

# **Academic Programme Guide**

## **Doctor of Philosophy (Ph.D.) (Engineering and Technology)**



**w.e.f.  
Academic Year: (2019-20)**

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## 1. GENERAL INFORMATION

Chitkara University offers an intellectually demanding doctoral program for high-potential applicants who already have a breadth of knowledge in the functional areas of Engineering and Technology as well as who have a strong interest in academic research. Conducting research requires combining knowledge gained in the classroom with the ability to read and interpret data and present and discuss technical results. Engineering research also requires significant experimental, computational, and analytical skill. Ph.D. programme has been designed to impart knowledge through courses, seminar, project and thesis work having thrust upon but is not limited to the following main areas, Cloud Computing, Wireless Sensor Networks, Internet of Things (IoT), Data Science, Artificial Intelligence & Machine Learning, Deep Learning, and Optimization Methods, UAV Networks, Medical Image Processing, Cryptography, Security and Privacy, Cyber-Physical / Embedded Systems Security, Explainable AI, Data Analytics, Data Mining, Database Indexing, Spatial Databases, Spectroscopy and Environment, Atomic and Radiation Physics, X-ray Fluorescence Spectroscopy and its Applications, Theoretical Nuclear Physics especially on Heavy-ion Fusion Reactions and Optical Fibre Technology, Theory of Inequalities, Solid Mechanics, Fractal Geometry, Statistics, Matrix Analysis, Elasticity and Plasticity, Information Theory and Data Mining, Chaos Theory, Reliability and Stochastic Modelling, Geotechnical Engineering, Construction Planning and Management, Material Processing, Construction Modelling etc. We encourage interaction within and across the subject areas, providing a rich environment for innovative, collaborating, and multi-disciplinary research. The Chitkara University Ph.D. programme is designed to produce a new generation of scholar-practitioners who precisely fit that description. If you're prepared to embark on a challenging, focused, and meaningful experience, we invite you to explore the possibilities in our Ph.D. programme.

### 1.1 PROGRAMME OUTCOMES (PO)

On completion of Doctor of Philosophy in Engineering and Technology, the students will be able:

- PO 1 To critically apply theories, methodologies and knowledge based on thorough knowledge of the related literature to address fundamental problems in their research area of study.
- PO 2 To bridge the knowledge gap between industry and academia through research by applying knowledge and skills to discover new solutions and generate new ideas.
- PO 3 To apply research skills to teaching and assessment of students learning.
- PO 4 To develop self-direction and originality in tackling and solving new research problems in their research areas by following the principles of ethics.
- PO 5 To identify and formulates research questions and conduct systematic research in order to develop new theories/experiments of national and international standards.
- PO 6 To develop the ability and skills sufficient to publish and present their research work in the applied discipline and prepare research grant proposals.
- PO 7 To pursue research of significance in the multidisciplinary domains and important from a social perspective.

## **1.2 SALIENT FEATURES OF THE PROGRAMME**

The salient features of programme are:-

- (i) Classes during course work held on regular/weekends modes.
- (ii) Course work is of 12 months duration and research work leading to submission of thesis is of minimum 36 months duration including course work duration.
- (iii) Wide variety of research area of study allowing research scholars to work on topics of specific interest.
- (iv) Personal supervision by experienced faculty members and research groups who are uncompromisingly committed to Scholar's success.
- (v) Encouragement of academic collaboration for addressing priority and gap areas in knowledge of basic and applied sciences.
- (vi) Sophisticated research labs equipped with modern computational and state-of-the-art research facilities.
- (vii) Support for participation in national and international conferences as per the University rules.
- (viii) To work collaboratively with all stakeholders to create, develop, and exchange research knowledge to influence and benefit society and the economy (in sync with UNSDGs 2015).

## **2. ELIGIBILITY FOR ADMISSION**

The candidates for the programme must have one of the following qualifications obtained from any of the universities incorporated by an Act of the central or state legislature of India or other educational institutions established by an act of parliament or declared to be deemed as a university under Section 3 of the UGC Act 1956 or possess an equivalent qualification recognized by the Ministry of Human Resources Development (MHRD), Government of India or an equivalent qualification from an institution approved by AICTE.

A Master's degree in the concerned discipline or equivalent in a relevant discipline with minimum of 55% marks or CGPA of 5.5 on a 10-point rating scale or equivalent (relaxation for reserved categories as per UGC norms).

## **3. PROGRAMME DURATION**

- (i) Ph.D. programme shall be for a minimum duration of three years, including course work and a maximum of six years.
- (ii) Extension beyond the above limits will be governed by the relevant clauses as stipulated in the Ph.D. Rules & Regulations of Chitkara University, Himachal Pradesh, India.

## **4. PEDAGOGICAL ASPECTS**

Each credit will be equal to 15 hours. At least one week prior to the commencement of a particular course, the faculty member concerned, or the course coordinator will circulate among the students the following pertaining to the course:

- (i) The course work outlines containing the syllabus along with recommended books and other online reading material web links.
- (ii) Course work schedule to be followed as per course handout supplemented with reading material & home assignments on the regular basis.
- (iii) The evaluation matrix will contain presentations, assignments, tests/examinations class participation and end term examinations.
- (iv) Other matters found desirable and relevant by Supervisor/ DRC

## 5. PROGRAMME STRUCTURE

The mandatory course work in the programme have been classified into the following course categories as prescribed by UGC which offers opportunities to learn fundamental skills required in the programme at higher stages.

**Semester I:** Course work of three core courses to be completed before doctoral concentration seminar and the subsequent submission and approval of the synopsis/research proposal in next semester.

- (a) Research Methodology (PRM3101)
- (b) Advanced Research Methodology (PRM3102)
- (c) Domain Specific (PRM3103)

The course details along with the evaluation scheme & credit classification are given below:

Course Code	Name of Course	Examination Scheme			Credits
		Internal Exam (Marks)	End Term Exam (Marks)	Total (Marks)	
PRM-3101	Research Methodology	50	50	100	3
PRM-3102	Advanced Research Methodology	50	50	100	3
PRM-3103	Domain Specific	50	50	100	3
<b>Total</b>		<b>150</b>	<b>150</b>	<b>300</b>	<b>9</b>

**Semester-II:** Submission of presentation/ report of the following:

**Doctoral Concentration Seminar (PRM3104):** To give a presentation related to literature review of a tentative research topic chosen, problem identification, conceptual development of the topic before Doctoral Research Committee (DRC).

**Synopsis/Research Proposal:** To submit and give a presentation on the work you wish to carry out in the presence of external subject expert and Doctoral Research Committee members. The overall duration for submitting a synopsis/research proposal in the prescribed format will be six months after the completion of course work.

## 6. DELIVERABLES

### Details:

S. No.	Deliverable	Overview
1	Deliverable – 1	Submission of application form
2	Deliverable – 2	<p>After acceptance of the form, the admission process will be as follows:</p> <ul style="list-style-type: none"> <li>• Written test</li> <li>• Personal Interview</li> </ul> <p>The syllabus of written test will be communicated to candidates via e-mail.</p>
3	Deliverable – 3	Once candidates are short-listed, after qualifying the written test and personal interview round, as per the merit for the Ph.D. Programme at Chitkara University (Himachal Pradesh, India) candidate would need to proceed towards registration and commencement of the course work.
4	Deliverable – 4	<p>Course work requirement (One Semester)</p> <p>Every candidate should complete three courses (Deliverable 4A – 4C) before working on Doctoral Dissertation. Every course will be held twice in a year. Course work dates for the year will be announced ahead of schedule so that candidate can plan a break from his/her workplace.</p> <p>Details of Courses:</p> <p>Deliverable 4 (A): Research Methodology</p> <p>Deliverable 4 (B): Advanced Research Methodology</p> <p>Deliverable 4 (C): Domain Specific</p>
5	Deliverable – 5	<p>Satisfactory completion of doctoral concentration seminar:</p> <p>This activity will commence immediately after the successful completion of the course work (i.e., Deliverable 4). Under this activity, the research scholar will deliver a presentation before Doctoral Research Committee based on the area chosen, problem identified and conceptualized. The purpose of this seminar is to identify the scholar's understanding of the theoretical and experimental framework of his/her chosen area. This seminar is also useful for preparing an effective research proposal/synopsis as it includes detailed discussions about the research area of the scholar.</p> <p>Finalization of Research Proposal/Synopsis and Approval</p> <p>This will commence immediately after a candidate successfully completes the doctoral concentration seminar. In this research scholar have to submit a detailed research proposal/synopsis which includes objectives, proposed methodology to be adopted to achieve objectives and expected outcomes followed by a presentation before external subject expert and Doctoral Research Committee members.</p>
6	Deliverable – 6	Progress Review Seminars. (Every Six Months)

		A minimum of three such seminars presentations will be held at the University campus. The candidate will approach the supervisor for a suitable schedule. The objective of these seminars is to track the progress of the research. One such seminar may be held every six months after the approval of Research Proposal/Synopsis.
7	Deliverable – 7	<b>Pre-Thesis Seminar</b> A seminar delivered by the research scholar based on the research work conducted before the final thesis is submitted for evaluation.
8	Deliverable – 8	<b>Publishing Tutorials</b> Each doctoral candidate is expected to publish a minimum of two research articles in domain specific refereed journals (UGC-CARE Listed/SCOPUS/SCI Indexed) during the entire research period. Progress seminars can be useful to prepare such articles. The candidate also needs to present her/his work in at least two academic conferences in India / abroad.
9	Deliverable – 9	<b>Deliverable 9 (A)</b> <b>Final Thesis Submission</b> Each candidate will submit three copies of thesis for examiners evaluation. These will be accompanied by abstract and summary of the thesis as per detailed guidelines. <b>Deliverable 9 (B)</b> <b>Defense of Thesis</b> In case the thesis is found to meet the University criteria and has been accepted by the examiners, candidates will be informed about the schedule for thesis defense (viva voce). <b>Deliverable 9 (C)</b> <b>Award of Degree and Convocation at the Campus.</b> After successful thesis completion and defense, the degree shall be awarded.

## 7. ASSESSMENT AND EVALUATION

### Evaluation for Ph.D. Course Work (Semester-I)

Name of Course	Course Code	Internal Assessment (50 Marks)	External Assessment (50 Marks)	Pass Percentage
Research Methodology	PRM-3101	Attendance (20) Class Performance (10) Assignment (20)	Written Examination (50)	55 % or more-Pass Less than 55%-Fail
Advanced Research Methodology	PRM-3102	Attendance (20) Class Performance (10) Assignment (20)	Written Examination (50)	55 % or more-Pass Less than 55%-Fail
Domain Specific	PRM-3103	Seminar (25) Assignment (25)	Written Examination (50)	55 % or more-Pass Less than 55%-Fail

It is mandatory for candidate to appear in both internal as well as external evaluations.

### Evaluation (Semester-II)

Name of Course	Course Code	Evaluation(Internal)	Pass Percentage
Doctoral Concentration Seminar	PRM-3104	Presentation	Passed Successfully

### 8. RULES FOR ATTENDANCE

The programme being highly rigorous, all the students are expected to show utmost regularity in attendance. Even a day's absence is detrimental to the scholar's interest. Therefore, university's requirement in this regard is very stringent. The university expects its scholars to be regular in attending the Ph.D. coursework classes. Although, we expect full 100% attendance, but the mandatory requirement of attendance is 75%. However, 10% relaxation is possible only in case of extreme circumstances and at the sole discretion of the Vice Chancellor.

### 9. GRADING SYSTEM

The list of the letter and non-letter grades, their applicability and connotation are given below:

Marks Range	Letter Grade	Qualitative Meaning	Grade Point
80 – 100	O	Outstanding	10
70 – 79	A+	Excellent	9
60 – 69	A	Very Good	8
55 – 59	B+	Good	7
0 – 54	F	Fail	0
	Ab	Absent	0

Non-letter grades: Satisfactory/Non-satisfactory/Passed Successfully.

The Cumulative Grade Point Average (CGPA) denotes the overall performance of a student in all courses in which he is awarded letter grades. It is the weighted average of the grade points of all the letter grades received by the student from the time of his entry into the University.

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### **Calculation of CGPA:**

The CGPA calculated on a 10 point scale is used to describe the overall performance of a research scholar in all courses for which LETTER GRADES will be awarded. The Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) are calculated as:

$$GPA = \frac{\sum_{j=1}^n C_j G_j}{\sum_{j=1}^n C_j} \qquad CGPA = \frac{\left( GPA \sum_{j=1}^n C_j \right)}{\left( \sum_{j=1}^n C_j \right)}$$

Where n = number of subjects in the course work; C<sub>j</sub> = number of credits for the j<sup>th</sup> course; and G<sub>j</sub> = Grade point corresponding to the grade obtained in the j<sup>th</sup> course.

### **Important Remarks:**

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

## **10. PROMOTION AND REGISTRATION**

Initially, the scholar has to qualify the entrance test and the panel interview. The selected candidates will be called for the registration to the Ph.D. Programme. He/She has to mandatory go under the Ph.D. course work Programme. The performance of the candidate in all the deliverables will be assessed by the Panel/Doctoral Research Committee (DRC). The satisfactory performance will be considered for the promotion to the higher levels of the deliverables.

## **11. MIGRATION/CREDIT TRANSFER POLICY**

As per Chitkara University's, Himachal Pradesh guidelines.

## **12. ELIGIBILITY TO AWARD THE DEGREE**

A scholar is deemed to have fulfilled the requirement of programme:

- (i) Cleared all deliverables prescribed for the programme.
- (ii) Obtained the minimum B+ grade in the course work.
- (iii) Scholar has to publish at least two research papers from the thesis work in refereed journals (UGC-CARE Listed/SCOPUS/SCI Indexed).
- (iv) In addition to point no (iii), Scholar has to present their thesis work in at least two national/international conferences.

- (v) Successfully defend the final viva voce examination.
- (vi) Submit the plagiarism report with similarity index not more than 10% in the overall thesis.
- (vii) Candidate has to submit four hard bound copies of the final thesis.
- (viii) Candidate has to submit the final electronic copy of thesis and other Ph.D. related data (if applicable) to the office of R&D.
- (ix) Candidate has to clear all the dues if any.

### **13. PROGRAMME ORVIEW**

The Programme is split into nine deliverables:

#### **Deliverable – 1/ Submission of Application Form**

#### **Deliverable – 2/ Acceptance by Chitkara University**

After acceptance of the form, the admission process will be as follows

- Written Test
- Personal Interview

#### **Deliverable – 3/ Selection for Doctoral Programme**

Once the candidate is short-listed, after qualifying in written test and personal interview round, as per the merit for the Ph.D. Programme at Chitkara University, Himachal Pradesh the candidate would need to proceed towards registration and commencement of the course work.

#### **Deliverable – 4/ Course Work Requirement**

Every candidate should complete three courses (deliverable 4a-4c) before working on doctoral thesis. Course work dates shall be announced ahead of schedule so that the candidates can plan accordingly.

#### **Details of Deliverable 4 – Courses**

##### **Deliverable 4 (a) – PRM-3101: Research Methodology**

**Course Credits: 3**

Research Methodology is a hands-on course designed to build and spread the understanding and knowledge related to the foundational approaches of research in different domains. The students would investigate and be practically exposed to the main components of a research framework i.e., reviewing the literature systematically, problem identification, conceptual development, hypotheses formulation, questionnaire development and testing, research design, data collection, research report writing, and presentations. After attaining this knowledge, students would be able to be conducted systematic research under their area of interest.

### Course Outcomes:

- Understand nature and functions of research.
- Introduction to Systematic Literature Review.
- Gain knowledge about basics of research designs that include problem formation, hypotheses/question forming, research design, sampling techniques, data collection and analyze.
- How to formulate research framework and hypothesis empirically.
- To learn how to develop a manuscript.

### Recommended Books:

1. Hair, J. F., Tatham, R. L., Anderson, R. E., & Black, W. (2006). Multivariate data analysis (Vol. 6). Upper Saddle River, NJ: Pearson Prentice Hall.
2. Krishnaswamy, K. N., Sivakumar, A. I., & Mathirajan, M. (2009). Management research methodology: integration of principles, methods and techniques. Pearson Education India.
3. Chawla, D., & Sodhi, N. (2011). *Research methodology: Concepts and cases*. Vikas Publishing House.
4. Creswell, J. W. (2003). Qualitative, quantitative, and mixed methods approach.
5. Malhotra, N., Hall, J., Shaw, M., & Oppenheim, P. (2006). *Marketing research: An applied orientation*. Pearson Education Australia.
6. Saunders, M.N., Saunders, M., Lewis, P., & Thornhill, A., (2011). *Research methods for business students*. 5th edition, Pearson.
7. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
8. Research methodology (2006). by D K Bhattacharyya.

### Other Readings:

S.N.	Link of Journals, and Magazines
1.	Journal of Mixed Methods Research: <a href="https://journals.sagepub.com/home/mmr">https://journals.sagepub.com/home/mmr</a>
2.	International Journal of Social Research Methodology: <a href="https://www.tandfonline.com/toc/tsrm20/current">https://www.tandfonline.com/toc/tsrm20/current</a>
3.	Organizational Research Methods: <a href="https://journals.sagepub.com/home/orm">https://journals.sagepub.com/home/orm</a>
4.	Harvard Magazine: <a href="https://harvardmagazine.com/">https://harvardmagazine.com/</a>

**Syllabus of the Course:**

<b>Subject:</b> Research Methodology		<b>Subject Code:</b> PRM-3101
<b>S. No.</b>	<b>Topic (s)</b>	
<b>Unit-I</b>	<b>Introduction to Research</b> Steps in the process of research - problem selection (meaning and need of research), Formulation and planning: research concepts (types and process) Ethical guidelines in research- respect for persons and their antinomy, beneficence and Nonmaleficence, justice, trust, fidelity and scientific integrity; Ethical issues in research – research misconduct, integrity in research, institutional approval, informed consent, confidentiality, anonymity and privacy, plagiarism check and similarity index	
<b>Unit-II</b>	<b>Literature Review and data</b> Literature review (primary and secondary literature, peer/ non-peer- reviewed, open/closed access literature, sources of literature and classifications etc), constructs, propositions, variables, hypothesis, and theory; types of data, data, collection and errors in data collection	
<b>Unit-III</b>	<b>Development of conceptual framework</b> Variables and calling methods - primary scales of measurement, comparative scales, noncomparative scales, noncomparative scale decisions, scale development; reliability and validity of scales. formulation of research problems and hypotheses, testing of hypothesis, writing of the synopsis / research proposal, issue in proposal designing	
<b>Unit-IV</b>	<b>Questionnaire and research design</b> Questionnaires, ethical issues in questionnaire development, qualitative research, types of research design: exploratory, descriptive research design, survey method, experimental; control group & experimental group; ex-post facto research design, conducting experiments, issues in research designs	

**Deliverable 4(b) PRM-3102: Advanced Research Methodology**

**Course Credits: 3**

Enabling scholars to know about tools and technologies to process their experimental/theoretical data, it's imperative for them to study statistics to make better interpretation and decisions. Statistics is about dealing with data. This is a time to have the students brainstorm on the wide variety of functions and disciplines where data is gathered and measured. It is important to define statistics, which focuses on procedures and methods involved in collecting, presenting and summarizing of a set of data or forming conclusions about that data.

**Course Outcomes:**

At the successful completion of the course, the students would be able to:

- Use statistical techniques for decision making
- Develop skills in structuring and analyzing problems statistically
- Formulate answers to common decision problems through statistical analysis
- Utilize computer-based statistical software to perform mathematical calculation and thereby minimize time requirements

**Recommended Books:**

1. Joseph F. Hair, Jr., William C. Black, Barry J. Babin, Rolph E. Anderson (2010) *Multivariate data analysis: Hair, Black, Babin and Anderson*, Pearson Education.
2. Chauhan A. K., (2015) *Research Analytics: A Practical Approach to Data Analysis*, Wiley
3. Bluman, A. G. (2009). *Elementary statistics: A step by step approach*. New York, NY: McGraw-Hill Higher Education.
4. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis*. 7<sup>th</sup> edition, Pearson New International Edition.
5. Levin, R. I., Rastogi, S., Siddiqui, M. H., & Rubin, D. S. (2012). *Statistics for management*. Pearson Education.
6. Levine, D. M. (2010). *Business statistics: A first course*. Pearson Education India.
7. Shenoy, G. V., & Pant, L. M. (1994). *Statistical methods in business and social sciences*. Macmillan India.
8. Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

**Other Readings:**

S.N.	Link of Journals
1.	International Journal of Data Analysis Techniques and Strategies: <a href="https://www.inderscience.com/jhome.php?jcode=ijdats">https://www.inderscience.com/jhome.php?jcode=ijdats</a>
2.	International Journal of Data Science and Analytics: <a href="https://www.springer.com/journal/41060/">https://www.springer.com/journal/41060/</a>
3.	Structural Equation Modeling: A Multidisciplinary Journal: <a href="https://www.tandfonline.com/toc/hsem20/current">https://www.tandfonline.com/toc/hsem20/current</a>

**Syllabus of the Course:**

<b>Subject:</b> Advanced Research Methodology		<b>Subject Code:</b> PRM-3102
<b>S. No.</b>	<b>Topic (s)</b>	
<b>Unit-I</b>	<b>Basics of Statistics</b> Introduction to basic statistics, Introduction to SPSS, Data view and variable review, ethical consideration in data collection, ethical guidelines for statistical practices, creating variables, SPSS commands (Popular 10 commands in SPSS).	
<b>Unit-II</b>	<b>Distribution of Data and Hypotheses Testing</b> Frequency distribution, central tendency and distribution analysis, outlier testing, cross tabulation and chi square test, Test of difference – T test and Z test, One sample T test, Independent sample T test and paired sample T test. Parametric vs Non Parametric tests, test of normality, Z-Scores, sampling distribution, level of significance, P-value, Chi-Square test, Pearson’s Chi-Square statistic, Phi & Cramer’s V Statistic, Somer’s D, Odd Ratio, MC Nemar test.	
<b>Unit-III</b>	<b>Analysis of Variance</b> One way ANOVA using Tukey post-hoc test, means plot; eexplained variance and unexplained variance, F-Ratio, Goodness of Fit, Un-standardised and standardised Beta.	
<b>Unit-IV</b>	<b>Multivariate Data Analysis</b> Correlation Analysis: Interactive plots with smoother curve, Covariance, Pearson Correlation Test, Non-parametric Correlation with Spearman’s and Kendal Tau, Partial Correlation, Simple Regression analysis, R, R-Square, Adjusted R –Square, Classical Linear Regression Model, BLUE Parameters, Multiple Regression Analysis. Ethical issues in preparing research proposal.	

**Deliverable 4(c): PRM-3103: Domain Specific**

**Course Credits: 3**

Enabling scholars to know about the specific domain in which he/ she wish to pursue his/her research work. Research supervisor finalize the content of this course by taking into account the research interest of the Scholar. This course provides rigorous research training to doctoral students in contemporary areas of engineering and allied disciplines. The students after completing the Programme, depending on their choice of the research area, are well prepared for a variety of jobs both in the industry and in academic institutions all over the world. The students acquire deep knowledge and strong expertise to enable them to pursue careers in scientific and industrial R&D laboratories, as well as in academic institutions. The scholar can select one course from the table given below with respect to nature of the research domain undertaken:

<b>Domain Specific (PRM3103)</b>	<b>Course Titles*</b>
<p><b>Course Outcomes:</b></p> <p>CO1: Develop requisite skills from the peers involved in the domain.</p> <p>CO 2: Familiarize with the existing/ emerging techniques used in research domain.</p> <p>CO 3: Able to write a review research paper in the domain selected &amp; prepare a research proposal.</p>	Urban Water management System
	Sustainable Civil Engineering Materials and Practices
	Advance Methodology and Materials in Pavement Design
	Water and Wastewater Treatment Engineering: Biochemical Technology
	Landslides in Practice: Modelling and Mitigation
	Seismic Assessment and retrofitting of heritage masonry structures
	Remote Sensing in Water Resource Management
	Geomatics Engg.: A Project Design
	Geotechnical Investigation Methods
	Environmental and Hydrological Systems Modelling
	Environmental Flows in Water Resources
	Remote Sensing in Water Resource
	Internet of Things (IoT)
	Web Mining
	Machine Learning and Data Mining
	Digital Forensics
	Artificial Intelligence & Machine Learning
	Concepts to Deep Learning and Optimization Methods
	Fundamentals of Data Science
	Network Security
	Advanced Fluid Mechanics
	Fractal Geometry
	Mechanics of Solids
	Probability and Information Theory
	Dynamical Systems
	Fuzzy sets and Fuzzy Logic
	Stochastic Processes and Reliability
	Rings and Modules
	Theory of Elasticity
	Atomic Spectroscopy and its Applications
Advanced Nuclear Physics	
Optical Fiber Technology	
X-Ray Spectrometry and Elemental Analysis	

\*The detailed syllabus about this course will be shared by the concerned supervisor.

### **Deliverable 5 (a): PRM-3104: Doctoral Concentration Seminar**

In this deliverable, the student will deliver a presentation to the nominated panel based on the area chosen, problem identification, and conceptual development of the topic. The purpose of this course is to identify the student's understanding of the theoretical and experimental framework of his/her chosen area. This seminar is also useful for preparing an effective research proposal as it includes detailed discussions about the research area of candidate. This seminar will cover the following:

- Recent trends and contemporary issues in the candidate's chosen area
- Theoretical and experimental framework
- Identification of base papers
- State of art (Important updated studies in the research area)
- Identification of research gaps
- Identification of Tools/Technology for conducting proposed research

### **Deliverable – 5(b)/Finalization of Synopsis/Research Proposal and Approval**

This will commence immediately after a candidate successfully completes the doctoral concentration seminar (i.e. Deliverable 5 (a)). In this, research scholar have to submit a detailed research proposal/synopsis which includes objectives, proposed methodology to be adopted to achieve objectives and expected outcomes followed by a presentation before external subject expert and Doctoral Research Committee members. The following process may be followed:

- Extensive review of literature under guidance of thesis guide
- Selection of a topic and alternative topic(s)
- Preparation of synopsis/ research proposal
- Presentation on research proposal to the Doctoral Research Committee
- Approval of proposal and commencement of research

### **Deliverable – 6/Progress Review Seminar (I, II, III)**

A minimum of three such seminars will be held in the University campus. The candidate with prior approval of his/her supervisor(s), will approach to Dean (R&D) for a suitable schedule. An objective of these seminars is to track progress on the research. One such seminar must be held every six months after the approval of Synopsis/Research Proposal.

### **Deliverable – 7/Pre-Thesis Seminar**

A seminar delivered by the research scholar based on the research work conducted before the final thesis is submitted for evaluation.

### **Deliverable – 8/Publishing Tutorials**

Each doctoral candidate is expected to publish a minimum of two research articles in domain specific refereed journals (UGC-CARE Listed/SCOPUS/SCI Indexed) during the entire research period. Progress seminars and mentoring by DRC are useful to prepare such articles.

### **Deliverable – 9**

#### **Deliverable 9 (a)/Final Thesis Submission**

Each candidate will submit three copies of thesis for examiners evaluation. These will be accompanied by abstract and summary of the thesis as per the schedule for defense.

#### **Deliverable 9 (b)/Defense of Thesis**

In case the thesis is found to meet university criteria and has been accepted by the examiners, candidates will be informed about the schedule for defense.

#### **Deliverable 9 (c)/Award of Degree and Convocation at the Campus**

After successful thesis completion degree will be awarded.



**14. Appendix A: Mapping of Programme Outcomes (POs) with Course Outcomes (COs):**

Course Code	Name of the Course	Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	
PRM-3101	Research Methodology	CO 1: Understand nature and functions of research.	H					H	H	
		CO 2: Introduction to systematic literature review.		H			H			
		CO 3: Gain knowledge about basics of research designs that include problem formation, hypotheses/question forming, research design, sampling techniques, data collection and analyse.	H						M	
		CO 4: How to formulate research framework and hypothesis empirically.					M	H		
		CO 5: To learn how to develop a manuscript.		H			M			
PRM-3102	Advanced Research Methodology	CO 1: Use statistical techniques for decision making.					H	M		
		CO 2: Develop skills in structuring and analyzing problems statistically.				M	H			
		CO 3: Formulate answers to common decision problems through statistical analysis.		H	M				H	
		CO 4: Utilize computer-based statistical software to perform a thematical calculations and there by minimize time requirements.				H				
PRM-3103	Domain Specific	CO1: Develop requisite skills from the peers involved in the domain.	H					M		
		CO 2: Familiarize with the existing/emerging techniques used in research domain.	M	H					H	
		CO 3: Able to write a review research paper in the domain selected & prepare a research proposal.		H		M	H			

<b>PRM-3104</b>	<b>Seminar on Doctoral Concentration</b>	CO1: Recent trends and contemporary issues in the candidate's chosen field.	M	H				H	H
		CO2: Problem statement and theoretical framework.					H		
		CO3: Important journals and seminar papers in the concerned research field.		M					
	<b>Finalization of Synopsis/Research Proposal and Approval</b>	CO1: To develop the competence in assessing the validity of published literature.		M				H	
		CO2: Identify the problem within the relevant literature and existing evidences from reports.	H	H					
		CO3: To determine the gaps in literature and develop a feasible research design.					M	H	
	<b>Progress Review Seminars</b>	CO1: To track the candidate's research progress.						M	
		CO2: To provide a critical feedback and encourage the scholar for constructive work.		H			M		
		CO3: To familiarise the scholar with the criteria of evaluation of research.		H					H
		CO4: To provide an opportunity to discuss publication of the thesis or papers arising from it with their supervisors.					M		H
	<b>Pre-thesis Seminar</b>	CO1: To assess the Ph.D. research work findings and the application of research tools used in the study.				H		M	
		CO2: To check the practical and theoretical applicability of research findings.				H	H		
		CO3: To assess the methodology used to achieve the research objectives.							H
		CO4: To check if any important literature is not included in the thesis.		M				H	

	<b>Publication Tutorial</b>	CO1: To check the minimum criterion attained by the scholar for publications/conferences attended.			M				
		CO2: To provide the opportunity to discuss publication of papers arising from it with their supervisors.			M			H	
		CO3: To produce research papers that: (i) constitute significant contributions in their major field of study; (ii) and that are publishable in high-quality, peer-reviewed academic journals.			H				
	<b>Final Thesis Submission</b>	CO1: To access the novelty of research work completed.				H			
		CO2: To access the practical and theoretical implications of the research work.		M	H				
		CO3: To discussed their next career move (e.g. application for post-doctoral fellowships or employment opportunities).	H	M					

**Note: H = High Compliance; M = Medium Compliance.**