, polarization types, activation polarization etc.
- Examine the electrochemical behavior of active and passive metals.
- Understand the determination of corrosion and corrosion inhibition parameters through various non-electrochemical and electrochemical methods.
- Explore methods for corrosion prevention and control in metals and alloys.

**COURSE OUTCOMES (COs):**

Learners able to:

1. Demonstrate a solid understanding of the fundamentals of corrosion.
2. Explore the significance of electrode kinetics, effectively interpreting kinetic data through graphical presentations.
3. Examine the electrochemical behavior of active and passive metals, gaining insights into their responses to corrosion processes.
4. Understand and apply various non-electrochemical and electrochemical methods to determine corrosion and corrosion inhibition.
5. Explore and evaluate methods for corrosion prevention and control in metals and alloys.

**UNIT I****Introduction and Principles:**

Definition –Cost of corrosion-importance of corrosion studies-classification of corrosion-expressions for corrosion rate. Electrochemical principles of corrosion: Faraday's laws –Types of electrochemical cells formed in corrosion process. thermodynamic principles of corrosion: Electrochemical series/ standard electrode potentials and thermodynamic corrosion theory-Galvanic series of metals and alloys and limitations.

Forms of corrosion (Definition –cause and effects): Galvanic –Crevice –Pitting -Intergranular – Selective leaching –Erosion-Stress-Hydrogen damage.

**UNIT II****Kinetics of Corrosion:**

Importance –Graphical presentation of kinetic data –exchange current density –different types of polarization of electrodes.Activation polarization and Tafel plots –Mixed potential theory – Application of electrode kinetics to experimental observations-Faradic impedance and corrosion.

### **UNIT III**

#### **Kinetics of Passivity:**

Introduction-electrochemical behaviour of active/passive metals-Flade potentials-criteria for selecting a metal exhibiting passivity-effects of various factors on electrochemical behaviour and corrosion rate of metal exhibiting passivity-measured versus theoretical anodic polarization behaviour-Theories of passivity.

### **UNIT IV**

#### **Monitoring of Corrosion:**

Determination of corrosion and corrosion inhibition parameters-Non-electrochemical methods:Coupon-Electrical resistance-Gasometric methods:Electrochemical methods: Polarisation-Galvanostatic-Potentiostatic –Potentiodynamic-AC impedance-Hydrogen permeation.

### **UNIT V**

#### **Corrosion control:**

Metals and alloys-metal purification-non metallic-cathodic and anodic protection – comparison.Alteration of environment : Changing the medium –use of inhibitors-classification of inhibitors –mechanism of inhibition-Coating (Elementary ideas only).

#### **SUGGESTED READINGS:**

1. Review, W.R., & Uhlig, H.H. (2008). *Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering* (IV Edition). New York: A Wiley Interscience Publication.
2. Fontana, M.G. (1985). *Corrosion Engineering* (III Edition). Singapore: Mc.Graw Hill Book Company.
3. Narayan, R. (1983). *An Introduction to Metallic Corrosion and Its Prevention*. New Delhi: Oxford and IBH Publishing Company.
4. Schmitt, G. *Application of Inhibitors for Acid Media: Report prepared for the European Federation of Corrosion Working Party on Inhibitors*. British Corrosion Journal 19(4), 1984.

**COURSE OBJECTIVES (CO):**

To make the learners to:

- Understanding of water quality parameters, biochemical processes, and sewage composition to evaluate environmental impacts and treatment methods.
- Understand the sources, effects, and measurement of air pollutants to assess their impact on environment.
- Gain the knowledge of air sampling, pollutant collection methods, and analysis techniques to effectively assess and manage air quality.
- Understand the chemistry of composting and the mechanisms of organic material decomposition through aerobic and anaerobic processes.
- Explore the processes of incineration and pyrolysis for solid waste management.

**COURSE OUTCOMES (COs):**

Learners able to:

1. Assess water quality by various parameters to evaluate potential environmental impacts and optimize treatment methods.
2. Understanding of the sources and effects of air pollutants, enabling the ability to evaluate their environmental impact.
3. Acquire practical skills in air sampling and pollutant collection methods, equipping you to conduct accurate and reliable assessments of air quality.
4. Apply advanced analysis techniques to interpret air quality data.
5. Understanding of both water and air quality parameters, enhancing your capability to perform integrated environmental assessments.

**UNIT I****Chemistry of Water and Waste water:**

Basic principles and their significance with special reference to colour, turbidity, alkalinity, acidity, chemical coagulation, hardness, water softening, disinfection, residual chlorine and chlorine demand, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nitrogen, phosphate, sulphate, gas analysis, enzymes, factors affecting enzyme activity, biochemistry of carbohydrates, proteins, fats and oils under aerobic and anaerobic conditions, detergents and their degradation, composition and characteristics of sewage.

**UNIT II****Chemistry of air pollutants-I:**

Introduction, definition, classification of air pollutants, effect of air pollutants on man, materials, animals and plants, ambient air quality standards, harmful concentrations, geographical and meteorological factors in air pollution control, measurement of gas flows, volume, quantity and velocity.

### UNIT III

#### Chemistry of air pollutants-II:

Methods of sampling, particulate collection by liquid scrubbing, centrifugal spray scrubbers, venturi scrubbers, foam scrubbers; field sampling techniques such as deposition, absorption, filtration, condensation, adsorption, adhesion, electrostatic precipitation, thermal precipitation, analysis of air pollutants such as particulates sulphur dioxide, carbon monoxide, oxides of nitrogen, hydrogen sulphide, etc., control measures.

### UNIT IV

#### Chemistry of solid wastes:

Chemistry of composting: mechanism involved in the decomposition of organic materials like hemicellulose, proteins, carbohydrates, food materials, organic insecticides, farm wastes, etc., by aerobic and anaerobic processes.

### UNIT V

#### Chemistry of Incineration and Pyrolysis:

Incineration; definition; Incineration of solid waste; combustion characteristics of various inorganic and organic materials; heating values-determination of heating values of combustible liquid and solid wastes; air requirement for combustion; fate of trace constituents such as sulphur during incineration; gaseous pollutants; definition of pyrolysis; chemical changes taking place in organic and inorganic materials during pyrolysis; importance of pyrolysis in the solid waste disposal; chemistry of recycling of solid waste; recycling and reuse of materials such as paper, plastic, glass, etc.

#### SUGGESTED READINGS:

1. American Public Health Association. American Water Works Association & Water Pollution Control Federation, 1985. *Standard Methods for the Examination of Water and Wastewater*, (16<sup>th</sup> Edition). American Public Health Assoc., Washington, D.C
2. Hagerty, D.J., Pavoni, J.L. & Heer, J.E. (1973). *Solid Waste Management*. New York: Van Nostrand Reinhold Company.
3. Jacobs, M.B. (1960). *Chemical Analysis of Air Pollutants*. New York: Interscience Publishers.
4. Leithe, W. (1971). *The Analysis of Air Pollutants* Translated by R. Kenor. German: Ann Arbor-Humphrey Science Publishers.
5. Ross, R.D. (1972). *Air Pollution and Industry*. New York: Van Nostrand Reinhold Company.
6. Sawyer, C.N., & McCarty, P.L. (1978). *Chemistry of Environmental Engineering* (III Edition). New York: McGraw-Hill Book Co.
7. Stern, A.C. (1968). *Air Pollution*. New York: Academic Press.
8. Strauss, W. (1978). *Air Pollution Control*. New York: Wiley Interscience.
9. Stumm, W., & Morgan, J.J. (1972). *Aquatic Chemistry*. Wiley Interscience.
10. Wilson, D. G. (1977). *Hand Book of Solid Waste Management*. New York: Van Nostrand Reinhold Company.

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**24RCH305 ORGANOMETALLIC CHEMISTRY OF TRANSITION METALS 4H-4C****Instruction Hours/week: L:4****Marks: 100****End Semester Exam: 3 Hours****COURSE OBJECTIVES (CO):**

To make the learners to:

- Gain a comprehensive understanding of organometallic compounds, including their classification, bonding types, synthesis, structures, and reactivity.
- Develop an in-depth understanding of metal alkyl, alkene, and alkyne complexes.
- Gain a comprehensive understanding of cyclopentadienyl complexes.
- Understand the organometallic chemistry in catalysis, focusing on key reactions such as oxidative addition, elimination processes, and C-H activation mechanisms.
- Understand the principles and applications of homogeneous catalysis by transition metal complexes, focusing on key reactions.

**COURSE OUTCOMES (COs):**

Learners able to:

1. Demonstrate a thorough understanding of organometallic compounds, including their classification, bonding types, synthesis methods, structures, and reactivity.
2. Gain an in-depth understanding of metal alkyl, alkene, and alkyne complexes, allowing them to identify their unique properties and reactivity.
3. Acquire comprehensive knowledge of cyclopentadienyl complexes, including their structure and reactivity.
4. Understand the role of organometallic compounds in catalysis.
5. Grasp the principles and applications of homogeneous catalysis using transition metal complexes, focusing on significant reactions

**UNIT I**

Definition of organometallic compound – 18 electron rule – effective atomic number rule – classification of organometallic compounds – the metal carbon bond types – ionic bond – sigma covalent bond – electron deficient bond – delocalised bond – dative bond – metal carbonyl complexes – synthesis, structure and reactions of metal carbonyls – the nature of M-CO bonding – binding mode of CO and IR spectra of metal carbonyls – metal carbonyls – metal carbonyl anions – metal carbonyl hydrides – metal carbonyl halides – metal carbonyl clusters – Wades rule and isolobal relationship – metal nitrosyls – dinitrogen complexes – dioxygen complexes.

**UNIT II**

Metal alkyl complexes – stability and structure – synthesis by alkylation of metal halides, by oxidative addition, by nucleophilic attack on coordinated ligands – metal alkyl and 18 electron rule – reactivity of metal alkyls – M-C bond cleavage reactions – insertion of CO to M-C bonds – double carbonylation – insertions of alkenes and alkynes – insertions of metals with C-H bonds – alkylidene and alkylidyne complexes – synthesis of alkylidene complexes in low oxidation states and in high oxidation states – bonding in alkylidene complexes – synthesis and bonding in alkylidyne complexes – reactivity of alkylidene and alkylidyne complexes.

Alkene complexes – synthesis of alkene complexes by ligand substitution, by reduction and by metal atom synthesis – bonding of alkenes to transition metals – bonding in diene complexes – reactivity of alkene complexes – ligand substitution – reactions with nucleophiles – olefin hydrogenation – hydrosilation – Wacker process – C-H activation of alkenes – alkyne complexes – bonding in alkyne complexes – reactivity of alkynes – alkyne complexes in synthesis – cobalt catalysed alkyne cycloaddition.

### UNIT III

Cyclopentadienyl complexes – metallocenes – synthesis of metallocenes – bonding in metallocenes – reactions of metallocenes – CpFe/Cp<sub>2</sub>Fe<sup>+</sup> couples in biosensors – bent sandwich complexes – bonding in bent sandwich complexes – metallocene halides and hydrides – metallocene and stereospecific polymerization of 1-alkenes – cyclopentadiene as a non-spectator ligand – monocyclopentadienyl (half-sandwich) complexes – synthesis and structures of allyl complexes – arene complexes – synthesis, structure and reactivity of arene complexes – multidecker complexes.

### UNIT IV

Role of organometallic chemistry in catalysis Coordinative unsaturation – oxidative addition – addition reactions of specific molecules – hydrogen addition – HX addition – addition of X<sub>2</sub> – addition of RX – addition reactions of Si-H, C-C, C-Si and Si-Si bonds – elimination reactions – eliminations – alkane activation – intramolecular and intermolecular C-H activation – activation of sulphur heterocycles – insertion of carbon monoxide – isocyanide insertion – alkene insertion – alkyne insertion.

### UNIT V

Homogeneous catalysis by transition metal complexes

Hydrogenation reactions – reversible cis-dihydro catalysts – monohydride catalysts – hydrogenation of alk-1-ene – asymmetric hydrogenation – role of ruthenium complexes in 2001 Nobel Prize for chemistry – transfer hydrogenations – hydrosilation and hydroboration reactions – water gas shift reaction – reduction of carbon monoxide by hydrogen – hydroformylation of alkenes – alcohol carbonylation – decarbonylation reactions – C-C cross coupling and related reactions – alkene oligomerisations and polymerizations – Zeigler-Natta polymerization – alkene dimerisation and oligomerisations – valence isomerisation of strained hydrocarbons – alkene and alkyne metathesis – oxidations of alkanes and alkenes – oxygen transfer reactions – supported homogeneous and phase transfer catalysis.

### SUGGESTED READINGS:

1. Bockmann, M. (1996). *Organometallics 1, Complexes with Transition Metal-Carbon Bonds*. Oxford: Oxford Science Publications.
2. Bockmann, M. (1996). *Organometallics 2, Complexes with Transition Metal-Carbon Bonds*. Oxford: Oxford Science Publications.
3. Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). *Advanced Inorganic Chemistry* (VI Edition). New York: John Wiley & Sons.
4. Huheey, J. E., Keitler, E. A., & Keitler, R. L. (2011). *Inorganic Chemistry- Principles of Structure and Reactivity* (IV Edition). Singapore: Pearson Education.

5. Aktins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F., & Hagerman, M. (2010). *Shriver & Atkins' Inorganic Chemistry* (V Edition). Britain: Oxford University Press.

**COURSE OBJECTIVES (CO):**

To make the learners to:

- Gain a comprehensive understanding of various polymerization techniques.
- Understand the kinetics of free-radical and polycondensation polymerization, focusing on rate expressions, kinetic chain length, and degree of polymerization.
- Evaluate and compare bulk, solution, suspension, and emulsion polymerization techniques, highlighting their advantages and disadvantages.
- Gain a comprehensive understanding of thermal analysis methods for polymers.
- Explore the relationship between polymer structure and physical properties.

**COURSE OUTCOMES (COs):**

Learners able to:

1. Demonstrate a comprehensive understanding of various polymerization techniques.
2. Analyze the kinetics of free-radical and polycondensation polymerization.
3. Evaluate and compare bulk, solution, suspension, and emulsion polymerization techniques.
4. Gain a comprehensive understanding of thermal analysis methods for polymers, equipping them to assess thermal properties.
5. Explore the relationship between polymer structure and physical properties.

**UNIT I****Chemistry of Polymerization:**

Addition polymerization – Free radical polymerization – Initiation, Propagation and termination – inhibitors and retarders. Ionic polymerization – cationic and anionic-Living polymers. Coordination polymerization – Zeigler – Natta catalysts. Condensation polymerization – Extend of reaction and DP – Carother's equation and its significance. Three dimensional polymerization – cross linking – gel point – Ring scission polymerization.

**UNIT II****Kinetics of Polymerization:**

Kinetics of free-radical polymerization- Kinetic chain length and DP. Derivation for rate expression and expression for kinetic chain length and hence degree of polymerization. Kinetics of polycondensation with polyester as example. Simple kinetic expression – catalyzed and uncatalyzed polycondensation.

**UNIT III****Techniques of Polymerization:**

Bulk polymerization – solution polymerization – Suspension polymerization – Emulsion polymerization – Advantages and disadvantages of these techniques – comparison of the above.



## **UNIT IV**

### **Characterization of Polymers:**

Molecular weight determination – Method based on colligative property measurements – cryoscopy – ebullioscopy – osmometry – membrane osmometry- vapour –pressure osmometry – Methods based on viscosity. Measurements – viscometry –Light scattering method – ultracentrifuge technique- End group analysis – GPC method. Thermal methods of analysis in polymers – TGA, DTA, DSC.

## **UNIT V**

### **Polymer structure and Physical Properties:**

Crystalline melting point, Glass transition temperature – Properties involving deformations.

### **SUGGESTED READINGS:**

1. Billmeyer, F. W. (2003). *Text Book of Polymer Science* (III Edition). New York: John Wiley.
2. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. (2015). *Polymer Science* (II Edition). New Delhi: New Age International Private Ltd.
3. Odian, G. (2004). *Principles of Polymerization* (IV Edition). New York: John Wiley & Sons.
4. Arora, M.G. & Singh, M. (2001) *Polymer Chemistry* (I Edition). New Delhi: Anmol Publications Pvt Ltd.