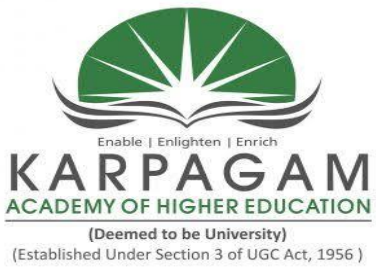
Ph.D. COMPUTER SCIENCE AND ENGINEERING

SYLLABI 2024-2025

Department of Computer Science and Engineering

FACULTY OF ENGINEERING



KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)

(Established Under Section 3 of UGC Act 1956)

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

Pollachi Main Road, Eachanari Post

Coimbatore-641 021

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 7th November, 2022
(The research scholars admitted from January, 2023 onwards will be governed by this regulation)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

Karpagam Academy of Higher Education

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Pollachi Main Road, Eachanari Post, Coimbatore – 641 021, Tamil Nadu, India
info@kahedu.edu.in; kuresearch@kahedu.edu.in
www.kahedu.edu.in

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, accreditor 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 and30% 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 enrollment /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 referred 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 points 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.

CERTIFICATE

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.

Signature of the Research Supervisor

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 fluorimetricassay 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: Antimutagenes is 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, Delhi University. 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 atleast 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.

TEMPLATE

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>

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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

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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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Submitted by

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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. Articles 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* (To be judged based on the DC Meeting, Time line Presentation and Annual Research Congress)	: Good/Satisfactory/Need improvement (Tick whichever is applicable)

Signature of the Research Scholar **Signature of the Research Supervisor**

*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 the presentation (enclose the attendance sheet)	:
9. A report on the Question & Answer Session (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* (additional sheets may be used)	: Good/Satisfactory/Needs improvement (Tick whichever is applicable)
11. After the Pre-submission Presentation whether the scholar may be permitted to submit the Thesis	: Permitted/Extended for one year (Strike out whichever is not applicable)

Signature:

Research Scholar **Research Supervisor** **HOD** **Dean**

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

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FORMAT – IV Annexure

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

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

Topic of the Research work:

Q1.
Answer:

Q2.
Answer:

Q3.
Answer:

Q4.
Answer:

Q5:
Answer:

Signature of

Research Scholar **Research Supervisor**

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FORMAT V

Pre-submission presentation
Certificate

Name & Reg. No. of the research scholar :

Subject :

Date of Presentation :

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

Place :
Date :

Signature of the Research Supervisor
(Name & Address)

Counter Signed:

HOD

(Name & Seal)

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

FORMAT - VI

Submission of Ph.D., Thesis: Check List

1. Name of the research scholar with Registration Number :
2. Name of the Research Supervisor :
   Designation :
   Department :
3. (a) Whether the minimum period completed? : Yes/No (Refer Registration Communication)
4. (b) If extension obtained, attach particulars :
5. Whether course fee paid for all the years : Yes/No (Attach No Dues Certificate)
6. Title of Ph.D. Research work :
7. Details of the Part I Course work :
8. (Enclose necessary documents)
9. Number of DC Meetings attended (Annually 2) :
10. Total No. of 6 months performance reports submitted : 6/8/10/12
    (a) No. of Time-line presentations attended :
    (b) No. of Annual Research Congress attended :
11. (a) Minimum No. of Research articles to be published : 2 as per KAHE regulation
    (b) No of articles published by the scholar :
    (Attach photocopies of reprints)
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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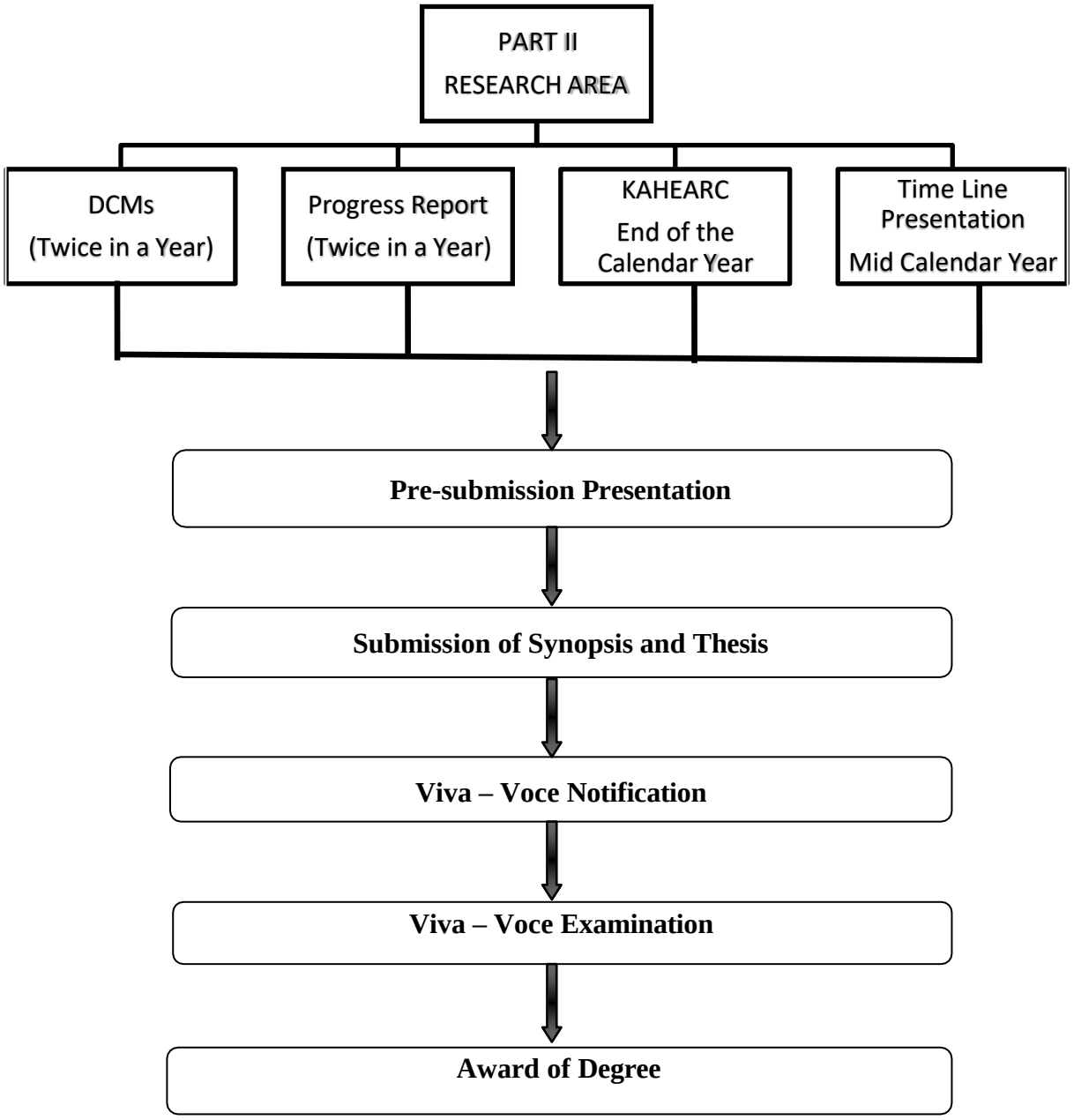
Certificate of Plagiarism

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


PART II
RESEARCH AREA
DCMs
(Twice in a Year)
Progress Report
(Twice in a Year)
KAHEARC
End of the
Calendar Year
Time Line
Presentation
Mid Calendar Year
Pre-submission Presentation
Submission of Synopsis and Thesis
Viva – Voce Notification
Viva – Voce Examination
Award of Degree

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 2008.

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, $\text{Impactfactor (in 2022)} = \frac{A}{B}$

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 physicist 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 SCI Search.

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.

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

RESEARCH PROGRAM – Ph.D in Computer Science and Engineering

(2024–2025 Batch and onwards)

Course Code	Name of the Course	Instruction Hours / Week	Credits	Maximum Marks (100)	Page No
24RCSE101	Research Methodology and Pedagogy	4	4	100	37
24RCSE201	Research Publication Ethics	4	4	100	39
24RCSE301	Advanced Digital Image Processing	4	4	100	41-88
24RCSE302	Ad hoc Networks				
24RCSE303	Artificial Intelligence				
24RCSE304	Big Data				
24RCSE305	Blockchain Technologies				
24RCSE306	Cloud Computing				
24RCSE307	Cyber Security				
24RCSE308	Data Visualization and Analytics				
24RCSE309	Data Warehousing and Data Mining				
24RCSE310	Deep Learning				
24RCSE311	Distributed Computing				
24RCSE312	Grid Computing				
24RCSE313	Image Processing and Pattern Recognition				
24RCSE314	Internet of Things				
24RCSE315	Machine Learning				
24RCSE316	Natural Language Processing				
24RCSE317	Network and Information Security				
24RCSE318	Network Routing Algorithms				
24RCSE319	Neural Networks and Applications				
24RCSE320	Optimization Techniques				
24RCSE321	Quantum Computing				
24RCSE322	Soft Computing				
24RCSE323	Virtual Reality				
24RCSE324	Wireless Sensor Networks				
Program Total		12	12	300	

24RCSE101 RESEARCH METHODOLOGY AND PEDAGOGY 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is:

- To demonstrate knowledge of research processes.
- To learn about the experimental design and testing methods.
- To understand about statistical methods and learning methods.

COURSE OUTCOMES

Upon completion of this course the students will be able to:

- Explain the Research process and Data collection methods.
- Illustrate measurement scales to judge an application.
- Apply hypotheses testing for statistical analysis in decisions making.
- Identify data analysis techniques used in research.
- Develop effective techniques for preparing and designing lectures.

UNIT I-INTRODUCTION TO RESEARCH

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps. Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

UNIT II-EXPERIMENTAL DESIGN

Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales –Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale-Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method – convenience sampling, judgment sampling, quota sampling.

UNIT III-TESTING METHODS

Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests), Concerning variance – one tailed Chi-square test-Nonparametric tests- One sample tests – one sample sign test, Kolmogorov-Smirnov test, run test for randomness, two sample tests – Two sample sign test, Mann-Whitney U test, K-sample test – Kruskal Wallis test (H-Test)

UNIT IV-MULTIVARIATE STATISTICAL TECHNIQUES

Data Analysis – Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical (SPSS) Software Package.in Research

UNIT V-PEDAGOGICAL METHODS IN HIGHER LEARNING

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 storming, Case studies and assignment, methods of evaluation-self-evaluation, student evaluation, diagnostics testing and remedial teaching –question banking-electronic media in education:-'e' learning researches-web based learning.

SUGGESTED READINGS

1. Donald R. Cooper and Ramela S. Schindler, (2000), Business Research Methods, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Uma Sekaran, (2000), Research Methods for Business, John Wiley and Sons Inc., New York.
3. C.R. Kothari, (2001), Research Methodology, Wishva Prakashan, New Delhi.
4. Donald H. Mc Burney, (2002), Research Methods, Thomson Asia Pvt. Ltd. Singapore.
5. G.W. Ticehurst and A.J. Veal, (1999), Business Research Methods, Longma.
6. Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi.
7. Raymond-Alain Thie'tart, et.al., (1999), Doing Management Research, Sage Publications, London.
8. Panneerselvam, R., (2004), Research Methodology, Prentice-Hall of India, New Delhi.

24RCSE201 RESEARCH PUBLICATION ETHICS 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand the philosophy of research and publication ethics.
- To familiarize the publication misconduct.
- To understand the publishing databases, research metrics and process in E-Conduct &IPR.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Explain the concepts of ethics, moral values, principles, and theories.
- Interpret ethical responsibilities of researchers and publishers in ensuring the integrity of published research
- Apply ethical principles and guidelines to real-world scenarios.
- Develop a solid principles and techniques involved in database indexing
- Utilize the objectives, scope, and benefits of SWAYAM, MOOCs and NPTEL in promoting open and accessible education.

UNIT I PHILOSOPHY AND ETHICS

Introduction to Philosophy: Definition, nature and scope, concept, branches- Ethics: Definition, moral Philosophy, nature of moral judgments and reactions. 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 II 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 III 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 Tumitin, Urkund and other opensource software tools.

UNIT IV DATABASE AND RESEARCH METRICS

Database: Indexing database - Citation database: Web of Science, Scopus, etc., Research Metrics: Impact Factor of journal as per journal citation Report, SNP, SJR, IPP, Cite score - Metrics:h-index, I10 index, altmetrics.

UNIT V DEVELOPMENT OF E-CONDUCT & IPR

Integrated Library Management System (ILMS): e-journals-e-books- e- shodsindu-shodhganga-Database –e-content Development –Learning Management system (LMS) –e- PG-Pathshala-CEC(UG) SWAYAM-MOOCs-NPTEL-NMEICT. IPR: Patent-Copyrights-Trademark-Geographical Indication

PRACTICE

OPEN ACCESS PUBLISHING

Open access publications and initiatives –SHERPA/ROMEO online resource to check polisher 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.

SUGESSTED READINGS

1. Best Practice Guidelines on Publishing Ethics: A Publisher's Perspective, Second Edition,2014 John Wiley & Sons, Ltd.
2. Wager E. The Committee on Publication Ethics (COPE): Objectives and achievements 1997-2012. Presse Med. 2012.
3. Carlson RV, Boyd KM, Webb DJ. The revision of the Declaration of Helsinki: Past, present and future. Br J ClinPharmacol. 2004.
4. KambadurMuralidhar, Amit Ghosh, & Ashok Kumar Singhvi "ETHICS in Science Education,Research and Governance",Indian National Science Academy, New Delhi 2019.
5. Publishing Ethics: Academic Research, Cambridge University Press, Version 2.0, May 2019.

24RCSE301 ADVANCED DIGITAL IMAGE PROCESSING 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand the image fundamentals and mathematical transforms necessary for image.
- To interpret the image segmentation and Extraction features on images
- To learn the concepts of image fusion and 3D image visualization.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Apply the mathematical principles to transforms its applications in image analysis and processing.
- Develop a comprehensive image segmentation techniques.
- Analyze algorithms, and parameters involved in detecting edges in images.
- Examine preprocessing techniques used to enhance image quality and remove noise in further analysis.
- Categorize color coding and mapping techniques to enhance the visual representation and interpretation of 3D data.

UNIT I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing.

UNIT II SEGMENTATION

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods

UNIT III FEATURE EXTRACTION

First and second order edge detection operators, Phase congruency, Localized feature extraction-detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Run length features, Fractal model-based features, Gabor filter, wavelet features.

UNIT IV REGISTRATION AND IMAGE FUSION

Registration- Preprocessing, Feature selection-points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, region matching Template matching. Transformation functions-Similarity transformation and Affine Transformation. Resampling-Nearest Neighbour and Cubic Splines Image Fusion-Overview of image fusion, pixel fusion, Multiresolution based fusion discrete wavelet transform, Curvelet transform. Region based fusion.

UNIT V 3D IMAGE VISUALIZATION

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

REFERENCES

1. John C.Russ, (2011), "The Image Processing Handbook", CRC Press.
2. Mark Nixon, Alberto Aguado, (2012), "Feature Extraction and Image Processing", Academic Press, 3rd edition.
3. Ardeshir Goshtasby, (2005), "2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications", John Wiley and Sons.
4. Rafael C. Gonzalez, Richard E. Woods, (2007), Digital Image Processing', Pearson Education, Inc., 3rd Edition.
5. Anil K. Jain, (2002), Fundamentals of Digital Image Processing', Pearson Education, Inc.,
6. Rick S.Blum, Zheng Liu, (2006), " Multisensor image fusion and its Applications", Taylor& Francis.

24RCSE302 **ADHOC NETWORKS** **4H–4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand the basics of Ad-hoc & Sensor Networks and protocols.
- To implement various security practices and protocols of Ad-hoc and Sensor Networks.
- To learn about QoS and Energy management in Ad-hoc network.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Illustrate the technical challenges associated with adhoc networks and the architecture of PRNET.
- Apply routing protocols effectively in adhoc wireless network scenarios.
- Develop protocols to different networking environments.
- Identify network security requirements in ad hoc wireless networks.
- Examine the architectural models and protocols that provide a systematic approach to QoS provisioning.

UNIT I INTRODUCTION

Introduction-Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum - Radio Propagation Mechanisms - Characteristics of the Wireless Channel - IEEE 802.11a, b Standard – Origin Of Ad hoc: Packet Radio Networks - Technical Challenges - Architecture of PRNETs - Components of Packet Radios – Ad hoc Wireless Networks -What Is an Ad Hoc Network? Heterogeneity in Mobile Devices - Wireless Sensor Networks - Traffic Profiles - Types of Ad hoc Mobile Communications - Types of Mobile Host Movements - Challenges Facing Ad Hoc Mobile Networks-Ad hoc wireless Internet

UNIT II AD HOC ROUTING PROTOCOLS

Introduction - Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks - Classifications of Routing Protocols -Table-Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV) - Wireless Routing Protocol (WRP) - Cluster Switch Gateway Routing (CSGR) - Source-Initiated On-Demand Approaches - Ad Hoc On- Demand Distance Vector Routing (AODV) - Dynamic Source Routing (DSR) - Temporally Ordered

Routing Algorithm (TORA) - Signal Stability Routing (SSR) - Location-Aided Routing (LAR) - Power-Aware Routing (PAR) - Zone Routing Protocol (ZRP)

UNIT III MULTICASTROUTING IN AD HOC NETWORKS

Introduction - Issues in Designing a Multicast Routing Protocol - Operation of Multicast Routing Protocols - An Architecture Reference Model for Multicast Routing Protocols - Classifications of Multicast Routing Protocols - Tree-Based Multicast Routing Protocols- Mesh-Based Multicast Routing Protocols - Summary of Tree-and Mesh-Based Protocols - Energy-Efficient Multicasting - Multicasting with Quality of Service Guarantees - Application-Dependent Multicast Routing - Comparisons of Multicast Routing Protocols

UNIT IV TRANSPORT LAYER, SECURITY PROTOCOLS

Introduction - Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks - Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks - Classification of Transport Layer Solutions - TCP Over Ad Hoc Wireless Networks - Other Transport Layer Protocols for Ad Hoc Wireless Networks - Security in Ad Hoc Wireless Networks - Network Security Requirements - Issues and Challenges in Security Provisioning - Network Security Attacks - Key Management - Secure Routing in Ad Hoc Wireless Networks

UNIT V QoS AND ENERGY MANAGEMENT

Introduction - Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks - Classifications of QoS Solutions - MAC Layer Solutions - Network Layer Solutions - QoS Frameworks for Ad Hoc Wireless Networks Energy Management in Ad Hoc Wireless Networks – Introduction - Need for Energy Management in Ad Hoc Wireless Networks - Classification of Energy Management Schemes - Battery Management Schemes - Transmission Power Management Schemes - System Power Management Schemes

SUGGESTED READINGS

1. Siva Ram Murthy C. and B.S. Manoj (2004), "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall PTR,
2. Toh C.K., (2001), Ad Hoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR
3. Charles E. Perkins, (2000), Ad Hoc Networking, Addison Wesley,
4. Mobile Ad Hoc networking**,** Stefano Basagni, Marco Conti, (26 August 2010) Wiley India Private Limited.
5. Mobile Ad Hoc Networks: Current Status and Future Trends Hardcover**,** Jonathan Loo, Jaime Lloret Mauri, (16 December 2011), CRC Press,

24RCSE303 **ARTIFICIAL INTELLIGENCE** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students

- To understand basic problem-solving strategies and constraint satisfaction.
- To explore reasoning and planning associated with AI.
- To understand probabilistic and statistical methods of AI.

COURSE OUTCOMES:

Upon completion of this course the students will be able to

- Illustrate problem solving methods to solve a puzzle of your choice
- Infer Game playing of a two-player game using AI techniques
- Develop an example using predicate Logic
- Model a case-based reasoning system
- Make use of methodologies to design ethical and explainable AI systems

UNIT I INTRODUCTION AND PROBLEM SOLVING

Artificial Intelligence -Introduction - Problem-solving -Solving Problems by Searching – Uninformed Search Strategies -Informed (Heuristic) Search Strategies - Local Search – Search in Partially Observable Environments

UNIT II ADVERSARIAL SEARCH AND CONSTRAINT SATISFACTION PROBLEMS

Game Theory- Optimal Decisions in Games - Heuristic Alpha--Beta Tree Search- Monte Carlo Tree Search - Stochastic Games - Partially Observable Games - Limitations of Game Search Algorithms Constraint Satisfaction Problems (CSP)– Examples - Constraint Propagation Backtracking Search for CSPs - Local Search for CSPs

UNIT III KNOWLEDGE, REASONING AND PLANNING

First Order Logic – Inference in First Order Logic -Using Predicate Logic – Knowledge Representation - Issues -Ontological Engineering - Categories and Objects – Reasoning Systems for Categories - Planning -Definition -Algorithms -Heuristics for Planning -Hierarchical Planning

UNIT IV UNCERTAIN KNOWLEDGE AND REASONING

Quantifying Uncertainty - Probabilistic Reasoning - Probabilistic Reasoning over Time Probabilistic Programming -Making Simple Decisions - Making Complex Decisions – Case Based Reasoning –Explanation-Based Learning – Evolutionary Computation

UNIT V PHILOSOPHY, ETHICS AND SAFETY OF AI

The Limits of AI – Knowledge in Learning –Statistical Learning Methods – Reinforcement

Learning - Introduction to Machine Learning and Deep Learning -Can Machines Really Think? - Distributed AI Artificial Life-The Ethics of AI - Interpretable AI- Future of AI - AI Components AI Architectures

Total: 45

REFERENCES:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 4th Edition, 2020.
2. Zhongzhi Shi "Advanced Artificial Intelligence", World Scientific; 2019.
3. Kevin Knight, Elaine Rich, Shivashankar B. Nair, "Artificial Intelligence", McGraw Hill Education; 3rd edition, 2017
4. Richard E. Neapolitan, Xia Jiang, "Artificial Intelligence with an Introduction to Machine Learning", Chapman and Hall/CRC; 2nd edition, 2018
5. Dheepak Khemani, "A first course in Artificial Intelligence", McGraw Hill Education Pvt Ltd., NewDelhi, 2013.
6. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann Publishers Inc; Second Edition, 2003.

24RCSE304 BIG DATA 4H–4C

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand the Big Data Platform and NO SQL queries.
- To learn about the Big Data framework like Hadoop and Map reduce functionalities.
- To learn about the implementations of Data models and hive.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Illustrate the concept of big data in managing large and complex datasets.
- Choose distribution models used in NoSQL databases.
- Identify the appropriate data format based on the nature of the data and the requirements in analyzing.
- Build HBase for Big data Environment.
- Apply HBase clients to perform CRUD operations effectively.

UNIT I UNDERSTANDING BIG DATA

What is big data – why big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data and marketing – fraud and big data – risk and big data – credit risk management – big data and algorithmic trading – big data and healthcare – big data in medicine – advertising and big data – big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics

UNIT II NOSQL DATA MANAGEMENT

Introduction to NoSQL – aggregate data models – aggregates – key-value and document data models – relationships – graph databases – schemaless databases – materialized views– distribution models – sharding – master-slave replication – peer-peer replication – sharding and replication – consistency – relaxing consistency – version stamps – map- reduce – partitioning and combining – composing map-reduce calculations

UNIT III BASICS OF HADOOP

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures

UNIT IV MAPREDUCE APPLICATIONS

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats

UNIT V DATA MODELS

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis.Cassandra cassandra data model – cassandra examples – cassandra clients – Hadoop integration. Pig– Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

Total:45

SUGGESTED READINGS

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, (2013), "BigData, Big Analytics:Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley
2. P. J. Sadalage and M. Fowler, (2012), "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional
3. Tom White, (2012), "Hadoop: The Definitive Guide", Third Edition, O'Reilley,Eric Sammer, (2012) ,
4. E. Capriolo, D. Wampler, and J. Rutherglen, (2012), "Programming Hive", O'Reilley,
5. Lars George, (2011), "HBase: The Definitive Guide", O'Reilley,
6. Eben Hewitt, (2010), "Cassandra: The Definitive Guide", O'Reilley, 8. Alan Gates, (2011), "Programming Pig", O'Reilley,

24RCSE305 BLOCKCHAIN TECHNOLOGIES 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is to

- To understand the basic principles and architecture of blockchain technology.
- To understand the trade-offs and applications of various consensus mechanisms.
- To learn to develop applications of hyper ledger using blockchain frameworks and security.

COURSE OUTCOMES

Upon completion of the course the student will be able to

- Explain the technology components of Block chain and its working principles.
- Illustrate Ethereum model code execution and the architectural components in Blockchain.
- Develop Hyperledger framework using its component.
- Identify the nature of threats and cyber security management goals and framework.
- Analyze malicious software attack and wireless network attack.

UNIT I INTRODUCTION OF BLOCKCHAIN TECHNOLOGY

History of Blockchain – Types of Blockchain – Consensus – Decentralization using Blockchain –Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization. Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets –Alternative Coins – Theoretical Limitations – Bitcoin Limitations – Name Coin – Prime Coin – Z cash– Smart Contracts – Ricardian Contracts.

UNIT II ETHEREUM NETWORK

The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule – Supporting Protocols – Solidity Language.

UNIT III-FRAMEWORKS FOR HYPERLEDGER FABRIC

Introduction to Web3 – Contract Deployment – POST Requests – Development frameworks Hyperledger as a protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger –Corda-Alternative Blockchains.

UNIT IV –CYBER SECURITY THREAT

Introduction – Cyberspace – Cyber Crime – Nature of Threat – Cyber security – Policy, Mission and Vision of Cyber security Program. Cyber security management system – goals, technology categories –perimeter defense and encryption.

UNIT V -WEB APPLICATION ATTACKS

Malicious Attacks, Threats, and Vulnerabilities- Malware –malicious software attack – social engineering attack – wireless network attack – web application attack –Countermeasures. Creating Mechanisms for IT Security.

Total:45

SUGGESTED READINGS

1. Imran Bashir & quot;astering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained & quot; Packt Publishing, Second Edition 2018.
2. Arshdeep Bahga, Vijay Madisetti & quot;Blockchain Applications: A Hands-On Approach & quot; VPT Publications, First Edition 2017.
3. David Kim and Michael G. Solomon " Fundamentals of Information Systems Security & quot; Jones & Bartl Learning, Third Edition 2018.
4. Peter Trim and Yang –Im Lee & quot;Cyber Security Management- A Governance, Risk and Compliance Framework & quot; Gower Publishing, First Edition 2014.
5. Andreas Antonopoulos, Satoshi Nakamoto & quot;Mastering Bitcoin & quot;, O'Reilly Publishing, Second Edition 2017.
6. Alex Leverington & quot;Ethereum Programming & quot;, Packt Publishing, First Edition 2017.
7. John G. Voeller & quot;Cyber Security & quot; John Wiley & amp;Sons, First Edition 2014.

24RCSE306 **CLOUD COMPUTING** **4H–4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course is for students

- To Understand the concepts of Cloud Computing and cloud services.
- To Acquaintance with the concept of cloud computing in relation to business activities.
- To Learn about the cloud application design and management.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Interpret the components and technologies that enable cloud computing.
- Interpret cloud service development services and tools available in the market.
- Choose security and privacy considerations associated with cloud-based collaboration tools.
- Apply online scheduling applications to facilitate collaborative scheduling.
- Identify best practices, challenges and the overall impact of web-based collaboration on productivity and teamwork.

UNIT I UNDERSTANDING CLOUD COMPUTING

Cloud Computing – History of Cloud Computing – Cloud Architecture – Cloud Storage – Why Cloud Computing Matters – Advantages of Cloud Computing – Disadvantages of Cloud Computing – Companies in the Cloud Today – Cloud Services

UNIT II DEVELOPING CLOUD SERVICES

Web-Based Application – Pros and Cons of Cloud Service Development – Types of Cloud Service Development – Software as a Service –Platform as a Service – Web Services – On-Demand Computing – Discovering Cloud Services Development Services and Tools Amazon Ec2 – Google App Engine – IBM Clouds

UNIT III CLOUD COMPUTING FOR EVERYONE

Centralizing Email Communications – Collaborating on Schedules – Collaborating on To-Do Lists – Collaborating Contact Lists – Cloud Computing for the Community – Collaborating on Group Projects and Events – Cloud Computing for the Corporation

UNIT IV CLOUD SERVICES

Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications – Exploring Online Planning and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management – Collaborating on Word Processing - Collaborating on Databases – Storing and Sharing Files

UNIT V OTHER WAYS TO COLLABORATE ONLINE

Collaborating via Web-Based Communication Tools – Evaluating Web Mail Services – Evaluating Web Conference Tools – Collaborating via Social Networks and Groupware – Collaborating via Blogs and Wikis

SUGGESTED READINGS

1. Antonopoulos, (2012), Cloud Computing: Principles, Systems and Applications, Springer India Private Limited
2. Dimitris N. Chorafas, (2 August 2014), Cloud Computing Strategies Hardcover, CRC Press,
3. Michael Miller, (August 2016), Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing,
4. Haley Beard, (July 2018), Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing, Applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited,

24RCSE307 **CYBER SECURITY** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES:

This course enables students

- To understand the security issues in networks and computer systems to secure an infrastructure
- To know cyber security strategies and policies
- To use the functionality of cyber security tools

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

- Infer the cyber security needs of an organization.
- Apply the security issues in networks and computer systems to secure an infrastructure.
- Identify operational cyber security strategies and policies.
- Apply critical thinking and problem-solving skills to detect current and future attacks on an organization.
- Analyse the functionality of cyber security tools in a given application.

UNIT I INTRODUCTION

Need for Cyber security - History of Cyber security - Defining Cyberspace and Cyber security Standards - CIA Triad – Cyber security Framework

UNIT II ATTACKS AND COUNTERMEASURES

Malicious Attacks, Threats, and Vulnerabilities – Scope of cyber-attacks – Tools used to attack computer systems – security breach – Risks, vulnerabilities and threats. Malware – malicious software attack – social engineering attack – wireless network attack – web application attack Access control - Audit – Authentication - Biometrics - Denial of Service Filters - Ethical Hacking – Firewalls - Scanning, Security policy, Threat Management - Applying software update and patches - Intrusion Detection Systems -Virtual Private Networks –Cryptographic Techniques

UNIT III SECURING THE INFRASTRUCTURE

Infrastructure Security in the Real World - Understanding Access-Control and Monitoring Systems - Understanding Video Surveillance Systems - Understanding Intrusion-Detection and Reporting Systems

UNIT IV SECURING LOCAL HOSTS AND NETWORKS

Local Host Security in the Real World - Securing Devices - Protecting the Inner Perimeter -

Protecting Remote Access Local Network Security in the Real World - Networking Basics - Understanding Networking Protocols - Understanding Network Servers - Understanding Network Connectivity Devices – Understanding Network Transmission Media Security

UNIT V TOOLS

Zenmap – Hydra –Kismet – John the Ripper – Airgeddon – Deauther Board – Aircrack-ng – EvilOSX

REFERENCES

1. William Stallings, Effective Cybersecurity: A Guide to Using Best Practices and Standards, 1st edition, 2019.
2. Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity Essentials, Wiley Publisher, 2018.
3. Yuri Diogenes, ErdalOzkaya, Cyber security - Attack and Defense Strategies, Packt Publishers,2018.
4. Carol C. Woody, Nancy R. Mead, Cyber Security Engineering: A Practical Approach for Systems and Software Assurance, Addison-Wesley, 2016.
5. Thomas A. Johnson Cyber Security- Protecting Critical Infrastructures from Cyber Attack and Cyber Warfare, CRC Press, 2015.

24RCSE308 **DATA VISUALIZATION AND ANALYTICS** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES:

This course enables students to

- Understand univariate and bivariate data exploration and analysis.
- Learn multivariate and time series data and its implementation using Matplotlib.
- Study and apply data visualization techniques using Tableau.

COURSE OUTCOMES:

After completing this course, students will be able to

- Explain the Objectives of Data Visualization and data abstraction techniques.
- Compare univariate and bivariate data exploration and analysis in real time project.
- Interpret data exploration and visualization techniques for multivariate and time series data.
- Apply data visualization technique's using Matplotlib.
- Identify data visualization techniques using Tableau.

UNIT I INTRODUCTION - DATA ABSTRACTION

Introduction to Data Visualization – History of Visualization – Need for Visualization – Interactive Visualization – Web Specific Components – Common Types of Data Visualization – Data Visualization and Infographics – Dashboards. Data Abstraction: Actions – Targets. Charts – Data Pre-processing - Choosing the optimal charts – Making charts effective – Context in Visualization- Analyzing Visual Patterns.

UNIT II UNIVARIATE & BIVARIATE ANALYSIS

Univariate Analysis: Introduction to Single variable: Distributions and Variables – Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality - Smoothing Time Series. Bivariate Analysis: Relationships between Two Variables - Percentage Tables – Analyzing Contingency Tables - Handling Several Batches - Scatterplots and Resistant Lines – Transformations.

UNIT III MULTIVARIATE AND TIME SERIES ANALYSIS

Introducing a Third Variable - Causal Explanations - Three-Variable Contingency Tables and Beyond - Longitudinal Data – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling.

UNIT IV VISUALIZING USING MATPLOTLIB – PYTHON

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization –

three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn. B. Tech Computer Science & Engineering

UNIT V VISUALIZING USING TABLEAU

Introduction to Tableau - Creating Charts in Tableau-Formatting the Charts-Creating Multiple Axis Charts-Filters-Sets and Groups-Tableau Charts - Dashboard-Building Interaction in the Dashboards Case study - Analyze the HR data of an IT firm – Analyze Titanic Dataset and give various charts

TEXT BOOK(S)

1. Mico Yuk. Data Visualization for Dummies,1st edition, 2014, Wiley.
2. Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008.

REFERENCE BOOKS

1. Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization:

24RCSE309 DATA WAREHOUSING AND DATA MINING 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To Understand the principles of databases, data mining, and data warehousing.
- To Interpret data preprocessing, visualization techniques, classification, and prediction of data.
- To Infer various data mining applications, concepts, architecture, business analysis, and tools.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Illustrate the functionality of data mining Techniques.
- Apply pre-processing and visualization techniques for data analysis.
- Make use of clustering methods used in data analysis.
- Apply OLAP tools for business analysis.
- Analyze text database and spatial data base mining procedures.

UNIT I INTRODUCTION

Relation To Statistics, Databases- Data Mining Functionalities-Steps In Data Mining Process-Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems - Overview Of Data Mining Techniques.

UNIT II DATA PREPROCESSING AND ASSOCIATION RULES

Data Preprocessing-Data Cleaning, Integration, Transformation, Reduction, Discretization Concept Hierarchies-Concept Description: Data Generalization And Summarization Based Characterization-Mining Association Rules In Large Databases.

UNIT III PREDICTIVE MODELING

Classification And Prediction: Issues Regarding Classification and Prediction- Classification By Decision Tree Induction-Bayesian Classification-Other Classification Methods-Prediction-Clusters Analysis: Types Of Data In Cluster Analysis- Categorization Of Major Clustering Methods: Partitioning Methods –Hierarchical Methods

UNIT IV DATA WAREHOUSING

Data Warehousing Components -Multi Dimensional Data Model- Data Warehouse Architecture-Data Warehouse Implementation- -Mapping the Data Warehouse To Multiprocessor Architecture - OLAP. - Need- Categorization of OLAP Tools.

UNIT V APPLICATIONS

Applications of Data Mining-Social Impacts of Data Mining-Tools-An Introduction to DB Miner-Case Studies-Mining WWW-Mining Text Database-Mining Spatial Databases.

SUGGESTED READINGS

1. Jiawei Han, Micheline Kamber, (2011), "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers,
2. Alex Berson, Stephen J. Smith, (2004), “Data Warehousing, Data Mining, & OLAP”, Tata Mcgraw-Hill, Usama M.Fayyad, Gregory Piatetsky - Shapiro, Padhrai Smyth and Ramasamy, (2016).
3. Uthurusamy, (2016), "Advances in Knowledge Discovery and Data Mining", The M.I.T Press,
4. Ralph Kimball, (2018), "The Data Warehouse Life Cycle Toolkit", John Wiley & Sons Inc.,
5. Sean Kelly, (2017), "Data Warehousing in Action", John Wiley & Sons Inc.,

24RCSE310 DEEP LEARNING 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand the fundamentals of neural networks, their components, and learning algorithms.
- To learn about recurrent neural networks, their applications, and describe the functions of convolutional neural networks.
- To implement neural networks to solve real-world problems and explore their practical applications.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Illustrate the computational units in modeling neural networks and artificial intelligence systems.
- Outline the challenges associated with training deep neural networks and strategies to facilitate effective training
- Identify optimization algorithms and its challenges in training neural networks.
- Develop the internal structure and operations of LSTM cells.
- Apply MVL techniques to problems that involve multiple views or modalities.

UNIT I INTRODUCTION **9**

Basics: Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm. Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders.

UNIT II DEEP NEURAL NETWORKS **9**

Deep Neural Networks: Difficulty of training deep neural networks, Greedy layer wise training.

UNIT III OPTIMIZATION METHODS **9**

Better Training of Neural Networks: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

UNIT IV RECURRENT NEURAL NETWORKS **9**

Recurrent Neural Networks: Back propagation through time, Long short term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs Convolutional Neural

Networks: LeNet, Alex Net. Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.

UNIT V RECENT TRENDS **9**

Recent trends: Variational Autoencoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning Applications: Vision, NLP, Speech (just an overview of different applications in 2-3 lectures)

Total:45

SUGGESTED READINGS

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
2. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996 2.
3. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

24RCSE311 DISTRIBUTED COMPUTING 4H–4C

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is to

- To understand the foundations of distributed systems and analyze the processes and distributed objects.
- To interpret classic distributed algorithms for synchronization, consistency, and fault-tolerance, and study various distributed client-server models.
- To analyze different distributed transaction processing methods.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Illustrate distributed systems and network architectures for specific use cases or applications.
- Interpret external data representation and marshalling techniques used in distributed systems.
- Identify the mechanisms and protocols used for communication between processes or components in a distributed system.
- Analyze the problems and solutions related to multicast communication.
- Examine the challenges of distributed deadlocks to get resolved in distributed transaction system.

UNIT I INTRODUCTION

Characterization of Distributed Systems - Examples - Resource Sharing and the Web - Challenges - System Models - Architectural and Fundamental Models - Networking and Internetworking - Types of Networks - Network Principles - Internet Protocols – Case Studies.

UNIT II PROCESSES AND DISTRIBUTED OBJECTS

Inter process Communication - The API for the Internet Protocols - External Data Representation and Marshalling - Client-Server Communication - Group Communication - Case Study - Distributed Objects and Remote Invocation - Communication Between Distributed Objects - Remote Procedure Call - Events and Notifications - Java RMI - Case Study.

UNIT III OPERATING SYSTEM ISSUES – I

The OS Layer - Protection - Processes and Threads - Communication and Invocation – OS Architecture - Security - Overview - Cryptographic Algorithms - Digital Signatures - Cryptography Pragmatics - Case Studies - Distributed File Systems - File Service Architecture - Sun Network File System - The Andrew File System

UNIT IV OPERATING SYSTEM ISSUES – II

Name Services -Domain Name System - Directory and Discovery Services – Global Name Service - X.500 Directory Service - Clocks, Events and Process States - Synchronizing Physical Clocks - Logical Time And Logical Clocks - Global States - Distributed Debugging - Distributed Mutual Exclusion – Elections – Multicast Communication Related Problems.

UNIT V DISTRIBUTED TRANSACTION PROCESSING

Transactions - Nested Transactions - Locks - Optimistic Concurrency Control - Timestamp Ordering-Comparison - Flat and Nested Distributed Transactions – Atomic Commit Protocols - Concurrency Control in Distributed Transactions – Distributed Deadlocks - Transaction Recovery - Overview of Replication and Distributed Multimedia Systems

SUGGESTED READINGS

1. George Coulouris, Jean Dollimore and Tim Kindberg, (2011), Distributed Systems Concepts and Design, Pearson Education, 5th Edition,
2. Sape Mullender, (1993), Distributed Systems, Addison Wesley, 2nd Edition,
3. Albert Fleishman, (1994), Distributes Systems- Software Design and Implementation, Springer-Verlag,
4. Liu M.L., (2004), Distributed Computing Principles and Applications, Pearson Education,
5. Andrew S Tanenbaum, Maartenvan Steen, (2006), Distibuted Systems –Principles and Pardigms, Pearson Education,
6. Mugesh Singhal, Niranjan G Shivaratri, (2008), Advanced Concepts in Operating Systems, Tata McGraw Hill Edition, 21st reprint,

24RCSE312 GRID COMPUTING 4H–4C

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To use grid computing and virtualization to solve large-scale scientific problems.
- To apply best practices in cloud application design and management.
- To identify technical challenges for cloud applications and assess their importance.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Identify the areas where grid computing can bring significant benefits and advancements.
- Analyze the challenges and strategies for achieving interoperability among different grid computing systems.
- Apply techniques and approaches used to integrate grid sources with web devices.
- Develop practical skills in designing, developing, and deploying grid services using OGSA and its associated components.
- Build APIs, libraries, and development frameworks used in the programming of grid applications.

UNIT I - GRID COMPUTING

Introduction - Definition - Scope of grid computing

UNIT II- GRID COMPUTING INITIATIVES

Grid Computing Organizations and their roles – Grid Computing analog – Grid Computing Road map.

UNIT III- GRID COMPUTING APPLICATIONS

Merging the Grid sources – Architecture with the Web Devices Architecture.

UNIT IV- TECHNOLOGIES

OGSA – Sample use cases – OGSA platform components – OGSI – OGSA Basic Services.

UNIT V- GRID COMPUTING TOOL KITS

Globus Toolkit – Architecture, Programming model, High level services – OGSI .Net middleware Solutions.

SUGGESTED READINGS

1. Joshy Joseph & Craig Fellenstein, (2016), “Grid Computing”, PHI, PTR
2. Ahmar Abbas, (2013), “Grid Computing: A Practical Guide to technology and Applications”, Charles River media.

24RCSE313 IMAGE PROCESSING AND PATTERN RECOGNITION 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100

Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To impart knowledge in image processing and understand the fundamentals of digital image processing.
- To learn the fundamentals of pattern recognition and choose appropriate features, and classify algorithms for pattern recognition problems.
- To apply digital image processing theories and pattern recognition algorithms using modern computing tools such as MATLAB, C/C++, etc.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Apply visual perception principles in image analysis and recognition.
- Build image compression algorithms and visual quality assessment.
- Utilize line and edge detection approaches to extract edges from images.
- Make use of pattern recognition approach in the image processing.
- Analyze the performance of classifiers and dimension reduction techniques using appropriate evaluation metrics and validation methods.

UNIT I INTRODUCTION TO IMAGE PROCESSING

Image formation, image geometry perspective and other transformation, stereo imaging elements of visual perception. Digital Image-sampling and quantization- serial & parallel Image processing.

UNIT II IMAGE RESTORATION

Image Restoration-Constrained and unconstrained restoration Wiener filter, motion blur remover, geometric and radiometric correction Image data compression-Huffman and other codes transform compression, predictive compression two tone Image compression, block coding, run length coding, and contour coding.

UNIT III SEGMENTATION TECHNIQUES

Segmentation Techniques-thresh holding approaches, region growing, relaxation, line and edge detection approaches, edge linking, supervised and unsupervised classification techniques, remotely sensed image analysis and applications, Shape Analysis – Gestalt principles, shape number, moment Fourier and other shape descriptors, Skelton detection, Hough trans-form, topological and texture analysis, shape matching.

UNIT IV PATTERN RECOGNITION

Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test.

UNIT V STATISTICAL PATTEN RECOGNITION

Bayesian Decision Theory, Classifiers, Normal density and discriminant functions, Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods – Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models

SUGGESTED READINGS

1. Digital Image Processing – Ganzalez and Wood, Addison Wesley, 1993.
2. Fundamental of Image Processing – Anil K.Jain, Prentice Hall of India.
3. Pattern Classification – R.O. Duda, P.E. Hart and D.G. Stork, Second Edition John Wiley, 2006
4. Digital Picture Processing – Rosenfeld and Kak, vol.I & vol.II, Academic,1982
5. Computer Vision – Ballard and Brown, Prentice Hall, 1982
6. An Introduction to Digital Image Processing – Wayne Niblack, Prentice Hall, 1986
7. Pattern Recognition and Machine Learning – C. M. Bishop, Springer, 2009.
8. Pattern Recognition – S. Theodoridis and K. Koutroumbas, 4th Edition, Academic Press,2009.

24RCSE314 **INTERNET OF THINGS** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To describe the working of IoT and understand the concept of the Internet of Things.
- To design and program various IoT protocols and learn about various clouds of things.
- To analyze the various applications of IoT.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Identify research challenges, limitation and open issues of IoT architectures.
- Apply research methodologies to contribute standardization efforts in IoT protocols.
- Choose Web of Things (WoT) or Internet of Things (IoT) with respect its applications.
- Apply models to investigate integrated billing solutions.
- Analyze application of IoT in the smart grid and electrical vehicle charging infrastructure.

UNIT I INTRODUCTION

Definitions and Functional requirements- Motivatations – Architecture-web 3.0- View of IOT-Ubiquitous IoT Applications – Four Pillars of IoT – DNA of IoT - The Toolkit Approach for End-user Participation in the Internet of Things. Middleware for IoT: Overview – Communication middleware for IoT –IoT Information Security

UNIT II IOT PROTOCOLS

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – KNX – Zigbee Architecture – Network layer – APS layer – Security

UNIT III WEB OF THINGS

Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence. Cloud of Things: Grid/SOA and Cloud Computing – Cloud Middleware – Cloud Standards – Cloud Providers and Systems – Mobile Cloud Computing – The Cloud of Things Architecture

UNIT IV INTEGRATED

Integrated Billing Solutions in the Internet of Things Business Models for the Internet of Things - Network Dynamics: Population Models – Information Cascades - Network Effects - Network Dynamics: Structural Models - Cascading Behavior in Networks - The Small-World Phenomenon

UNIT V APPLICATIONS

The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments – Resource Management in the Internet of Things: Clustering, Synchronisation and Software Agents. Applications - Smart Grid-Electrical Vehicle Charging

SUGGESTED READINGS

1. The Internet of Things in the Cloud: A Middleware Perspective – HonboZhou (2012), CRC Press.
2. Architecting the Internet of Things - Dieter Uckelmann; Mark Harrison; Florian Michahelles-(Eds.) (2011) – Springer.
3. Networks, Crowds, and Markets: Reasoning About a Highly Connected World - David Easley and Jon Kleinberg, (2010), Cambridge University Press.
4. The Internet of Things: Applications to the Smart Grid and Building Automation by - Olivier Hersent, Omar Elloumi and David Boswarthick - Wiley (2012).
5. Olivier Hersent, David Boswarthick, Omar Elloumi, (2012), “The Internet of Things – Key applications and Protocols”, Wiley.

24RCSE315 MACHINE LEARNING 4H–4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand machine learning basics and different machine learning models used to solve real time applications.
- To analyze machine learning algorithms strengths and weaknesses.
- To apply various machine learning models to solve real-world problems.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Apply Learning model performance using Linear Regression.
- Develop multilayer Perception to solve problems such as classification, regression, and pattern recognition.
- Identify the strengths and weaknesses and their implications for ensemble learning.
- Build dimensionality reduction techniques to real-world datasets using programming languages.
- Analyze Markov Chain Monte Carlo (MCMC) and statistical modeling to random sampling.

UNIT I INTRODUCTION TO MACHINE LEARNING

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

UNIT II MACHINE LEARNING LINEAR MODELS

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi layer Perceptron in Practice – Examples of using the MLP – Overview– Radial Basis Functions and splines– Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

UNIT III TREE AND PROBABILISTIC MODELS

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

UNIT IV DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators– Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process

UNIT V MACHINE LEARNING GRAPHICAL MODELS

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models– Tracking Methods

SUGGESTED READINGS

1. Ethem Alpaydin, (2014) ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press,
2. Jason Bell, (2014) ― Machine learning – Hands on for Developers and Technical Professionals, First Edition, Wiley,
3. Peter Flach, (2012) ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data, First Edition, Cambridge University Press,
4. Stephen Marsland, (2014) ―Machine Learning – An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series,
5. Tom M Mitchell, (2013) ―Machine Learning, First Edition, McGraw Hill Education,
6. Christopher Bishop, (2007) "Pattern Recognition and Machine Learning" Springer,
7. Kevin P. Murphy, (2012), "Machine Learning: A Probabilistic Perspective", MIT Press,
8. Trevor Hastie, Robert Tibshirani, Jerome Friedman, (2011), "The Elements of Statistical Learning" Springer, Second Edition,
9. https://www.coursera.org/learn/machine-learning

24RCSE316 NATURAL LANGUAGE PROCESSING 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100

Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To learn the fundamentals of natural language processing, including the use of CFG and PCFG.
- To identify the role of semantics and pragmatics in sentences, and understand anaphora resolution techniques.
- To apply NLP techniques to information retrieval applications.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Apply Finite-State Automata (FSAs) to model and process regular languages for simple pattern recognition tasks.
- Identify smoothing techniques to address the data sparsity problem in N-gram models.
- Apply techniques for transforming grammars into normal forms to facilitate parsing and analysis.
- Develop supervised methods for Word Sense Disambiguation (WSD).
- Analyze anaphora resolution techniques to resolve references to previously mentioned entities.

UNIT I INTRODUCTION

Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance

UNIT II WORD LEVEL ANALYSIS

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

UNIT III SYNTACTIC ANALYSIS

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures.

UNIT IV SEMANTICS AND PRAGMATICS

Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

UNIT V DISCOURSE ANALYSIS AND LEXICAL RESOURCES

Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC)

SUGGESTED BOOKS

1. Daniel Jurafsky, James H. Martin―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication,2014
2. Steven Bird, Ewan Klein and Edward Loper, ―Natural Language Processing with Python‖, First Edition, O'Reilly Media, 2009.
3. Breck Baldwin, ―Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.
4. Richard M Reese, ―Natural Language Processing with Java‖, O_Reilly Media, 2015.
5. Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
6. Tanveer Siddiqui, U.S. Tiwary, ―Natural Language Processing and Information Retrieval‖, Oxford University Press, 2008.

24RCSE317 NETWORK AND INFORMATION SECURITY 4H–4C

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand the fundamentals of cryptography and various key distribution and management schemes.
- To acquire knowledge of CIA triad and deploy encryption techniques to secure data in transit.
- To design security applications in the field of information technology

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Identify security mechanisms employed to implement security services.
- Apply the effectiveness and limitations of cryptographic techniques in real-world scenarios.
- Model security considerations in public key cryptography.
- Identify tools and techniques for identifying and mitigating vulnerabilities in software applications.
- Analyze the steps involved in the Kerberos authentication process.

UNIT I INTRODUCTION

An Overview of Computer Security-Security Services-Security Mechanisms- Security Attacks Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies.

UNIT II CRYPTOSYSTEMS & AUTHENTICATION

Classical Cryptography-Substitution Ciphers-permutation Ciphers-Block Ciphers-DES-Modes of Operation- AES-Linear Cryptanalysis, Differential Cryptanalysis- Hash Function - SHA 512- Message Authentication Codes-HMAC - Authentication Protocols

UNIT III PUBLIC KEY CRYPTOSYSTEMS

Introduction to Public key Cryptography- Number theory- The RSA Cryptosystem and Factoring Integer- Attacks on RSA-The ELGamal Cryptosystem- Digital Signature Algorithm-Finite Fields Elliptic Curves Cryptography- Key management – Session and Interchange keys, Key exchange and generation-PKI

UNIT IV SYSTEM IMPLEMENTATION

Design Principles, Representing Identity, Access Control Mechanisms, Information Flow and Confinement Problem Secure Software Development: Secured Coding - OWASP/SANS Top Vulnerabilities - Buffer Overflows - Incomplete mediation XSS - Anti Cross Site Scripting Libraries - Canonical Data Format - Command Injection Redirection - Inference – Application Controls

UNIT V NETWORK SECURITY

Secret Sharing Schemes-Kerberos- Pretty Good Privacy (PGP)-Secure Socket Layer (SSL)-Intruders – HIDS- NIDS - Firewalls – Viruses

SUGGESTED READINGS

1. William Stallings, "Cryptography and Network Security: Principles and Practices", Third Edition, Pearson Education, 2006.
2. Matt Bishop, "Computer Security art and science", Second Edition, Pearson Education, 2002
3. Wade Trappe and Lawrence C. Washington, "Introduction to Cryptography with Coding Theory" Second Edition, Pearson Education, 2007
4. Jonathan Katz, and Yehuda Lindell, Introduction to Modern Cryptography, CRC Press, 2007
5. Douglas R. Stinson, "Cryptography Theory and Practice", Third Edition, Chapman & Hall/CRC, 2006 6.
6. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, First Edition, 2006.
7. Network Security and Cryptography, Menezes Bernard, Cengage Learning, New Delhi, 2011.

24RCSE318 NETWORK ROUTING ALGORITHMS 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand the principles of data transfer mechanisms over conventional networks and configure routing algorithms on routers.
- To interpret data traversal through various crosspoints (routers) in the network and network management.
- To analyze various algorithm for mobile ad hoc networks communications.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Identify responsibilities of the network layer, such as addressing, routing, and logical network organization.
- Develop multicast routing, its benefits, and its challenges.
- Apply the classification of RWA algorithms used in optical networks.
- Develop the principles associated with macro-mobility and micro-mobility protocols in wireless communication networks.
- Identify research challenges, limitations and open issues in the performance of internet-based mobile ad-hoc network.

UNIT I INTRODUCTION

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Non-hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.

UNIT II INTERNET ROUTING

Interior protocol: Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

UNIT III ROUTING IN OPTICAL WDM NETWORKS

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting-Benefits and Issues, Light path Migration, Rerouting Schemes, Algorithms- AG, MWPG.

UNIT IV MOBILE - IP NETWORKS

Macro-mobility Protocols, Micro-mobility protocol: Tunnel based: Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII).

UNIT V MOBILE AD –HOC NETWORKS

Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).

SUGGESTED READINGS

1. William Stallings, (2009), "High speed networks and Internets Performance and Quality of Service", 2nd Edition, Pearson Education Asia. Reprint India.
2. M. Steen Strub, (2019), 'Routing in Communication network, Prentice –Hall International, Newyork.
3. S. Keshav, (2019), 'An engineering approach to computer networking' Addison Wesley.
4. William Stallings, (2019), 'High speed Networks TCP/IP and ATM Design Principles, Prentice-Hall, New York.
5. C.E Perkins, (2011), 'Ad Hoc Networking', Addison – Wesley.
6. Ian F. Akyildiz, Jiang Xie and Shantidev Mohanty, (Aug.2004, pp 16-27) "A Survey of mobility Management in Next generation All IP- Based Wireless Systems", IEEE Wireless Communications.

24RCSE319 NEURAL NETWORKS AND APPLICATIONS 4H-4C

Instruction Hours/week: L:4 T:0 P:0 Marks: External:100 Total:100

Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand neural network architectures and learning algorithms, backpropagation for multilayer neural networks.
- To interpret the Supervised Hebbian learning models for neural networks.
- To learn the basics of radial network and hop field networks.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Illustrate the concept of multiple layers in neural networks and their significance in deep learning models.
- Apply the convergence of the Perceptron Learning Rule to classify patterns correctly.
- Identify Supervised Hebbian Learning, used in neural networks for supervised pattern recognition tasks.
- Analyze backpropagation algorithm for training multilayer perceptrons (MLPs) with multiple layers.
- Examine Hopfield Network that uses a feedback mechanism to store and retrieve patterns.

UNIT I INTRODUCTION TO NEURAL NETWORKS

Introduction - history-Applications-Biological inspiration -Neuron Model and Network Architecture: Objectives - notation – neuron model - Network Architectures - A layer of neurons - multiple layers of Neurons-recurrent networks - An Illustrative example

UNIT II PERCEPTRON LEARNING RULE

Perceptron Learning Rule: Perceptron Learning Rule: Perceptron architecture -Perceptron learning rule - proof of convergence - Signal and weight vector spaces: Linear vector spaces - Linear Independence-spanning a space - inner product - norm -orthogonality-vector expansions - Linear Transformations for neural networks: Linear Transformations-matrix representations-change of basis - eigen values and eigen vectors

UNIT III SUPERVISED HEBBIAN LEARNING

Supervised Hebbian learning: Supervised Hebbian learning: Linear associator-Hebb rule-pseudo inverse rule - variations of hebbian learning – performance surfaces and optimum Points: Taylor series - directional derivatives-minima -necessary conditions for Optimality-quadratic functions Performance Optimization: steepest descent-newton's method - conjugate gradient-

competitive networks: Hamming network - competitive layer -self organizing feature maps-learning vector quantization

UNIT IV MULTILAYER PERCEPTRONS

Widroff - Hof f - Hoff Learning: f Learning: ADALINE network - MSE - LMS algorithm Analysis of convergence - back propagation: Multilayer perceptrons - back propagation algorithm - Generalization - Methods for improving generalization.

UNIT V RADIAL BASIS NETWORKS

Radial basis networks: Radial basis networks: Radial basis network - training RBF networks - grossberg network: Basic nonlinear model – two-layer competitive network - Adaptive resonance theory: Overview of adaptive resonance-Layer 1-Layer 2 -Learning Law: L1-L2 and L2-L1- Hopfield network

SUGGESTED BOOKS

1. David Kriesel, A Brief Introduction to neural networks, Make Your Own Neural Network, Tariq Rashid, 2016
2. Satish Kumar, “Neural Networks: A Classroom Approach”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
3. Neural Network Design (2nd Edition), Martin T. Hagan, Howard B. Demuth, Mark H. Beale, Orlando De Jesus, ISBN-10: 0- 9717321-1-6, ISBN-13: 978-0-9717321-17
4. Neural Networks for Pattern Recognition by Christopher M. Bishop, Springer, 2006
5. Neural networks and Learning Machines (3rd Edition), Simon Haykin, ISBN-13: 978-0131471399, ISBN-10: 0131471392
6. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education (Singapore) Private Limited, Delhi, 2003.

24RCSE320 OPTIMIZATION TECHNIQUES 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To understand engineering applications of optimization and design problems, and analyze optimization structures.
- To apply the concept of mathematical programming using branches and analyze various optimization algorithms.
- To apply recent trends of optimization techniques to real-world problems.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Analyze optimization techniques and the principles, advantages, and limitations.
- Analyze the geometric interpretation of constraints and feasible regions in optimization problems.
- Examine duality concept and its applications in linear programming.
- Analyze the performance of Genetic Algorithms in solving optimization problems.
- Analyze the results of optimization algorithms in real-world contexts.

UNIT I ENGINEERING APPLICATION

Engineering application of Optimization, Formulation of design problems as mathematical programming problems.

UNIT II OPTIMIZATION STRUCTURE

General Structure of Optimization Algorithms, Constraints, the Feasible Region.

UNIT III MATHEMATICAL PROGRAMMING

Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming

UNIT IV OPTIMIZATION ALGORITHMS

Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.

UNIT V RECENT TRENDS

Recent trends: Recent trends: Real Recent trends: world applications of ant colony optimization, genetics and linear and quadratic programming.

SUGGESTED BOOKS

1. Operations Research – Kanti Swarup, P.K. Gupta, Man Mohan (Sultan Chand & Sons)
2. Introduction to Operations Research: Computer oriented Algorithmic (Mc Graw Hill 1976)
3. Laurence A. Wolsey, Integer programming, Wiley Inter science, 1st Edition, 1998.
4. Andreas Antoniou & Wu-Sheng Lu Practical Optimization Algorithms and Engineering Applications, Springer 2007.
5. Edwin K., P. Chong & Stanislaw h. Zak, An Introduction to Optimization, Wiley, 4th Edition, 2013.

24RCSE321 **QUANTUM COMPUTING** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
End Semester Exam:3 Hours

COURSE OBJECTIVES:

This course enables students

- To understand the quantum computing and mechanics
- To know the quantum computation, environments and frameworks
- To understand Entropy and Information Theory

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

- Infer the basics of quantum computing.
- Interpret the background of Quantum Mechanics.
- Apply the computation models in Quantum computing.
- Model the circuits using quantum computation, environments and frameworks.
- Identify the quantum operations like noise and error-correction

UNIT I QUANTUM MECHANICS AND QUANTUM COMPUTATION

The postulates of quantum mechanics, The density operator, The Schmidt decomposition and purifications, EPR and the Bell inequality, Quantum circuits: Quantum algorithms, Single qubit operations, Controlled operations. Measurement, Universal quantum gates, Summary of the quantum circuit model of computation, Simulation of quantum systems.

UNIT II QUANTUM COMPUTERS AND ALGORITHMS

Guiding principles, Conditions for quantum computation, Harmonic oscillator quantum computer, Optical photon quantum computer, Optical cavity quantum electrodynamics, Ion traps, Nuclear magnetic resonance, other implementation schemes, The quantum Fourier transform and its applications, Quantum search algorithms

UNIT III QUANTUM INFORMATION

Quantum noise and quantum operations: Classical noise and Markov processes, Quantum operations, Examples of quantum noise and quantum operations, Applications of quantum operations, Limitations of the quantum operations formalism, Distance measures for quantum information: Distance measures for classical information, How close are two quantum states? How well does a quantum channel preserve information?

UNIT IV QUANTUM ERROR-CORRECTION

Introduction, The Short code, Theory of quantum error-correction, constructing quantum codes, Stabilizer codes, Fault-tolerant quantum computation.

UNIT V ENTROPY AND INFORMATION THEORY

Entropy: Shannon Entropy, Basic properties of entropy, Von Neumann entropy, Strong sub additivity, Quantum information theory: Distinguishing quantum states and the accessible information, Data compression, Classical information over noisy quantum channels, Quantum information over noisy quantum channels, Entanglement as a physical resource, Quantum cryptography

REFERENCES

1. Michael A. Nielsen, Issac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, Tenth Edition 2010.
2. Parag K Lala, Quantum Computing, A Beginners Introduction, Mc Graw Hill Education, First edition 2020.
3. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Reprint edition 2020.
4. Jack D. Hidary's Quantum Computing: An applied approach, Springer, 2019.
5. Eric Johnston, Nic Harrigan, and Mercedes Gimeno Segovia, Programming Quantum Computers: Essential Algorithms and Code, O′reilly, 2019.
6. Pierpaolo Marturano, Quantum Computing, De Gruyter Oldenbourg Publishing, 2023.

24RCSE322 SOFT COMPUTING 4H-

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**

End Semester Exam:3 Hours

COURSE OBJECTIVES:

This course enables students

- To understand the students to soft computing concepts and techniques and foster their abilities in designing and implementing soft computing based solutions for real-world and engineering problems.
- To introduce students to fuzzy systems, fuzzy logic and its applications.
- To apply soft computing methodology for a particular problem.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

- Interpret human intelligence and AI Explain how intelligent system works.
- Identify the feasibility of a soft computing methodology for a particular problem.
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
- Utilize genetic algorithms to optimization problems.
- Analys neural networks for pattern classification and regression problems

UNIT I SOFT COMPUTING AND FUZZY COMPUTING

Introduction to Soft Computing and Fuzzy logic, Fuzzy membership functions, Operations on Fuzzy sets Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences, Defuzzyfication Techniques, Fuzzy logic controller, Industrial Applications.

UNIT II FUNDAMENTALS OF NEURAL NETWORKS

Neuron, Nerve Structure and Synapse – Artificial Neuron and its Model – Activation Functions – Neural Network Architecture: Single Layer and Multilayer Feed Forward Networks, Recurrent Networks – Various Learning Techniques: Perception and Convergence Rule, Auto-Associative and Hetero-Associative Memory.

UNIT III BACK PROPAGATION NETWORKS AND COMPETITIVE NEURAL NETWORKS

Back Propagation Networks Architecture: Perceptron Model- Single Layer Artificial Neural Network, Multilayer Perception Model – Back Propagation Learning Methods – Effect of Learning Rule Co-Efficient – Factors Affecting Back Propagation Training – Kohenen's Self Organizing Map – SOM Architecture, learning procedure – Application; Learning Vector Quantization, learning by LVQ – Adaptive Resonance Theory – Learning procedure –

Applications.

UNIT IV GENETIC ALGORITHM

Basic Concepts – Working Principle – Procedures of GA – Flow Chart of GA – Genetic Representation: (Encoding) Initialization and Selection – Genetic Operators: Mutation, Generational Cycle – Applications. Multi-objective Optimization Problem Solving: Concept of multi-objective optimization problems (MOOPs) and issues of solving them -Multi-Objective Evolutionary Algorithm (MOEA) -Non-Pareto approaches to solve MOOPs - Pareto-based approaches to solve MOOPs - Some applications with MOEAs.

UNIT V APPLICATIONS

Control systems; Speech systems; Image processing; Natural language processing and decision making, Handwritten Script Recognition; Automotive Systems and Manufacturing; Decision Support System; Bioinformatics; Investment and trading.

REFERENCES

1. S. Rajasekaran, G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, Prentice Hall of India, 2010.
2. J.S.R. Jang, C.T. Sun, E. Mizutani, “Neuro-Fuzzy and Soft Computing”, Pearson Education, 2004.
3. An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press)
4. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2ndEdition), Collelo, Lament, Veldhnizer (Springer)
5. S.N. Sivanandam, S.N. Deepa, “Principles of Soft Computing”, Second Edition, Wiley-India, 2007.

24RCSE323 **VIRTUAL REALITY** **4H–4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks: External:100 Total:100**
Exam:3 Hours

COURSE OBJECTIVES

The goal of this course for students is

- To describe the history and recent developments of AR, discuss various visual physiology and perception concepts, and understand and apply various tracking methods.
- To use a variety of visual rendering methods in AR applications.
- To provide the technological components necessary for AR implementation.

COURSE OUTCOMES

Upon completion of this course the students will be able to

- Infer the basics of geometric modeling in Virtual Reality using mathematical models.
- Compare scotopic vision and photopic vision.
- Illustrate the challenges associated with orientation tracking and methods for correcting these drifts.
- Apply rendering technologies and platforms used in Virtual Reality.
- Examine the principles and techniques of manipulation interfaces in Virtual Reality.

UNIT I INTRODUCTION

Introduction to VR, Historical perspective, Birds-eye view: general, Hardware, software, Sensation and perception. Geometry of Virtual Worlds: Geometric modeling, transforming models, Matrix algebra, 2D and 3D rotations, Homogeneous transforms, The chain of viewing transforms, Eye transforms, Canonical view transform, Viewport transform. Light and Optics, Visual Physiology, Visual Perception, Tracking Systems, Visual Rendering.

UNIT II VISUAL PHYSIOLOGY AND PERCEPTION

Parts of the human eye, photoreceptors and densities, scotopic and photopic vision, display resolution requirements, eye movements, neural vision structures, sufficient display resolution, other implications of physiology on VR. Photoreceptors, Sufficient resolution for VR, Light intensity, Eye movements, Neuroscience of vision. Depth perception, Motion perception, Frame rates and displays

UNIT III TRACKING

Overview, Orientation tracking, Tilt drift correction, Yaw drift correction, Tracking with a camera, Perspective n-point problem, Filtering, Lighthouse approach, Velocities, acceleration, vestibular system, virtual world physics, simulation, collision detection, avatar motion.

UNIT IV RENDERING

Visual Rendering: Visual Rendering-Overview, Shading models Rasterization, Pixel shading, VR specific problems, Distortion shading, post - rendering image warp.

UNIT V AUDIO AND INTERFACES

Audio: Physics and physiology, Auditory perception, Auditory localization, Rendering, Spatialization and display, Combining other senses. Interfaces: Locomotion, Manipulation, System control, social interaction, Evaluation of VR Systems.

SUGESSTED READINGS

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
2. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.
3. Future Cyborgs: Human-Machine Interface for Virtual Reality Applications by Robert R Powell. 2012.
4. George Mather, Foundations of Sensation and Perception: Psychology Press; 2 edition, 2009.
5. Peter Shirley, Michael Ashikhmin, and Steve Marschner, Fundamentals of Computer Graphics, A K Peters/CRC Press; 3edition, 2009.
6. The history of the future: Oculus, Facebook and the Revolution that swept Virtual Reality, by Blake J. Harris, 2019.
7. Virtual Reality by Steven M. LaValle. Cambridge University Press. 2019.

24RCSE324 WIRELESS SENSOR NETWORKS 4H-4C

Instruction Hours/week: L: 4 T:0 P: 0 **Marks: External:100 Total:100**

End Semester Exam:3 Hours

COURSE OBJECTIVES:

This course enables students

- To Infer the architecture of WSN.
- To study the various protocols layers of WSN.
- To study the establishment of WSN infrastructure.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

- Infer the wireless sensor networks and its applications
- Explain the importance of MAC and its protocols.
- Illustrate the routing mechanisms in WSN
- Summarize the role of Transport layer in WSN and Infrastructure Establishment
- Identify security issues and evaluation metrics in WSN

UNIT I INTRODUCTION

Basic Introduction, Architectural elements, Basic Technology- Sensor type, Operating systems and Middleware, Transport protocols, Data dissemination and routing – types Sensor Network organization and tracking, Computation, Communication, Sensor Node hardware and software, Sensor node technology, Sensor taxonomy, Characteristics and design challenges, Applications

UNIT II MAC PROTOCOLS FOR WSN

Fundamentals of MAC protocols, Performance requirements Common Protocols- Fixed assignment, Demand Assignment and Random Assignment ALOHA, CSMA, CSMA-CD, CSMA-CAMAC Protocols for WSN- Schedule based protocols, Random access based Protocols, Sensor MAC, IEEE 802.15.4 LR WPAN Standard

UNIT-III ROUTING PROTOCOLS FOR WSN

Data dissemination and gathering, Challenges and Design issues, Network scale and time varying characteristics, Routing strategies, Flooding and its variants

UNIT IV TRANSPORT CONTROL PROTOCOLS FOR WSN AND INFRASTRUCTURE ESTABLISHMENT

Design Issues Congestion Detection and Avoidance, Event to sink reliable transport, Reliable

multi segment transport, Pump slowly and fetch quickly, Garuda, ATP Congestion and packet loss recovery Topology control, Clustering, Time synchronization, Localization and positioning Sensor, Tracking and control

UNIT V SECURITY AND PERFORMANCE EVALUATION OF WSN

Security: Fundamentals – Security Considerations in WSN Wireless sensor network modeling: Simulation Models, Modeling the behavior of sensors and sensor networks, Simulation tools for WSN, Topology of WSN, and Performance Metrics. Introduction to IoT protocols, Edge Computing devices.

REFERENCES

1. Holger Karl & Andreas Willig, " Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2007.
2. K. Sohraby Minoli and T. Zanti," Wireless Sensor Networks: Technology, Protocols, and Applications", John Wiley and Sons, March 2007.
3. H. Karl, and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley and Sons, October 2007.
4. C. S. Raghavendra, K.M. Sivalingam and T. Zanti," Wireless Sensor Networks", Springer Verlag, Sep. 2006.
5. E. H. Callaway, Jr. Auerbach," Wireless Sensor Networks: Architectures and Protocols", Aug. 2003.