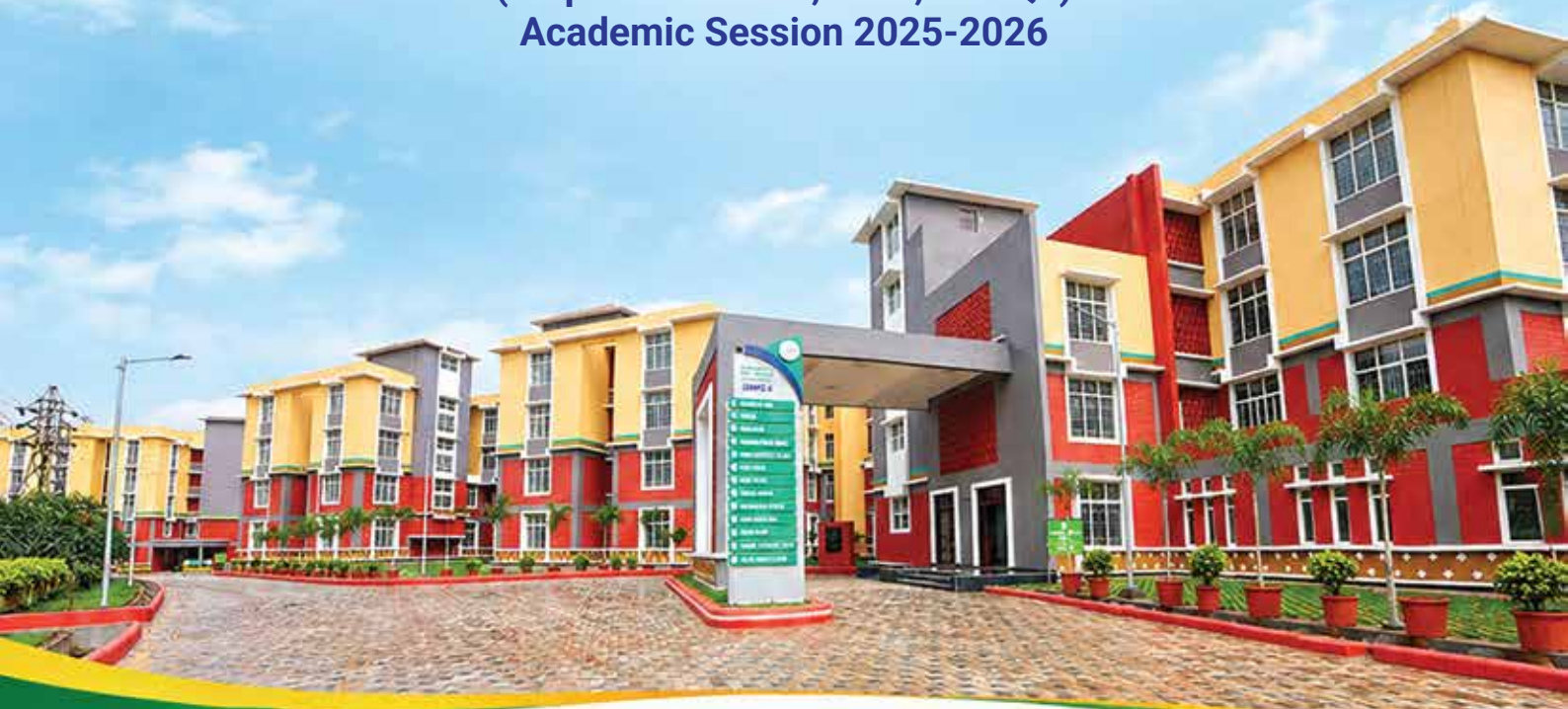
KISS

KALINGA INSTITUTE OF SOCIAL SCIENCES

# CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMME

# MASTER OF SCIENCE

**(As per NEP-2020, NCrF, NHEQF)**
**Academic Session 2025-2026**



## DEPARTMENT OF COMPUTER SCIENCE

### SCHOOL OF INDIGENOUS KNOWLEDGE, SCIENCE AND TECHNOLOGY


## KALINGA INSTITUTE OF SOCIAL SCIENCES (KISS)
**DEEMED TO BE UNIVERSITY**

Higher Education Campus, KISS Campus-3, Bhubaneswar, Odisha, 751024
https://university.kiss.ac.in | https://kiss.ac.in

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# I. About the Department / School and Programme

**About the School**

The School of Indigenous Knowledge, Science and Technology, KISS Deemed to be University, was established in 2017-18 with a view to study Indigenous scientific knowledge and technology that were developed in a symbiotic relationship with Nature. Indigenous people have had an innate understanding of natural resources available in our ecosystem, but it was in a supine state over the years. In the present age of globalization, the tribes who are the custodians of indigenous knowledge and technology in a real sense are far behind in the race of advancement.

Gradual developments of such people in varied facets of life enable them to explore their traditional knowledge for human welfare. As the over-exploitation of natural resources threatens the ecological balance and sustainable livelihood of tribal people, it is imperative to study our time-tested indigenous knowledge and tribal technology with greater vigour. Hence, an innovative School – **School of Indigenous Knowledge, Science and Technology** – has been set up to promote, preserve and protect indigenous knowledge and implement it for sustainable development.

The importance of this School is to disseminate advanced knowledge by providing instructional and research facilities in tribal medicinal systems through phytochemical analysis, geosciences, and their impact on the health conditions. The importance of cosmology in their culture, Sutras and sub-sutras of Vedic mathematics, a nutritional component of the food habit of tribes, intellectual property rights to preserve and conserve the biodiversity of indigenous people and advancement in technologies relating to the natural resources of the tribal areas as well as in other branches of learning as it may deem fit.

This could be possible by teaching innovative courses in *Indigenous Knowledge and Intellectual Property Rights*, *Indigenous People and the Science of Gemmology*, *Indigenous People and the Science of Cosmology* and *Vedic Mathematics*. The courses attempt to examine indigenous knowledge and technology, blending both traditional and modern scientific methods from interdisciplinary and multidisciplinary approaches. The School of Indigenous Knowledge, Science and Technology constantly endeavours to improve the

knowledge and practice content of its academic programme to match the local, regional, national and international standards.

### About the Department

The Department of Computer Science at KISS Deemed to be University was established in the academic session 2017–18 with the objective of providing quality computer science education to tribal students through an inclusive and technology-driven learning environment. The department offers postgraduate, postgraduate, and doctoral programmes in Computer Science, following the National Education Policy (NEP) framework and an outcome-based curriculum. The curriculum encompasses programming, data structures, algorithms, database management systems, artificial intelligence, machine learning, data analytics, cloud computing, cyber security, and software engineering, supported by well-equipped computer laboratories and ICT-enabled classrooms. The department is staffed by qualified and experienced faculty members actively engaged in teaching, research, innovation, and interdisciplinary collaborations. Students are encouraged to participate in research projects, coding competitions, seminars, workshops, internships, and community-oriented technological initiatives. With a strong emphasis on academic excellence, ethical values, innovation, and employability, the department prepares graduates to meet the evolving demands of academia, industry, entrepreneurship, and research while contributing to sustainable societal development.

# II. Vision & Mission of the School

### Vision

Be an internationally acclaimed School, recognized for excellence in teaching, research, consultancy and outreach; skill development and social entrepreneurship for tribal youth by promoting Indigenous Science and Technology.

### Mission

- Foster all-around development of students through multi-faceted education.
- Focus on Indigenous Science and Technology with the help of innovative courses like Vedic Mathematics, Indigenous people and the Science of Gemmology, Indigenous Knowledge, and Intellectual Property Rights.

- Engage with local, national, and global communities to get ideas about Indigenous Science and Technological applications for contemporary needs and problems and become successful in life.
- Manage resources self-employment and create employment for others.

# III. Programme Overview

**Programme Title:**

M.Sc. in Computer Science

**Programme Type:**

Postgraduate / Honours / Honours with Research / Diploma / Certificate

**Programme Description**

The M.Sc. Computer Science with Specialization in Indigenous Knowledge, Science and Technology is a two-year postgraduate programme designed in alignment with the National Education Policy 2020, the National Credit Framework, the National Higher Education Qualification Framework (Level 8), and the UGC Curriculum and Credit Framework for Postgraduate Programmes (2023). The programme integrates core competencies in computer science with Indigenous Knowledge Systems, preparing students for advanced research, industry roles, entrepreneurship, and community-based innovation. Students develop strong foundations in software engineering, computational mathematics, artificial intelligence, web technologies, cybersecurity, and database systems, while also exploring Indigenous scientific knowledge and its contemporary applications. The curriculum incorporates lectures, case studies, field works, SWAYAM MOOC Courses, and research projects, ensuring a holistic and experiential learning environment consistent with NEP 2020.

# IV. Process of Curriculum Development

All Schools shall follow the standard KISS-DU curriculum development protocol:

1. Formation of Syllabus Committee with domain experts.
2. Consultation with stakeholders (students, alumni, employers, community).
3. Review and approval by School faculty.
4. Vetting by Board of Studies (BoS) with external experts.

5. Final approval by Academic Council.
6. Integration of NEP-2020, CBCS, NCrF, and NHEQF guidelines.

# V. Definitions of Components

a) Academic Bank of Credits (ABC): The ABC has been envisaged by the UGC to facilitate the academic mobility of students with the freedom to study across the HEIs in the country with an appropriate 'credit transfer' mechanism from one programme to another, leading to attain a Degree/Diploma/Certificate, etc.
b) Academic Year: Two consecutive semesters constitute one academic year.
c) Major is the subject of main focus.
d) Credit Based Semester System (CBSS): Under the CBSS, the requirement for awarding a degree/diploma/Certificate is prescribed in terms of number of credits to be earned.
e) Credit: A unit by which the course work is measured. One credit is equivalent to one hour of lecture or tutorials or two hours of practical work/field work per week in a semester.
f) Research has been provided in the Eighth semester (for students securing 7.5 CGPA or above) involving application of knowledge in exploring/critical analysis/solving issues related to a real-life situation.

# VI. NCrF-Aligned Components (National Credit Framework)

1. Operational Definition of Credit (NCrF Standard)

*"1 Credit = 30 Notional Learning Hours."*

A standard 4-credit course = 120 Notional Learning Hours.

# VII. NCrF-Compliant Course Engagement Table

| Component | Operational Definition | Hours (Example for 4-credit course) |
|---|---|---|
| **Face-to-Face Lectures** | Concept delivery, interactive instruction | 45 |
| **Tutorials / Labs / Field** | Hands-on practice, experimentation | 30 |
| **Independent Self-Study** | Pre-reading, journal review | 20 |
| **Continuous Assessment** | Assignments, quizzes, mid-term | 12 |
| **Final Semester Exam Preparation** | Revision, project completion | 13 |
| **Total Notional Hours** | **Must equal 30 hours × credits** | **120** |

MOOC Courses (SWAYAM and SWAYAM Plus)

According to the UGC guidelines integrated into the new curriculum structures, Higher Education Institutions (HEIs) are permitted to allow students to take up to 40% of their total courses in a semester through the national MOOC platform, SWAYAM (or SWAYAM Plus for industry-aligned courses).

Credits earned via SWAYAM are mapped directly against the appropriate NHEQF academic level and digitally stored in the student's Academic Bank of Credits (ABC) to count toward their final degree, diploma, or certificate.

**NCrF Category Wise Credit Distribution (UGC CCFUP Compatible) (for PG Programme)**

| Semester | Core Courses | | IKS | | Dissertation | | Grand Total Credits |
|---|---|---|---|---|---|---|---|
| | No. Of Papers | Total Credits | No. Of Papers | Total Credits | No. Of Papers | Total Credits | |
| I | 5 | 20 | 1 | 4 | | | 24 |
| II | 5 | 20 | 1 | 4 | | | 24 |
| III | 5 | 18 | 1 | 4 | | | 22 |
| IV | - | - | | | 1 | 20 | 20 |
| Total Credits for the Course | | 58 | | 12 | | 20 | 90 |

These exit awards correspond to progressive NHEQF / NSQF levels and are fully NCrF-compliant for credit accumulation, mobility and re-entry through the Academic Bank of Credits.

These courses are designed at appropriate NSQF levels, with clear competency descriptors and notional hours.

## Eligibility for Admissions with No. of Seats

As per the admission guidelines and brochure of the KISS Deemed to be University.

## Examination Pattern:

The medium of examination is English which will be reflected in their final grade sheet/certificate. Provided that for a language subject answers are to be in that language. Sanskrit may be written in Odia script but language has to be Sanskrit.

### Duration of the Examinations-Mid Semester & End Semester:

Duration of examination for all term End examination shall be for 2.5 hours and for all Mid Term examination for 1 hour irrespective of full marks in the course/subjects and irrespective of credit. The practical examinations shall be of 2 hours duration.

Each School shall have a designated faculty as Examination Coordinator to be decided by

the Vice Chancellor in addition to the Controller of Examinations of the University.

**Continuous Evaluation and Mid Semester Examination:**

a) Mid semester examination will be of 1-hour duration for 20/10 marks (20 for subjects having no practical and 10 for subject with practical papers). There shall be no pass mark in Mid Semester examination.

b) The Mid-Semester Examination shall be conducted and valued by the Faculty who are teaching the corresponding paper. A student who fails to appear in a Mid-Semester Examination **will be allowed one more chance to** take the same examination before appearing the concerned term-end examination. There will be no provision to re-appear in the Mid-Semester Examination for improvement.

c) For subjects with practical there will be a Mid-Semester practical examination carrying 10 marks.

d) The University authority of the valuation zones will preserve the answer Script of the End Semester examination for 06 months from the date of publication of result for reference.

e) A student has to appear the mid semester examination positively. Absence in the mid semester examination will be considered as fail however the candidate may be allowed to appear the mid semester examination before commencement of the concerned Term-End examination under special case duly considered by the HoD (for the ***candidates who represent the University or State for Inter- University or inter-state competitions in Games and Sports or attending different recognized National level camps/any critical medical case duly certified by the designated medical officer).***

## Distribution of Marks in End Semester and Continuous Evaluation: (Irrespective of credit in a course/Paper)

| Course Type | Maximum Marks | Semester-End theory Mark | Continues Evaluation Marks /Sessional | Mid Semester theory Mark | Semester-End and Practical mark | Mid Semester Practical Mark |
|---|---|---|---|---|---|---|
| **Without Practical** | **100** | **60** | **20** | **20** | **----** | **--** |
| **With Practical** | **100** | **50** | **10** | **10** | **20** | **10** |
| **Thesis/ Dissertation/ Seminar/Field Work** | **100** | **------** | **-------** | **-------** | **-------** | **-------** |

The **modes of evaluation** of **Thesis/ Dissertation/ Seminar/Field Work** shall be as follows:

Literature Review
Synopsis Presentation
Field Work / Data Collection and Data Analysis
Findings and Conclusions
Presentation and Viva-Voce

**Distribution of Sessional Marks:(Continuous Evaluation)**

| Course Type | Maximum Mark | Mid Semester | Attendance | Surprise Test/Quiz/Viva | Assignment/ Presentation |
|---|---|---|---|---|---|
| **Without Practical** | **40** | **20** | **Above 95%- 5 Marks** | **10** | **05** |
| **With Practical** | **30** | (Theory 10 + Practical 10)=20 | **85%-94%- 4 Marks**<br>**75%-84%- 3 Marks** | **05** | **Nil** |

**Examination Question Pattern of End Term Examination and Mark Distribution:**

The evaluation process may cover summative and formative aspects and assess understanding applications, articulation, program and course outcome.

| **Question Pattern** | | **With Practical** | **Without Practical** |
|---|---|---|---|
| **Part-I –Objective** | **Answer in MCQ/ in one word/in one sentence as directed** | **1x5=5** | **1x6=6** |
| **Part-II- Very Short Type** | **Answer within 50 words. Answer any 3 out of 5 questions (with practical) and Answer any 5 out of 7 question (without practical)** | **2x3=6** | **2x5=10** |
| **Part-III- Short Type** | **Answer within 250 words Answer any 3 out of 5 questions (with practical) and Answer any 4 out of 6 question (without practical)** | **5x3=15** | **5x4=20** |
| **Part-IV- Long Type** | **Answer within 800 words. Answer any 3 out of 5 questions** | **8x3=24** | **8x3=24** |
| **Total** | | **50** | **60** |
| **For Practical Paper** | | **One Major Experiment-10 Record- 05 Viva voce-05** | --------- |

**Examination Question Pattern of Mid Semester Examination and Mark Distribution**

| Question Pattern | | With Practical | Without Practical |
|---|---|---|---|
| Part-I –Objective | Answer in MCQ/ in one word/in one sentence as directed | 1x3=3 | 1x6=6 |
| Part-II- Very Short Type | Answer within 50 words. Answer any 1out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical) | 2x1=2 | 2x2=4 |
| Part-III- Short Type | Answer within 250 words Answer any 1 out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical) | 5x1=5 | 5x2=10 |
| Total | | 10 | 20 |
| For Practical Paper | | One Major Experiment-5 Record- 02 Viva voce-03 | -------- |

**Award of Degree:**

A Degree certificate under the official seal of the university and signed by the Vice-Chancellor shall be presented at the Convocation or in absentia to each of the successful students of particular degree. The Controller of Examinations shall issue the mark/grade sheet of each semester to the candidates in the sheet of each semester to the candidates in the prescribed format.

# VIII. Duration and Types of Courses and Process of Multiple Entry and Exit

**NHEQF-Aligned Components (National Higher Education Qualifications Framework)**

1. **NHEQF Level Mapping for Multi-Entry / Multi-Exit**

*"This programme is structured according to the multi-entry, multi-exit parameters defined by UGC. The progressive qualification bands map directly onto the National Higher Education Qualifications Framework (NHEQF)."*

Insert the following table:

| **Milestone / Year Completed** | **Exit Award** | **NHEQF Level** | **Standard Credit Range** |
|---|---|---|---|
| **Year 1 (Sem I–II)** | Post-Graduate Diploma in Computer Science | Level 6.0 | **48 Credits** (Coursework including Core Courses, Electives, Laboratory Courses, Seminar, if applicable) |
| **Year 2 (Sem III–IV)** | Master of Science (M.Sc.) in Computer Science | Level 6.5 | **90 Credits** (Total) including Advanced Coursework, Project/Dissertation, Seminar, and Research/Industrial Training, where applicable) |
| | Doctoral Degree | Level 8.0 | Credits for coursework and, a thesis and published work |

# IX. Programme Educational Objectives (PEO)

*(Schools may adapt these based on discipline.)*

**PEO1:** Within 2 years of post-graduation, graduates will establish successful careers in industry, academia, government, or the IT sector by applying advanced knowledge of Computer Science, analytical thinking, and problem-solving skills to develop innovative and sustainable computing solutions.

**PEO2:** Graduates will demonstrate entrepreneurial competence by creating technology-driven products, services, or start-ups, collaborating with industry, and contributing to economic growth through innovation and leadership.

**PEO3:** Graduates will engage in higher education, research, and lifelong learning by adopting emerging technologies, conducting interdisciplinary research, publishing scholarly work, and pursuing professional certifications to address contemporary challenges

.

**PEO4:** Graduates will uphold professional ethics, environmental sustainability, inclusiveness, and social responsibility while developing technology-enabled solutions that improve the quality of life and contribute to national and global development.

**PEO5:** Graduates will integrate indigenous knowledge systems, traditional wisdom, and local community needs with modern computing technologies to develop culturally relevant, sustainable, and socially impactful digital solutions.

# X. Programme Outcomes (PO)

*(Aligned with NEP-2020 Graduate Attributes)*

| | | |
|---|---|---|
| PO1 | Moral & Ethical Values | Apply ethical principles and commit to professional ethics and responsibilities and norms of the software professional practices. |
| PO2 | Disciplinary Knowledge | Acquire and apply the knowledge of mathematics and computer science to solve real life problems. |
| PO3 | Communication Skills | To develop an understanding of, and ability with the different forms of communication - writing, reading, speaking, listening-including visual and graphical, within science and beyond and the ability to apply these appropriately and effectively for different audiences. |

| | | |
|---|---|---|
| PO4 | Critical Thinking, Problem solving & analytical reasoning | Acquire an ability to think and work creatively, including the capacity for self-starting, and the ability to apply science skills to unfamiliar applications. It encompasses skills such as understanding risk management and risk-taking, "thinking outside the box", and questioning the norm to suggest new solutions for old problems. Develop an understanding of the scientific method of evidence-based knowledge acquisition, deduction, inference, and induction. Including problem-solving, critical thinking & analysis and the ability to discover new knowledge. |
| PO5 | Indian Knowledge Systems (IKS) | Indian Knowledge Systems (IKS) connects traditional scientific knowledge with modern computing concepts such as algorithms, formal languages, artificial intelligence, and problem-solving techniques. Integrating IKS into computer science education encourages interdisciplinary learning, ethical computing, sustainable technology development, and a deeper understanding of the historical foundations of modern computational methods. |
| PO6 | Research-Related Skills | Use application-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO7 | Cooperation/Teamwork | Function effectively as an individual, and as a member or in diverse teams, and in multidisciplinary settings. |
| PO8 | Digital Literacy | Create, select, and apply appropriate techniques, resources, and modern IT tools to model complex solutions with an understanding of their limitations. |
| PO9 | Experiential & Life – long learning | Develop the capacity to engage in reflection and learning beyond formal educational contexts, that is based on the ability to make effective judgments about one's own work and to undertake self-directed, curiosity motivated, learning. The capacity to learn in, and from, new disciplines to enhance the application of scientific knowledge and skills in professional contexts. |
| PO10 | Leadership Qualities | To acquire skills to function as a leader which includes not only subject specific skills such as laboratory skills, computing skills or quantitative data handling skills, but also more generic skills such time management, personal organization, teamwork and negotiation. |
| PO11 | Professional & Decision-making Skills | To acquire, develop, employ, and integrate a range of technical, practical and professional skills, in appropriate and ethical ways within a professional |

| | | |
|---|---|---|
| | | context, autonomously and collaboratively and across a range of disciplinary and professional areas. |
| PO12 | Environment Awareness and Sustainability | To build an awareness of the role of science within a global culture and willingness to contribute to the shaping of community views on complex issues where the methods and findings of science are relevant. This includes an understanding of how science underpins society, the applications of science in different cultures and identifying and engaging with current and future challenges. |

# XI. Programme Specific Outcomes (PSO)

**PSO1:** Ability to demonstrate a degree of mastery in computer applications through the advanced knowledge of data acquisition, data mining, knowledge discovery and artificial intelligence

**PSO2:** Ability to independently carry out research/investigation and developmental work to solve practical problems.

**PSO3:** Develop sound knowledge and skill sets to develop and expand professional careers in fields related to human-computer interaction and management of industrial processes for the design and implementation of intelligent systems.

**PSO4:** To cater to the demands of the IT and IT-enabled sectors through strong theoretical foundation with high quality teaching complemented with extensive practical training.

# XII. Course Structure of the Postgraduate Programme

**SEMESTER – I**

| Paper Code | Paper Name | Credits | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| CS40001 | Computer Graphics | 3 | 1 | 0 | 4 |
| CS40003 | Algorithms for Computational Problem Solving | 3 | 0 | 1 | 4 |
| CS40005 | Cloud Technologies | 3 | 0 | 1 | 4 |
| CS40007 | Artificial Neural Networks | 3 | 0 | 1 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| CS40009 | Python for Computational Science | 3 | 0 | 1 | 4 |
| **Choose any One** | | | | | |
| IK40051 | Tribal Sports, Nutrition and Health Management | 3 | 1 | 0 | 4 |
| IK40053 | Vedic Mathematics | 3 | 1 | 0 | 4 |
| **Total Credits: 20 + 4 = 24** | | | | | |

## SEMESTER – II

| **Paper Code** | **Paper Name** | **Credits** | | | **Credits** |
|---|---|---|---|---|---|
| | | **L** | **T** | **P** | |
| CS40002 | Compiler Design | 3 | 1 | 0 | 4 |
| CS40004 | Internet of Things | 3 | 1 | 0 | 4 |
| CS40006 | Blockchain Technologies | 3 | 1 | 0 | 4 |
| CS40018 | Digital Image Processing | 3 | 0 | 1 | 4 |
| CS40010 | Artificial Intelligence for Natural Language Processing | 3 | 0 | 1 | 4 |
| | | | | | |
| IK40052 | Indigenous People and the Science of Gemology | 3 | 1 | 0 | 4 |
| **Total Credits: 20 + 4 = 24** | | | | | |

Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma in Computer Science

## SEMESTER – III

| **Paper Code** | **Paper Name** | **Credits** | | | **Credits** |
|---|---|---|---|---|---|
| | | **L** | **T** | **P** | |
| RM50001 | Research Methodology | 3 | 1 | 0 | 4 |
| CA50005 (For other Discipline) | Computer Application and Data Analysis | 3 | 0 | 1 | 4 |
| CA50007 | Data Analysis and Visualization | 3 | 0 | 1 | 4 |
| RE50003 | Research and Publication Ethics | 2 | 0 | 0 | 2 |
| **Electives (Choose TWO)** | | | | | |
| CS50031 | Recommender Systems | 3 | 0 | 1 | 4 |
| CS50033 | Machine Learning for Predictive Analytics | 3 | 0 | 1 | 4 |
| CS50035 | Big Data Technologies | 3 | 1 | 0 | 4 |
| CS50037 | Soft Computing | 3 | 0 | 1 | 4 |
| | | | | | |
| IK50051 | Indigenous Knowledge and Intellectual | 3 | 1 | 0 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| | Property Rights | | | | |
| | | | | | |
| **Total Credits: 18 + 4 = 22** | | | | | |

## SEMESTER – IV

| Paper Code | Paper Name | Credits | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| RT50082 | Research Thesis | 0 | 0 | 20 | 20 |
| | | | | | |
| **Total Credits: 20** | | | | | |

Students will be awarded a **PG Computer Science degree** provided they secure 92 credits.

**Grand Total Credits = 78 + 12 = 90**

*** One Credit = 1 hour for Theory classes (15 hours of lecture/tutorial)**
*** One Credit = 2 hours for Practical classes (30 hrs of practicum)**

# Course Structure (Semester-wise)

## SEMESTER – I

| Paper Code | Paper Name | Credits | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| CS40001 | Computer Graphics | 3 | 1 | 0 | 4 |
| CS40003 | Algorithms for Computational Problem Solving | 3 | 0 | 1 | 4 |
| CS40005 | Cloud Technologies | 3 | 0 | 1 | 4 |
| CS40007 | Artificial Neural Networks | 3 | 0 | 1 | 4 |
| CS40009 | Python for Computational Science | 3 | 0 | 1 | 4 |
| **Choose any One** | | | | | |
| IK40051 | Tribal Sports, Nutrition and Health Management | 3 | 1 | 0 | 4 |
| IK40053 | Vedic Mathematics | 3 | 1 | 0 | 4 |

| **Total Credits: 20 + 4 = 24** |
|---|

# Course Title: Computer Graphics

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40001 | Computer Graphics | 4 | 3-1-0 |

**Course Objectives**:

1. To provide students with advanced knowledge and practical skills in computer graphics
2. Enabling them to design and implement complex graphical applications
3. Critically evaluate and optimize graphical systems.

**Course Outcomes**:

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computer graphics, graphics systems, display devices, coordinate systems, and graphical transformations.
- **CO2 (Understanding):** Explain and interpret the principles of line, circle, and polygon generation algorithms, clipping techniques, windowing, viewing transformations, and two-dimensional graphical operations.
- **CO3 (Application):** Apply geometric transformations, clipping algorithms, and projection techniques to develop computer graphics applications using suitable programming tools and graphics libraries.
- **CO4 (Analysis):** Analyze and compare different computer graphics algorithms, rendering techniques, and three-dimensional viewing methods based on computational efficiency, accuracy, and application requirements.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate interactive two-dimensional and three-dimensional computer graphics solutions by integrating transformation, illumination, shading, and rendering techniques to solve real-world visualization problems.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | 1 | - | - |
| CO2 | - | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO3 | | 3 | | 2 | - | - | - | - | - | - | - | - | - | - | 2 | 1 |
| CO4 | - | - | - | - | - | - | 3 | - | - | - | - | - | 2 | - | - | - |
| CO5 | - | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 | - | 2 |

**Course Duration**: 45 hours

**Tutorial**: 30 hours

**Course Syllabus**

**Unit 1: Introduction to Computer Graphics [8 Classroom Contact Hours]**

Introduction to Computer Graphics, Applications of Computer Graphics, Graphics Hardware and Software, Display Devices, Raster Scan and Random Scan Displays, Input Devices, Frame Buffer, Graphics Software Standards

**Unit 2: 3D Modeling and Transformation [8 Classroom Contact Hours]**

Coordinate Systems, Translation, Rotation, Scaling, Reflection, Shearing, Homogeneous Coordinates, Composite Transformations, Window-to-Viewport Transformation

**Unit 3: Illumination and Shading [9 Classroom Contact Hours]**

Light Sources, Reflection Models, Phong Illumination Model, Shading Techniques, Flat Shading, Gouraud Shading, Phong Shading, Introduction to Ray Tracing, Texture Mapping, Basics of Animation, Key Frame Animation

**Unit 4: Advanced Rendering Techniques** [10 Classroom Contact Hours]

Ray Tracing, Path Tracing, Global Illumination, Radiosity, Physically Based Rendering (PBR), Texture Mapping, Environment Mapping, Shadow Mapping, Bump Mapping, Normal Mapping, Displacement Mapping, Anti-Aliasing Techniques, High Dynamic Range (HDR) Rendering, Real-Time Rendering, GPU-Based Rendering, Rendering Pipeline Optimization.

**Unit 5: Graphics Programming and GPU** [10 Classroom Contact Hours]

Graphics Programming Fundamentals, OpenGL Programming, OpenGL Graphics Pipeline, Shader Programming, Vertex Shader, Fragment Shader, Geometry Shader, GLSL (OpenGL Shading Language), Buffer Objects, Vertex Array Objects (VAO), Vertex Buffer Objects (VBO), Texture Loading and Mapping, GPU Architecture, GPU Computing Basics, CUDA and OpenCL Overview, Parallel Processing on GPU, Performance Optimization Techniques, Introduction to Vulkan and DirectX

- **Textbook**:

1. "Computer Graphics: Principles and Practice" by John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, and Kurt Akeley

- **Reference Books**:

1. "Real-Time Rendering" by Tomas Akenine-Möller, Eric Haines, and Naty Hoffman
2. "Fundamentals of Computer Graphics" by Steve Marschner and Peter Shirley

**SWAYAM Course**

Computer Graphics - https://onlinecourses.nptel.ac.in/noc24_cs82/preview

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | High-quality technical education |
| SDG 9 | Innovation in visualization and simulation |
| SDG 10 | Inclusive visual design |
| SDG 12 | Efficient use of computational resources |

# Course Title: Algorithms for Computational Problem Solving

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40003 | Algorithms for Computational Problem Solving | 4 | 3-0-1 |

**Course Objectives**:

1. To formulate algorithm, translate into program and then execute the programs for verifying its correctness.
2. To analyze a problem for knowing its efficiency and decompose it into functions using divide and conquer approach.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of algorithms, asymptotic notations, complexity analysis, and data structures used for solving computational problems.
- **CO2 (Understanding):** Explain and interpret the principles of algorithm design paradigms, including divide and conquer, greedy method, dynamic programming, backtracking, and branch and bound techniques.
- **CO3 (Application):** Apply appropriate algorithm design techniques and data structures to develop efficient solutions for computational problems based on their characteristics and constraints.
- **CO4 (Analysis):** Analyze and compare different algorithms with respect to time complexity, space complexity, correctness, and efficiency to determine the most suitable solution for a given problem.
- **CO5 (Synthesis/Evaluation):** Design, formulate, and evaluate optimized algorithms using appropriate algorithmic paradigms to solve complex computational problems and explore emerging research trends in algorithm design.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | 1 | 3 | 2 | 2 | - |
| CO2 | - | 3 | - | 3 | 3 | - | - | - | - | - | - | - | - | 2 | - | - |
| CO3 | - | 3 | - | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 1 |
| CO4 | - | - | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO5 | - | - | - | 3 | - | 2 | - | - | - | - | - | - | 1 | 3 | - | 2 |

**Course Duration**: 45 hours

**Course Syllabus**

**UNIT I: Introduction** [8 Classroom Contact Hours]

Definition of algorithm**,** Characteristics of algorithm**,** Growth of Functions**,** Asymptotic analysis**,** Recurrences: solution of recurrences by substitution, recursion tree and Master methods.

**UNIT II: Divide-and- conquer Approach** [12 Classroom Contact Hours]

Binary search, Quick sort, Merge sort, Heap Sort, Priority Queue, Lower bounds for sorting, Elements of dynamic programming, Matrix-chain multiplication, Longest common subsequence, Assembly-line scheduling., Elements of Greedy strategy,, Activity selection Problem, Fractional knapsack problem, Huffman codes.

**UNIT III: Graph Algorithms** [9 Classroom Contact Hours]

Data structure for disjoint sets, Disjoint set operations, Linked list representation, Path compression, Disjoint set forests, Breadth first search and depth-first search, , Minimum Spanning Trees, Kruskal algorithm and Prim's algorithms, Single- source shortest paths (Bellman-ford Algorithm and Dijkstra's algorithms), All-pairs shortest paths (Floyd–Warshall Algorithm).

**UNIT IV: Backtracking and Pattern Matching** [9 Classroom Contact Hours]

Back tracking, Branch and Bound, Eight Queen problem, Sub Set Sum Problem, String matching algorithms: naïve string-matching algorithm, Rabin-Karp algorithm, Knuth–Morris–Pratt algorithm

**UNIT V: NP and NP Hard** [7 Classroom Contact Hours]

NP – Completeness, Polynomial time, Polynomial time verification, NP - Completeness and reducibility, NP-Complete problems (without Proofs), Approximation algorithms characteristics, Traveling Salesman Problem, vertex Cover Problem.

**List of Experiments:** [30 Lab Contact Hours]

1. Implement Merge Sort, Quick sort.
2. Implement binary search technique.

3. Implement dynamic programming.
4. Implement Longest common subsequence
5. Implement Knapsack as well as Fractional knapsack problem
6. Implement Kruskal algorithm and Prim's algorithms.
7. Implement Bellman-ford Algorithm and Dijkstra's algorithms.
8. Implement Floyd–Warshall Algorithm.
9. Implement Branch and Bound problem.
10. Implement Rabin-Karp algorithm.

- **Text Books**

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest: "Introduction to Algorithms", PHI

- **References**

1. Seymour Lipschutz: "Theory & Problems of Data Structures", Schaum's Outline Series (McGraw-Hill)
2. Trembley, Sorenson:- An Introduction to Data Structures with Applications. (TMH)
3. Kutty: Data Structures using C++ (PHI)
4. Bhagat Singh, Naps : Introduction to Data Structures (TMH)
5. E Horowitz and S. Sahani, Fundamentals of Computer Algorithm, Universities Press

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Strengthening analytical competencies |
| SDG 9 | Foundations for innovation and intelligent systems |
| SDG 10 | Reducing algorithmic bias |
| SDG 13 | Efficient algorithms reduce energy consumption |

# Course Title: Cloud Technologies

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40005 | Cloud Technologies | 4 | 3-0-1 |

**Course Objectives**:

1. To provide students with a comprehensive understanding of cloud computing technologies.
2. Enabling them to design, implement, and manage cloud-based solutions while addressing complex problems
3. Fostering critical thinking, and promoting sustainable practices.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts, architecture, characteristics, components, and service models of cloud computing.
- **CO2 (Understanding):** Explain and interpret the principles of cloud service models, deployment models, virtualization, resource management, and cloud security mechanisms.
- **CO3 (Application):** Apply cloud computing tools, platforms, and technologies to design, develop, and deploy cloud-based applications and services.
- **CO4 (Analysis):** Analyze and compare different cloud service providers, deployment strategies, virtualization techniques, and security models to determine appropriate cloud solutions for various application requirements.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate scalable, secure, and cost-effective cloud-based solutions by integrating appropriate cloud technologies, services, and best practices to address real-world computing challenges.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 3 | - |
| CO2 | - | 3 | - | 2 | 1 | - | - | - | - | - | - | - | - | 2 | - | - |
| CO3 | - | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 |
| CO4 | - | - | - | - | - | - | 3 | - | - | - | - | - | 2 | - | - | - |
| CO5 | - | - | - | 3 | - | - | - | - | - | - | - | - | - | 1 | - | 2 |

**Course Duration**: 45 hours

**Course Syllabus**

**Unit 1: Introduction to Cloud Computing** [7 Classroom Contact Hours]

Definition and Characteristics of Cloud Computing, Evolution of Cloud Computing, Cloud Architecture, Cloud Service Models (IaaS, PaaS, SaaS), Cloud Deployment Models (Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud), Benefits of Cloud Computing, Challenges of Cloud Computing, Virtualization Basics, Cloud Computing Applications, Case Studies of Cloud Adoption.

**Unit 2: Cloud Architecture and Infrastructure** [8 Classroom Contact Hours]

Cloud Architecture, Components of Cloud Architecture, Cloud Computing Layers, Virtualization Concepts, Types of Virtualization, Virtualization Technologies, Hypervisors, Data Centers, Cloud Infrastructure, Storage Virtualization, Network Virtualization, Cloud Networking, Load Balancing, Resource Provisioning, Security in Cloud Environments, Identity and Access Management (IAM), Data Protection, Compliance and Governance.

**Unit 3: Cloud Services and Applications** [10 Classroom Contact Hours]

Cloud Storage, Cloud Databases, Object Storage, Block Storage, File Storage, Cloud-Based Applications, Cloud Services, Development Platforms for Cloud Applications, Cloud Development Tools, APIs and SDKs, Microservices Architecture, Containerization, Docker, Kubernetes, Serverless Computing, Function as a Service (FaaS), Cloud Application Deployment.

**Unit 4: Cloud Management and Operations** [11 Classroom Contact Hours]

Cloud management platforms and tools, Monitoring and managing cloud resources, Cost management and optimization, Disaster recovery and business continuity, Performance tuning and scaling

**Unit 5: Emerging Trends and Future Directions** [9 Classroom Contact Hours]

Edge computing and IoT integration with cloud, Artificial Intelligence and Machine Learning in the cloud, Blockchain and cloud computing, Green cloud computing and sustainability, Future trends and research directions in cloud computing

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Analyze a case study of cloud adoption in a real-world organization.
2. Compare and contrast different cloud service models.
3. Design a cloud architecture for a given application scenario.
4. Implement a simple cloud-based application using a chosen platform.
5. Set up and configure a virtual machine in a cloud environment.
6. Develop a microservice-based application and deploy it on a cloud platform.
7. Create and manage cloud storage solutions.
8. Monitor and optimize the performance of a cloud application.
9. Implement a disaster recovery plan for a cloud-based system.
10. Evaluate the security measures of a cloud service provider.
11. Conduct a cost analysis for deploying an application on different cloud platforms.
12. Develop a serverless function and deploy it on a cloud platform.
13. Integrate IoT devices with a cloud platform.
14. Implement a machine learning model using cloud-based tools.
15. Explore the use of blockchain technology in cloud computing.
16. Research and present on the environmental impact of cloud computing.
17. Collaborate on a group project to design a comprehensive cloud solution.
18. Write a report on the future trends in cloud computing.
19. Create a presentation on the benefits and challenges of cloud computing.
20. Participate in a debate on the ethical implications of cloud computing.

- **Textbook:**
  1. **"**Cloud Computing: Concepts, Technology & Architecture**"** by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini

- **Reference Books:**
  1. **"**Cloud Computing: Principles and Paradigms" by Rajkumar Buyya, James Broberg, and Andrzej Goscinski
  2. "Mastering Cloud Computing: Foundations and Applications Programming" by Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi
  3. "Cloud Computing: A Hands-On Approach**"** by Arshdeep Bahga and Vijay Madisetti

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Access to modern ICT skills |
| SDG 8 | Employability in cloud-driven industries |
| SDG 9 | Infrastructure modernization |
| SDG 13 | Energy-efficient cloud practices |

# Course Title: Artificial Neural Networks

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40007 | Artificial Neural Networks | 4 | 3-0-1 |

**Course Objectives**:

1. To equip students with a deep understanding of artificial neural networks (ANNs)
2. Enabling them to design, implement, and evaluate neural network models for solving complex problems in various domains, while fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of artificial neural networks, biological neurons, network architectures, learning paradigms, and activation functions.
- **CO2 (Understanding):** Explain and interpret the principles of supervised, unsupervised, and reinforcement learning, neural network training algorithms, and optimization techniques.
- **CO3 (Application):** Apply neural network models, learning algorithms, and appropriate software tools to design and implement solutions for classification, prediction, and pattern recognition problems.
- **CO4 (Analysis):** Analyze and compare different neural network architectures, training algorithms, and performance evaluation metrics to select suitable models for specific application domains.

- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate optimized neural network models by integrating advanced architectures and learning techniques to solve complex real-world problems in artificial intelligence and data analytics.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - | 2 |
| CO2 | - | 3 | - | 2 | 3 | - | - | - | - | - | - | - | 2 | 3 | - | 2 |
| CO3 | - | 3 | - | - | 3 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO4 | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | 2 | - |
| CO5 | - | - | - | 3 | - | 3 | - | - | - | - | - | - | 2 | - | 2 | 1 |

**Course Duration**: 45 hours

**Course Syllabus**

**Unit 1: Introduction to Artificial Neural Networks** [8 Classroom Contact Hours]

Overview of neural networks and their biological inspiration, Basic concepts: Neurons, activation functions, and network architectures, Types of neural networks: Feedforward, recurrent, convolutional, etc., Learning paradigms: Supervised, unsupervised, and reinforcement learning, Historical development and key milestones in ANN research

**Unit 2: Feedforward Neural Networks** [8 Classroom Contact Hours]

Perceptron and multilayer perceptron (MLP), Backpropagation algorithm and gradient descent, Activation functions: Sigmoid, tanh, ReLU, and others, Regularization techniques: Dropout, weight decay, and batch normalization, Case studies and applications of feedforward networks

**Unit 3: Convolutional Neural Networks** [10 Classroom Contact Hours]

Convolutional layers and pooling layers, Architectures: LeNet, AlexNet, VGG, ResNet, etc., Transfer learning and fine-tuning pre-trained models, Applications in image recognition, object detection, and more, Practical implementation using frameworks like TensorFlow and PyTorch

**Unit 4: Recurrent Neural Networks** [10 Classroom Contact Hours]

Recurrent neural networks (RNNs) and their variants, Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU), Sequence modeling and time series prediction, Applications in natural language processing and speech recognition, Practical implementation using frameworks like Keras and TensorFlow

**Unit 5: Advanced Topics and Future Directions** [9 Classroom Contact Hours]

Generative Adversarial Networks (GANs) and Their Applications, Reinforcement Learning and Neural Networks, Explainable AI and Interpretability of Neural Networks, Ethical Considerations and Societal Impact of Neural Networks, Future Trends and Research Directions in ANN.

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Implement a simple perceptron model for binary classification.
2. Train a multilayer perceptron (MLP) on a given dataset and evaluate its performance.
3. Apply regularization techniques to improve the performance of an MLP.
4. Design and implement a convolutional neural network (CNN) for image classification.
5. Fine-tune a pre-trained CNN model for a specific application.
6. Develop an RNN model for time series prediction.
7. Implement an LSTM network for text generation.
8. Compare the performance of different activation functions in a neural network.
9. Use transfer learning to adapt a pre-trained model to a new task.
10. Implement a GAN to generate synthetic data.
11. Evaluate the performance of a neural network using different metrics.
12. Optimize the hyperparameters of a neural network model.
13. Implement a neural network using TensorFlow or PyTorch.
14. Develop a sequence-to-sequence model for machine translation.
15. Analyze the impact of different regularization techniques on model performance.
16. Implement a reinforcement learning algorithm using neural networks.
17. Explore the interpretability of a neural network model.
18. Research and present on the ethical implications of neural networks.
19. Collaborate on a group project to design a comprehensive neural network solution.

20. Write a report on the future trends in artificial neural networks.

- **Textbook:**

1. **"**Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

- **Reference Books:**

1. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal
2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | High-quality technical education |
| SDG 9 | Innovation in visualization and simulation |
| SDG 10 | Inclusive visual design |
| SDG 12 | Efficient use of computational resources |

# Course Title: Python for Computational Science

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40009 | Python for Computational Science | 4 | 3-0-1 |

**Course Objectives**:

1. To provide students with the skills and knowledge to use Python for solving complex computational problems in science and engineering.
2. Fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of Python programming, data types, control structures, functions, modules, and scientific computing libraries.

- **CO2 (Understanding):** Explain and interpret the principles of Python programming, object-oriented programming, file handling, exception handling, and the use of scientific libraries for computational problem-solving.
- **CO3 (Application):** Apply Python programming techniques and scientific computing libraries to develop solutions for mathematical, statistical, data analysis, and scientific computing applications.
- **CO4 (Analysis):** Analyze and compare Python algorithms, data structures, and scientific computing approaches to develop efficient and optimized solutions for computational problems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate Python-based scientific computing applications by integrating appropriate programming techniques, libraries, and visualization tools to solve real-world scientific and engineering problems.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 | 3 | 2 |
| CO2 | - | 3 | - | 2 | 3 | - | - | - | - | - | - | - | 2 | - | 2 | - |
| CO3 | - | 3 | - | - | 3 | - | - | - | - | - | - | - | - | 2 | - | 2 |
| CO4 | - | - | - | - | - | - | 3 | - | - | - | - | - | 2 | 2 | - | - |
| CO5 | - | - | - | 3 | - | 2 | - | - | - | - | - | - | - | 2 | 3 | - |

**Course Duration**: 45 hours

**Course Syllabus**

**Unit 1: Introduction to Python and Computational Science** [8 Classroom Contact Hours]

Overview of Python Programming Language, Python Installation and Setup, Basic Syntax and Data Types, Control Structures: Loops and Conditionals, Introduction to Computational Science and Its Applications.

**Unit 2: Scientific Computing with Python** [9 Classroom Contact Hours]

NumPy for Numerical Computations, SciPy for Scientific Computing, Matplotlib for Data Visualization, Pandas for Data Manipulation and Analysis, Case Studies in Scientific Computing.

**Unit 3: Advanced Python Programming** [8 Classroom Contact Hours]

Object-Oriented Programming in Python, File Handling and Data Processing, Error Handling and Debugging, Performance Optimization Techniques, Introduction to Parallel Computing with Python.

**Unit 4: Python for Data Analysis and Visualization** [10 Classroom Contact Hours]

Data Analysis with Pandas, Data Visualization with Matplotlib and Seaborn, Statistical Analysis and Hypothesis Testing, Machine Learning Basics with Scikit-learn, Real-World Data Analysis Projects.

**Unit 5: Applications of Python in Computational Science** [10 Classroom Contact Hours]

Bioinformatics and Computational Biology, Computational Physics and Chemistry, Environmental Modeling and Simulation, Big Data and Cloud Computing with Python, Future Trends and Research Directions in Computational Science.

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Write a Python program to solve a basic mathematical problem.
2. Implement a numerical computation using NumPy.
3. Create a data visualization using Matplotlib.
4. Analyze a dataset using Pandas and present the findings.
5. Develop a Python script for file handling and data processing.
6. Implement object-oriented programming concepts in a Python project.
7. Debug and optimize a Python program for better performance.
8. Perform a statistical analysis on a given dataset.
9. Develop a simple machine learning model using Scikit-learn.
10. Implement a parallel computing task using Python.
11. Create a data visualization project using Seaborn.
12. Develop a Python program for a bioinformatics application.
13. Simulate a physical system using Python.
14. Model an environmental process using Python.
15. Analyze big data using Python and cloud computing tools.
16. Collaborate on a group project to solve a computational science problem.
17. Write a report on the application of Python in a specific scientific domain.
18. Present a case study on the use of Python in computational science.

19. Research and present on the future trends in Python for computational science.
20. Participate in a debate on the ethical implications of computational science.

- **Textbook:**
  1. **"**Python for Data Analysis" by Wes McKinney

- **Reference Books:**
  1. "Python Programming: An Introduction to Computer Science" by John Zelle
  2. "Python for Scientists and Engineers" by Andrew Knight
  3. "Python Data Science Handbook" by Jake VanderPlas

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Foundational computational literacy |
| SDG 9 | Innovation through scientific computing |
| SDG 12 | Efficient resource use in computation |
| SDG 17 | Open-source collaboration |

# Course Title: Vedic Mathematics

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| IK40053 | Vedic Mathematics | 4 | 3-1-0 |

**Course Objectives**:

1. To provide students with the skills and knowledge to use Python for solving complex computational problems in science and engineering.
2. Fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Learning Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of Vedic Mathematics, its historical development, major Sutras, Sub-Sutras, and their applications in mathematical computations.

- **CO2 (Understanding):** Explain and interpret the principles of arithmetic operations, simple equations, arithmetic progression, and computational techniques based on Vedic Mathematics.
- **CO3 (Application):** Apply Vedic Mathematics techniques, including factorization, HCF, partial fractions, and differential calculus, to solve mathematical problems using appropriate Sutras and Sub-Sutras.
- **CO4 (Analysis):** Analyze and compare conventional mathematical methods with Vedic Mathematics techniques to evaluate their efficiency, accuracy, and applicability in solving computational problems.
- **CO5 (Synthesis/Evaluation):** Evaluate the significance of ethnomathematics, indigenous mathematical knowledge systems, numerals, and naming systems, and assess their relevance in modern mathematics and interdisciplinary applications.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| CO2 | - | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - |
| CO3 | - | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | - | - | - | - | - | - | 3 | - | - | - | - | - | - | 2 | - | - |
| CO5 | - | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 | - | 1 |

**Course Duration**: 45 hours

**Tutorial**: 30 hours

**Course Syllabus**

**Unit-I: Introduction to Mathematics in Vedas** [11 Classroom Contact Hours]

Introduction to Mathematics in Vedas, different sutras and sub sutras, examples of sutras and sub sutras, Basic Concepts of Ancient Arithmetic, development and their uses, Different operations in Vedic mathematics: Addition, subtraction, multiplication, division, square, square root, cube and cube root and Examples.

**Unit – II: Knowledge on Arithmetic progression** [12 Classroom Contact Hours]
Knowledge on Arithmetic progression in Ancient India and different techniques, Simple equations, quadratic equations, Cubic equation, biquadrate equation, Simultaneous equation in Vedic mathematics.

**Unit – III: Mathematical numbers in Indian Tradition** [12 Classroom Contact Hours]
Mathematical numbers in Indian Tradition and different types of problems relating to Vedic sutras, Factorization, H.C.F, Partial fractions, Differential calculus in Vedic mathematics.

**Unit – IV: Mathematical Concept in Tribal Tradition** [10 Classroom Contact Hours]
Ethno mathematics: development and meaning of "ethno mathematics", Numerals and naming systems, Mathematics in folk art, Informal mathematics. Pythagoras theorem, Integration by partial fractions, Apollonius theorem, Analytical geometry in Vedic mathematics.

- **Textbook**:

1. Vedic Mathematics space book by S,.JK. Cosmic Kapoor- 2005
2. Vedic Arithmetic and Development of basic concepts Dr. K.P. Chamola – 2006 Arithmetic

**Note: Latest edition of the text books should be used.**

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Strengthening foundational numeracy |
| SDG 10 | Promoting equity through accessible methods |
| SDG 11 | Preserving cultural heritage |
| SDG 17 | Knowledge partnerships and cultural exchange |

## SEMESTER – II

| Paper Code | Paper Name | Credits | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| CS40002 | Compiler Design | 3 | 1 | 0 | 4 |
| CS40004 | Internet of Things | 3 | 1 | 0 | 4 |
| CS40006 | Blockchain Technologies | 3 | 1 | 0 | 4 |
| CS40018 | Digital Image Processing | 3 | 0 | 1 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| CS40010 | Artificial Intelligence for Natural Language Processing | 3 | 0 | 1 | 4 |
| | | | | | |
| IK40052 | Indigenous People and the Science of Gemology | 3 | 1 | 0 | 4 |
| **Total Credits: 20 + 4 = 24** | | | | | |

# Course Title: Compiler Design

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40002 | Compiler Design | 4 | 3-1-0 |

**Course Objectives**:

1. To provide students with an in-depth understanding of compiler construction
2. Enabling them to design and analyze compilers that efficiently translate high-level programming languages into machine code
3. Fostering complex problem-solving and critical thinking skills.

**Course Outcomes**:

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of compiler design, language processors, lexical analysis, syntax analysis, semantic analysis, and compiler phases.
- **CO2 (Understanding):** Explain and interpret the principles of lexical analysis, parsing techniques, syntax-directed translation, symbol table management, and error handling in compiler construction.
- **CO3 (Application):** Apply compiler construction techniques to develop lexical analyzers, parsers, intermediate code generators, and runtime environments using appropriate tools and programming languages.
- **CO4 (Analysis):** Analyze and compare parsing methods, code optimization techniques, runtime environments, and code generation strategies to improve compiler efficiency and performance.

- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate compiler components by integrating lexical analysis, syntax analysis, semantic analysis, code optimization, and code generation techniques for programming language translation.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | - |
| CO2 | - | 3 | - | - | 3 | - | - | - | - | - | - | - | - | 2 | - | - |
| CO3 | - | 3 | - | - | 3 | - | - | - | - | - | - | - | - | 3 | - | 2 |
| CO4 | - | - | 3 | - | - | - | - | - | - | - | - | - | 3 | 2 | - | - |
| CO5 | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |

**Course Duration**: 45 hours

**Tutorial**: 30 hours

**Course Syllabus**:

**Unit 1: Introduction to Compiler Design** [8 Classroom Contact Hours]

Introduction to Compiler Design, Language Processing System, Compiler Structure, Phases of a Compiler, Lexical Analysis, Tokens, Patterns and Lexemes, Finite Automata, Regular Expressions, Lexical Analyzer Generation, Symbol Table Management, Error Handling, Introduction to Compiler Construction Tools.

**Unit 2: Syntax-Directed Translation** [10 Classroom Contact Hours]

Context-Free Grammars (CFG), Parse Trees, Ambiguity in Grammars, Syntax Analysis, Top-Down Parsing, Recursive Descent Parsing, Predictive Parsing (LL(1)), Bottom-Up Parsing, Shift-Reduce Parsing, LR Parsing, Syntax-Directed Definitions (SDD), Syntax-Directed Translation Schemes (SDT), Intermediate Code Generation, Abstract Syntax Trees.

**Unit 3: Type Checking and Runtime Environments** [9 Classroom Contact Hours]

Type Systems, Type Checking, Type Conversion and Coercion, Type Expressions, Scope and Binding of Names, Symbol Table Organization, Storage Organization, Runtime Memory Management, Activation Records, Parameter Passing Mechanisms, Procedure Calls, Stack and Heap Allocation, Garbage Collection, Runtime Environments.

**Unit 4: Code Optimization** [9 Classroom Contact Hours]

Introduction to Code Optimization, Basic Blocks and Flow Graphs, Directed Acyclic Graph (DAG) Representation, Common Subexpression Elimination, Constant Folding, Constant Propagation, Copy Propagation, Dead Code Elimination, Loop Optimization, Peephole Optimization, Data Flow Analysis, Local and Global Optimization Techniques.

**Unit 5: Code Generation and Linking** [9 Classroom Contact Hours]
Code Generation Principles, Target Machine Architecture, Register Allocation and Assignment, Instruction Selection, Code Scheduling, Machine-Dependent Optimization, Object Code Generation, Linking and Loading, Static and Dynamic Linking, Relocation, Assembly Process, Compiler Testing and Debugging, Introduction to Just-In-Time (JIT) Compilation.

- **Textbook**:
  1. Compilers: Principles, Techniques, and Tools" by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman
- **Reference Books**:
  1. "Engineering a Compiler" by Keith D. Cooper and Linda Torczon
  2. "Modern Compiler Implementation in C" by Andrew W. Appel

**SWAYAM Courses**
Compiler Design - https://onlinecourses.nptel.ac.in/noc24_cs18/preview

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Strengthens advanced computing education |
| SDG 9 | Supports innovation in programming languages and systems |
| SDG 12 | Efficient compilation contributes to sustainable computing |

# Course Title: Internet of Things

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40004 | Internet of Things | 4 | 3-1-0 |

**Course Objectives**:

1. To provide students with a comprehensive understanding of the Internet of Things (IoT) ecosystem, including its architecture, technologies, and applications,
2. Eabling them to design and implement IoT solutions that address complex problems and contribute to sustainable development.

**Course Outcomes**:

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of the Internet of Things (IoT), IoT architecture, sensors, actuators, communication technologies, and IoT ecosystem.
- **CO2 (Understanding):** Explain and interpret the principles of IoT communication protocols, embedded systems, cloud integration, data acquisition, and security mechanisms in IoT environments.
- **CO3 (Application):** Apply IoT hardware platforms, communication protocols, and software tools to design, develop, and implement smart IoT-based applications for real-world problems.
- **CO4 (Analysis):** Analyze and compare IoT architectures, communication protocols, data management techniques, and security models to identify appropriate solutions for diverse application domains.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate secure, scalable, and sustainable IoT solutions by integrating sensors, embedded systems, cloud services, and data analytics to address industrial and societal challenges.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 2 | - |
| CO2 | - | 3 | - | - | 1 | - | - | - | - | - | - | - | - | 3 | - | 2 |
| CO3 | - | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - |
| CO4 | - | - | 3 | - | - | - | 2 | - | - | - | - | - | - | 2 | - | - |
| CO5 | - | - | 3 | - | - | - | - | - | 2 | - | - | - | 2 | - | - | 2 |

**Course Duration**: 45 hours

**Tutorial**: 30 hours

**Course Syllabus**:

**Unit 1: Introduction to IoT** [9 Classroom Contact Hours]

Overview of IoT and its significance, IoT architecture and design principles, Sensors, actuators, and smart objects

**Unit 2: IoT Communication Technologies** [9 Classroom Contact Hours]

Wired and wireless communication protocols, Networking for IoT: LAN, PAN, and mesh networks, IoT standards and ecosystems

**Unit 3: IoT Data Management and Analytics** [9 Classroom Contact Hours]

Data acquisition, preprocessing, and storage, Big data analytics in IoT, Cloud computing and IoT integration

**Unit 4: IoT Security and Privacy** [9 Classroom Contact Hours]

Security challenges in IoT, Privacy concerns and data protection, Secure IoT design and best practices

**Unit 5: IoT Applications and Future Trends** [9 Classroom Contact Hours]

Smart cities, homes, and grids, Industrial IoT and automation, Future trends and challenges in IoT

- **Textbook**:

1. Internet of Things: Principles and Paradigms" edited by Rajkumar Buyya and Amir Vahid Dastjerdi.

- **Reference Books**:

1. "Internet of Things: A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti
2. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj.

**SWAYAM Course**

Introduction to Internet of Things - https://onlinecourses.nptel.ac.in/noc24_cs115/preview

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 3 | IoT in health monitoring |
| SDG 9 | Smart infrastructure |
| SDG 11 | Smart cities |
| SDG 13 | Environmental sensing and climate action |
| SDG 15 | Biodiversity monitoring |

# Course Title: Blockchain Technologies

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40006 | Blockchain Technologies | 4 | 3-1-0 |

**Course Objectives**:

1. To provide students with a comprehensive understanding of blockchain technology, its underlying principles, and its application
2. Enabling them to design and implement blockchain solutions that address complex problems and contribute to technological innovation.

**Course Outcomes**:

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of blockchain technology, distributed ledger systems, cryptographic principles, consensus mechanisms, and blockchain architecture.
- **CO2 (Understanding):** Explain and interpret the principles of blockchain networks, consensus algorithms, smart contracts, decentralized applications, and blockchain security.
- **CO3 (Application):** Apply blockchain platforms, smart contract development tools, and decentralized application frameworks to design and implement blockchain-based solutions for real-world applications.

- **CO4 (Analysis):** Analyze and compare different blockchain architectures, consensus protocols, smart contract platforms, and security mechanisms to determine suitable solutions for various application domains.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate secure, scalable, and efficient blockchain-based systems by integrating smart contracts, decentralized applications, and emerging blockchain technologies to address industrial and societal challenges.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO2 | - | 3 | - | - | 3 | - | - | - | - | - | - | - | - | - | - | 2 |
| CO3 | - | 3 | - | 3 | 2 | - | - | - | - | - | - | - | 3 | - | 2 | - |
| CO4 | - | - | 3 | - | - | - | - | 2 | - | - | - | - | - | 3 | - | 3 |
| CO5 | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 | 2 | - | 3 |

**Course Duration**: 45 hours

**Tutorial**: 30 hours

**Course Syllabus**:

**Unit 1: Introduction to Blockchain** [9 Classroom Contact Hours]

Fundamentals of blockchain technology, History and evolution of blockchain, Cryptography and security principles

**Unit 2: Blockchain Architecture** [9 Classroom Contact Hours]

Distributed ledger technology, Consensus algorithms, Smart contracts and decentralized applications

**Unit 3: Blockchain Development** [9 Classroom Contact Hours]

Blockchain platforms: Ethereum, Hyperledger, etc., Development tools and environments, Building and deploying smart contracts

**Unit 4: Blockchain for Business** [9 Classroom Contact Hours]

Use cases in finance, supply chain, and other industries, Tokenization and digital assets, Regulatory environment and compliance

**Unit 5: Advanced Topics in Blockchain** [9 Classroom Contact Hours]

Scalability solutions and layer-two protocols, Privacy-preserving technologies, Future trends and challenges in blockchain

- **Textbook**:
  1. "Mastering Blockchain" by Imran Bashir

- **Reference Books**:
  1. "Blockchain: Blueprint for a New Economy" by Melanie Swan
  2. "Blockchain Revolution" by Don Tapscott and Alex Tapscott

**SWAYAM Courses**

Blockchain and its Applications - https://onlinecourses.nptel.ac.in/noc24_cs15/preview

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 8 | Financial inclusion, digital economy |
| SDG 9 | Innovation in secure digital infrastructure |
| SDG 10 | Reducing inequalities through decentralized systems |
| SDG 16 | Transparent governance and anti-corruption |

# Course Title: Digital Image Processing

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40018 | Digital Image Processing | 4 | 3-0-1 |

**Course Objectives**:

To provide students with a comprehensive understanding of digital image processing techniques, enabling them to analyze, process, and interpret images for various applications, while fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of digital image processing, image representation, sampling, quantization, image enhancement, and image transformation techniques.
- **CO2 (Understanding):** Explain and interpret the principles of image enhancement, filtering, segmentation, feature extraction, image compression, and morphological operations.
- **CO3 (Application):** Apply digital image processing techniques and appropriate software tools and libraries to develop solutions for image enhancement, restoration, segmentation, and pattern recognition applications.
- **CO4 (Analysis):** Analyze and compare different image processing algorithms, filtering methods, segmentation techniques, and feature extraction approaches to determine suitable solutions for specific image analysis problems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate digital image processing applications by integrating image enhancement, segmentation, feature extraction, and machine learning techniques to solve real-world computer vision and image analysis problems.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 2 | - | - |
| CO2 | - | 3 | - | 3 | 3 | - | - | - | - | - | - | - | - | 3 | - | 2 |
| CO3 | - | 3 | - | 3 | - | - | - | - | - | - | - | - | 3 | 3 | - | - |
| CO4 | - | 3 | - | - | - | - | - | 2 | - | - | - | - | - | 2 | 2 | - |
| CO5 | - | - | 3 | - | - | 2 | - | - | - | - | - | - | 2 | - | - | 2 |

**Course Duration**: 45 hours

**Course Syllabus**:

**Unit 1: Introduction to Digital Image Processing** [8 Classroom Contact Hours]

Fundamentals of Digital Image Processing, Image Acquisition and Representation, Basic Operations on Images: Arithmetic, Logical, and Geometric Operations, Image Enhancement Techniques: Spatial Domain Methods, Histogram Processing and Equalization.

**Unit 2: Image Transforms and Filtering** [9 Classroom Contact Hours]

Fourier transform and its applications in image processing, Discrete cosine transform (DCT) and wavelet transform, Image filtering in the frequency domain, Smoothing and sharpening filters, Edge detection techniques

**Unit 3: Image Restoration and Reconstruction** [10 Classroom Contact Hours]

Image degradation models, Noise reduction techniques, Inverse filtering and Wiener filtering, Image reconstruction from projections, Applications in medical imaging

**Unit 4: Image Segmentation and Feature Extraction** [10 Classroom Contact Hours]

Thresholding techniques, Region-based segmentation, Edge-based segmentation, Morphological image processing, Feature extraction and representation

**Unit 5: Advanced Topics and Applications** [8 Classroom Contact Hours]

Color image processing, Texture analysis and pattern recognition, Image compression techniques, Machine learning for image processing, Emerging trends and research directions in digital image processing

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Implement basic arithmetic operations on images using Python.
2. Apply histogram equalization to enhance image contrast.
3. Perform Fourier transform on an image and analyze the frequency components.
4. Implement a smoothing filter to reduce noise in an image.
5. Develop an edge detection algorithm using the Sobel operator.
6. Apply inverse filtering to restore a degraded image.
7. Implement a noise reduction technique using median filtering.
8. Reconstruct an image from its projections using the Radon transform.
9. Segment an image using thresholding techniques.
10. Develop a region-based segmentation algorithm.
11. Extract features from an image using morphological operations.
12. Implement color image processing techniques.
13. Analyze texture patterns in an image using GLCM.
14. Compress an image using JPEG compression.

15. Develop a simple image classification model using machine learning.
16. Implement a pattern recognition algorithm for object detection.
17. Collaborate on a group project to develop an image processing application.
18. Write a report on the application of digital image processing in a specific domain.
19. Present a case study on the use of image processing in medical imaging.
20. Research and present on the future trends in digital image processing.

- **Textbook:**
  1. **"**Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods

- **Reference Books:**
  1. **"**Digital Image Processing: An Algorithmic Introduction Using Java" by Wilhelm Burger and Mark J. Burge
  2. "Image Processing, Analysis, and Machine Vision" by Milan Sonka, Vaclav Hlavac, and Roger Boyle
  3. **"**Computer Vision: Algorithms and Applications" by Richard Szeliski

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 3 | Medical imaging |
| SDG 9 | Innovation in imaging technologies |
| SDG 13 | Climate and environmental image analysis |
| SDG 15 | Biodiversity monitoring through images |

# Course Title: Artificial Intelligence for Natural Language Processing

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS40010 | Artificial Intelligence for Natural Language Processing | 4 | 3-0-1 |

**Course Objectives**:

1. To equip students with the knowledge and skills to apply artificial intelligence techniques to natural language processing (NLP) tasks
2. Fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of natural language processing, artificial intelligence, text representation, linguistic analysis, and language models.
- **CO2 (Understanding):** Explain and interpret the principles of text preprocessing, feature extraction, word embeddings, sequence models, transformer architectures, and NLP evaluation techniques.
- **CO3 (Application):** Apply artificial intelligence techniques, machine learning algorithms, and NLP frameworks to design and implement solutions for text classification, sentiment analysis, machine translation, information retrieval, and question answering.
- **CO4 (Analysis):** Analyze and compare different NLP models, language representation techniques, deep learning architectures, and performance evaluation metrics to determine suitable approaches for diverse language processing tasks.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate intelligent NLP applications by integrating advanced AI models, transformer-based architectures, and language processing techniques to solve real-world multilingual and domain-specific language challenges.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 | - | - |
| CO2 | - | 3 | - | 3 | 3 | - | - | - | - | - | - | - | 3 | 3 | 2 | - |
| CO3 | - | - | 3 | - | 2 | - | - | - | - | - | - | - | 3 | 3 | - | - |
| CO4 | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 | - | - | 2 |
| CO5 | - | - | 3 | - | - | 2 | - | - | - | - | - | - | - | 2 | 2 | 2 |

**Course Duration**: 45 hours

**Course Syllabus**:

**Unit 1: Introduction to Natural Language Processing** [8 Classroom Contact Hours]
Overview of NLP and its applications, Basic concepts: Tokens, types, and corpora, Text preprocessing: Tokenization, stemming, lemmatization, and stopword removal, Language models: N-grams, smoothing techniques, Introduction to AI techniques in NLP

**Unit 2: Machine Learning for NLP** [10 Classroom Contact Hours]
Supervised and unsupervised learning for NLP, Feature extraction: Bag of words, TF-IDF, word embeddings, Text classification: Naive Bayes, SVM, and logistic regression, Sequence labeling: Part-of-speech tagging, named entity recognition, Evaluation metrics for NLP tasks

**Unit 3: Deep Learning for NLP** [10 Classroom Contact Hours]
Neural networks for NLP: RNNs, LSTMs, GRUs, Attention mechanisms and Transformers, Pre-trained models: Word2Vec, GloVe, BERT, GPT, Sentiment analysis and text generation, Practical implementation using frameworks like TensorFlow and PyTorch

**Unit 4: Advanced NLP Techniques** [9 Classroom Contact Hours]
Machine translation and sequence-to-sequence models, Question answering systems, Summarization techniques: Extractive and abstractive, Dialogue systems and chatbots, Ethical considerations in AI and NLP

**Unit 5: Applications and Future Directions** [8 Classroom Contact Hours]
NLP in healthcare, finance, and other industries, Multilingual NLP and cross-lingual models, Explainability and interpretability in NLP, Emerging trends and research directions in AI for NLP, Sustainability and environmental impact of AI models

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Implement text preprocessing techniques on a given dataset.
2. Develop a simple language model using N-grams.
3. Perform text classification using Naive Bayes and evaluate its performance.
4. Implement a part-of-speech tagger using a sequence labeling algorithm.
5. Train a word embedding model using Word2Vec.
6. Develop a sentiment analysis model using LSTM.
7. Implement a text generation model using a Transformer.

8. Fine-tune a pre-trained BERT model for a specific NLP task.
9. Develop a machine translation system using sequence-to-sequence models.
10. Implement a question answering system using a pre-trained model.
11. Create a text summarization tool using extractive techniques.
12. Develop a chatbot using a dialogue system framework.
13. Evaluate the performance of different NLP models using suitable metrics.
14. Implement a multilingual NLP model for cross-lingual tasks.
15. Analyze the ethical implications of AI in NLP.
16. Collaborate on a group project to develop an NLP application.
17. Write a report on the application of NLP in a specific industry.
18. Present a case study on the use of AI in NLP for healthcare.
19. Research and present on the future trends in AI for NLP.
20. Participate in a debate on the environmental impact of AI models.

- **Textbook:**
  1. **"**Speech and Language Processing" by Daniel Jurafsky and James H. Martin

- **Reference Books:**
  1. "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper
  2. "Deep Learning for Natural Language Processing" by Palash Goyal, Sumit Pandey, and Karan Jain
  3. "Neural Network Methods for Natural Language Processing" by Yoav Goldberg

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Language technologies for education |
| SDG 5 | Gender-fair NLP systems |
| SDG 9 | AI-driven innovation |
| SDG 10 | Reducing linguistic inequalities |
| SDG 16 | NLP for governance, transparency, and justice |

# Course Title: Indigenous People and the Science of Gemmology

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| IK-5051 | Indigenous People and the Science of Gemmology | 4 | 3-1-0 |

**Course Objectives**:

The main objective of this course is to look at the course in a more general way, then Gemology mainly involves topics related to the identification of gems, physical and chemical properties of gems, differentiating gems on the various basis, grading and assorting gems, processing them, and designing them for accessories etc.

**Course Outcomes**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of gemology, mineralogy, gemstone formation (genesis), classification, and occurrence of gemstones.
- **CO2 (Understanding):** Explain and interpret the physical, optical, and chemical properties of gemstones and the techniques used for their identification and characterization.
- **CO3 (Application):** Apply standard gemological methods and instruments to identify, classify, and characterize gemstones based on their physical and optical properties.
- **CO4 (Analysis):** Analyze and evaluate the quality, grading, cutting, engraving, and authenticity of gemstones using appropriate gemological techniques and standards.
- **CO5 (Synthesis/Evaluation):** Evaluate the origin of gemstone colours, treatment methods, and the scientific basis of their perceived healing properties, and assess their significance in gemological and commercial applications.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| CO2 | - | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO3 | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - |
| CO4 | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 | - | - | - |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | - | - | 3 | - | - | 2 | - | - | - | - | - | - | - | - | - | 2 |

**Course Duration**: 45 hours

**Tutorial**: 30 hours

**Course Syllabus**:

**Unit I: Introduction to the world of Gemstones** [12 Classroom Contact Hours]

Ancient history of Gem stones, Mythology related to Gem stones, Use of Gems among indigenous people, Crystallography, Study on crystal growth, formation of atomic lattice, origin and structure of gem stones, twinned crystal, Rough gemstone identification, knowledge of identification process.

**UNIT 2: Properties of Gemstones** [10 Classroom Contact Hours]

Physical and optical properties of gemstones, Grading parameters of gemstones, Various shapes and cutting of gemstones, Engraving on stones, drilled stones, Interlink of beauty, rarity, durability and its effect on valuation, Internal and external factors that affects valuation.

**UNIT 3: Colour and Healing Power** [11 Classroom Contact Hours]

The healing power of Gem stones, Tribal concept on Gemstones, Scientific approach of gemstones, Top gemstones with their colours and healing qualities, Science behind different colours of gemstones and their healing effects, precious gemstones found in tribal areas. , Tribal ornaments having gemstones, semiprecious stones and their practical identification, organic gemstones, Ornament making techniques in both traditional and modern, Ornament design, stones used in fine and fashion jewelers, rare stones collection.

**UNIT 4: Terminology and nomenclature** [12 Classroom Contact Hours]

Terminology and nomenclature of gemstones as per Indian and International markets, weights used in the gem trade, Market system of gems buying and selling, Gems and human race, Career and jobs, Scope in Gemology, Gemology as a tool for tribal development.

- **Text Books:**
    1. Colour encyclopedia of Gemstones by Joel. E. Arem
    2. The Gemsstones Handbook by Arthur Thomas
    3. Precious Stones, Vol-I & II: Max Bauer

4. Gemstones of the World: Walter Schumann
5. Gemology: Cornelius S. Hurlbut & Robert C Kammerling
6. Popular Gemology: Richard M Pearl
7. Dictionary of Gems and Gemology: Robert M Shiplley
8. Gemmolog: Peter G Read
9. Gem: Smiths Onian
10. Stoned:Jewellery,obsession: Aja Raden
11. Rocks,Minerals and Gems: John Farndon

**SDG Mapping for this Course**

| **SDG** | **Rationale** |
|---|---|
| SDG 4 | Education rooted in Indigenous knowledge |
| SDG 5 | Gender roles in traditional gem practices |
| SDG 10 | Empowering Indigenous communities |
| SDG 12 | Sustainable resource use |
| SDG 15 | Protecting natural mineral ecosystems |
| SDG 17 | Partnerships with Indigenous communities |

## SEMESTER – III

| **Paper Code** | **Paper Name** | **Credits** | | | **Credits** |
|---|---|---|---|---|---|
| | | **L** | **T** | **P** | |
| IK50001 | Research Methodology for Physical Sciences | 3 | 1 | 0 | 4 |
| CA50005 (For other Discipline) | Computer Application and Data Analysis | 3 | 0 | 1 | 4 |
| CA50007 | Data Analysis and Visualization | 3 | 0 | 1 | 4 |
| RE50003 | Research and Publication Ethics | 2 | 0 | 0 | 2 |
| **Electives (Choose TWO)** | | | | | |
| CS50031 | Recommender Systems | 3 | 0 | 1 | 4 |
| CS50033 | Machine Learning for Predictive Analytics | 3 | 0 | 1 | 4 |
| CS50035 | Big Data Technologies | 3 | 1 | 0 | 4 |
| CS50037 | Soft Computing | 3 | 0 | 1 | 4 |
| | | | | | |
| IK50051 | Indigenous Knowledge and Intellectual Property Rights | 3 | 1 | 0 | 4 |
| | | | | | |
| **Total Credits: 18 + 4 = 22** | | | | | |

# Course Title: Research Methodology for Physical Sciences

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| RM50001 | Research Methodology | 4 | 3-1-0 |

**Course Objectives**:

1. Provide exposure to various research techniques and methods (both quantitative and qualitative).
2. Build upon the basic assumptions in adopting different methodologies for different kinds of research themes.
3. Adopt appropriate methodologies for building upon hypotheses and analyzing research gaps.
4. Teach certain quantitative methods, statistical techniques and qualitative methods to collect and analyze the data would help them organize and analyze the information gathered by them.

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Know the formulation of research problems and plan for their structural study.
- **CO2 (Understanding):** Understand the scope of collection of relevant data and their interpretations
- **CO3 (Application):** Apply the use of various statistical analysis for decision making.
- **CO4 (Analysis):** Apply different quantitative methods, statistical techniques and qualitative methods to collect and analyze the data.
- **CO5 (Synthesis/Evaluation):** Create the methodologies to build hypotheses and test them with appropriate methods.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | 3 | 2 | - |
| CO2 | - | 3 | - | - | - | - | - | - | - | - | - | - | 3 | 3 | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | - | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 3 | 2 | 2 |
| CO4 | - | - | 3 | - | - | - | 2 | - | - | - | - | - | 2 | 3 | - | - |
| CO5 | - | - | 3 | - | - | 3 | - | - | - | - | - | - | - | 2 | - | 2 |

**Course Duration:** 45 hours

**Tutorial**: 30 hours

**Course Syllabus**

**UNIT- I: Introduction To Research [**12 Classroom Contact Hours]

Meaning of Research, Philosophy of Research, Motivation of Research, Importance and Scope of Research, Scientific Research Methods and its Application to Social Phenomenon, Introduction to various aspects of research methods, Types of Research.

**UNIT- II: Research Design and Data Collection [**12 Classroom Contact Hours]

Research Design: Meaning, Need and features of a good design, Types of Research Design , Literature Review and its Importance, Steps in the Process of Research**,** Write a Research Proposal**,** Write qualitative research for publication/communication ,Sources and Methods of Data Collection

**UNIT- III: Research Problem and Types [**12 Classroom Contact Hours]

Research Problem, Research objectives and its Formulation, Fundamental research questions, Research Variables, Measurement and Scaling: Measurement in Research, Measurement Scales, Source of Error in Measurement, Test of sound Measurement: Reliability and Validity, Qualitative Research, Ethnographic Study, Observation, Case Study Method, Interviewing, Schedule, Mail Survey Method, Action Research: PRA and RRA, Focused Group discussion (FGD)

**UNIT-IV: Statistics [**12 Classroom Contact Hours]

Descriptive Statistics: Frequency Distribution, Relative, Percentage and Cumulative Frequency Distribution, Graph and Diagrams: Two Variables Graphs, Bar Diagrams, Pie Diagram, Pictorial Diagrams, Measures of Central Tendency: Mean, Mode, Median, Measures of Variability: Range, Standard Deviation, Coefficient of Variation, Normal Distribution: Basic Concept only, Standard Scores. Correlation: Correlation Coefficient and its properties, Linear Regression: Regression coefficients, Line of Regressions, Relation between Regression Coefficients and Correlation Coefficient., Rank Correlation Coefficient, Biserial Correlation Coefficient, Coefficient of Determination

**UNIT-V: Sampling** **[**12 Classroom Contact Hours]

Sampling: Need for Sampling, Methods of Probability Sampling and Non probability Sampling, Sampling and Non sampling Error, Hypotheses: Concept of Population, Sample, Parameter and Statistic, Concept of Hypothesis, Types of Hypotheses, Formulation of Hypothesis, Procedure of Testing of Hypothesis, Test of Significance, One- tailed and Two-tailed Test, Testing of Single Mean and Difference of Means, Parametric and Non parametric Test, Variable Analysis. Report Writing: Objective, Purpose of Report, Type of Reports, Report Writing Process, Guidelines for Effective Report Writing.

- **Textbook:**


1. Kothari, C.R. Research Methodology, Methods and Techniques –Wiley Eastern Limited – New Delhi
2. Ahuja, R (2010), Research Methods, Rawat Publication, Jaipur.
3. Sondhi N, Chawla D.(2nd Edition), Research Methodology, Vikas Publication.


- **Reference Book:**


1. "Creswell, John W (2009) Research design: qualitative, quantitative, and mixed methods approaches
2. Creswell, John W (2013) Qualitative inquiry and research design: choosing among five approaches
3. Garett, Henry, E Statistics in Psychology and Education – David Heley and Co.
4. Huberman, A. Michael (2002) Qualitative researcher's companion
5. Maxwell, Joseph (2005) Qualitative research design: an interactive approach
6. W.J. Goode and P. K. Hatt (1952) Methods in Social Research. Mc Graw Hill Co.


**SWAYAM Course**

Research Methodology - https://onlinecourses.swayam2.ac.in/nou24_cm17/preview

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Research-based higher education |
| SDG 9 | Strengthening scientific research capacity |
| SDG 12 | Responsible consumption in research |
| SDG 13 | Climate-aware scientific inquiry |

# Course Title: Computer Application and Data Analysis

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CA50005 (For Other discipline) | Computer Application and Data Analysis | 4 | 3-0-1 |

**Course Objectives**:

1. Increase knowledge and requisite skills of participants on the use of SPSS
2. enable the students make the most of this powerful software package while allowing them to work independently with SPSS on their own data
3. Provide a solid foundation for advanced data analysis work.
4. Increase proficiency of scholars on the use of Basic computer Applications and SPSS.

**Course Outcomes:**
*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computer hardware, software, operating systems, and basic computer applications.
- **CO2 (Understanding):** Explain and interpret the features and applications of MS Office packages and various analytical and research software tools used for data organization, documentation, and presentation.
- **CO3 (Application):** Apply appropriate computer applications and statistical methods to formulate research hypotheses, organize data, and perform basic computational tasks.
- **CO4 (Analysis):** Analyze research data using statistical software such as SPSS and interpret the results to support evidence-based decision-making and problem-solving.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate data analysis workflows by integrating computer applications, MS Office tools, and SPSS to prepare professional reports and support research and organizational decision-making.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | 3 | - | - |
| CO2 | - | 3 | - | 3 | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO3 | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 | - | 2 | - |
| CO4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | - | - | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | - | 2 |

**Course Duration: 45 hours**

**Course Syllabus**

**Unit I: Computer Basic and Computer Fundamental** [8 Classroom Contact Hours]

Hardware and Software, Functional units comprising a typical computer configuration: input/output, fixed and removable data storage, internal storage, control and arithmetic/logic unit, The concepts relating to execution speed, data access times, storage capacities and similar comparative aspects of hardware performance. Operating Systems: Windows, Linux etc. Application software, role and functions of commonly available applications, Computer Network Concept- Data communication and network terminology, IP address and its significance, Internet, Multimedia, WWW, FTP, E-mail, and Web pages. Concept of VPNs. Concept of Network security and management.

**Unit II: Microsoft word** [9 Classroom Contact Hours]

Creating and editing documents, formatting text and paragraph, formatting documents, creating and formatting tables, illustration documents with graphics. Creating a web page, mail merge and document merging, working with styles and templates, developing multi-page documents, integrating word with other applications, exploring advance graphics, building forms, working with charts and diagrams

**Unit III: Microsoft Excel** [9 Classroom Contact Hours]

Building and editing worksheets, formatting a worksheet, working with charts, Working with formulas and functions, managing workbooks and preparing them for the web,

automating worksheet tasks with macros, using lists, analyzing list data, enhancing charts and worksheets Using analysis tools, Analyzing data with pivot tables, exchanging data with other programs.

**Unit IV: Microsoft PowerPoint** [9 Classroom Contact Hours]

Creating a presentation with Microsoft PowerPoint, modifying a presentation, inserting objects into presentation, finishing a presentation, Working with advanced tools and masters, enhancing charts, inserting illustration, objects and media clips, using advanced features.

**Unit V: Statistical Analysis** [10 Classroom Contact Hours]

The analysis will be done with the help of SPSS, and other statistical packages. M Descriptive Analysis: Mean, Median, Mode, Standard Deviation, Correlation. Regression Analysis, t- test, chi-square test, R-Square test, Factor Analysis, ANOVA, NVIVO, SPSS, JAMOVI, AMOS.

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Create and format a table in Word with at least 5 rows × 5 columns; apply borders, shading, and sorting.
2. Perform a Mail Merge: prepare a personalized invitation letter using an Excel data source (name, address).
3. Build a student mark sheet with fields (Name, Roll, Subject Marks). Apply formulas for Total, Average, Percentage, and Grade.
4. Format the worksheet (merge cells, adjust column width, borders, number formatting). Apply conditional formatting (highlight marks <40 in red).
5. Create different charts (bar, pie, line) for student performance or sales data. Enhance charts with titles, legends, and labels.
6. Demonstrate formulas and functions:
   SUM, AVERAGE, MAX, MIN, COUNT, IF
7. Create a PowerPoint presentation (minimum 8 slides) on “Emerging Technologies in Computing.” Include title slide, content slides, conclusion, and references.
8. Create a PowerPoint presentation (minimum 10 slides) on “Emerging Trends in Computer Science.” Include:

1. Slide designs, transitions, and animations
2. Insert images, charts, and SmartArt
3. Add audio or video clips

9. Input a dataset of student scores into SPSS. Perform Descriptive Statistics: Mean, Median, Mode, Standard Deviation, and Correlation. Generate graphs (histogram, scatter plot).
10. Using SPSS, perform Hypothesis Testing:
    - t-test for comparing two groups
    - Chi-square test for categorical data
    - ANOVA for comparing more than two groups
    - Report R-square and regression results with interpretations

- **Text Books:**


1. Hari Shankar Asthana, Braj Bhushan, Statistics for Social Sciences (With SPSS Applications, PHI Publication.
2. Jesus Salcedo, Keith Mccormick, SPSS Statistics for Dummies, 3rd Edition (Paperback), Wiley Publication.
3. Sabine Landau and Brian S. Everitt, A Handbook of Statistical Analysis Using SPSS


**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Digital literacy |
| SDG 9 | Data-driven innovation |
| SDG 10 | Equity through unbiased data |
| SDG 17 | Data for partnerships and policy |

# Course Title: Data Analysis and Visualization

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CA50007 | Data Analysis and Visualization | 4 | 3-0-1 |

**Course Objectives**:

1. Increase knowledge and requisite skills of participants on the use of data analysis, visualization and on SPSS
2. Enable the students make the most of this powerful software package while allowing them to work independently with SPSS on their own data

3. Provide a solid foundation for advanced data analysis and visualization work.
4. Increase proficiency of scholars on the use of pandas, numpy, seaborn and SPSS.

**Course Learning Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of data science, data visualization, data analytics, and the data science lifecycle.
- **CO2 (Understanding):** Explain and interpret the principles of data preprocessing, data wrangling, data aggregation, grouping operations, and the functionalities of Python libraries such as NumPy, Pandas, and Seaborn for data analysis and visualization.
- **CO3 (Application):** Apply Python programming, data science libraries, and statistical techniques to formulate hypotheses, preprocess datasets, perform exploratory data analysis, and generate meaningful visualizations.
- **CO4 (Analysis):** Analyze datasets using statistical and visualization tools, including SPSS and Python libraries, to identify patterns, interpret results, and support evidence-based decision-making.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate end-to-end data analysis and visualization workflows by integrating Python, SPSS, and visualization techniques to solve real-world data-driven problems and communicate actionable insights.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 | - | 3 |
| CO2 | - | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 | - |
| CO3 | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 | - | - | 3 |
| CO4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | - | - | 3 | - | 3 | - | - | - | - | - | - | - | 2 | - | - | 2 |

**Course Duration: 45 hours**

**Course Syllabus**

**Unit I: Introduction** [8 Classroom Contact Hours]

Introduction to Data Science, Exploratory Data Analysis and Data Science Process, Motivation for using Python for Data Analysis, Introduction of Python shell iPython and Jupyter Notebook, Essential Python Libraries: NumPy, pandas, matplotlib, SciPy, scikit-learn, statsmodels.

**Unit-II: Getting Started with Pandas** [9 Classroom Contact Hours]

Arrays and vectorized conputation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Data Loading, Storage and File Formats. Reading and Writing Data in Text Format, Web Scraping, Binary Data Formats, Interacting with Databases Data Cleaning and Preparation. Handling Missing Data, Data Transformation.

**Unit III: Data Wrangling** [8 Classroom Contact Hours]

Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting, Data Visualization matplotlib: Basics of matplotlib, plotting with pandas and seaborn, other python visualization tools.

**Unit IV: Data Aggregation and Group operations** [10 Classroom Contact Hours]

Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation 67 Time Series Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion.

**Unit V: SPSS** [10 Classroom Contact Hours]

SPSS, Descriptive Analysis: Mean, Median, Mode, Standard Deviation and Correlation. Regression Analysis, t-test, chi-square test, R- Square test, ANOVA using SPSS.

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

Practical Use data set of your choice from Open Data Portal (https://data.gov.in/) for the following exercises.

1. Practicals based on NumPy ndarray
2. Practicals based on Pandas Data Structures
3. Practicals based on Data Loading, Storage and File Formats
4. Practicals based on Interacting with Web APIs
5. Practicals based on Data Cleaning and Preparation
6. Practicals based on Data Wrangling
7. Practicals based on Data Visualization using matplotlib
8. Practicals based on Data Aggregation
9. Practicals based on Time Series Data Analysis

- **Text Books:**


1. Hari Shankar Asthana, Braj Bhushan, Statistics for Social Sciences (With SPSS Applications, PHI Publication.
2. Jesus Salcedo, Keith Mccormick, SPSS Statistics for Dummies, 3rd Edition (Paperback), Wiley Publication.
3. Sabine Landau and Brian S. Everitt, A Handbook of Statistical Analysis Using SPSS


- **References:**


1. McKinney, W.(2017). Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython. 2nd edition. O'Reilly Media.
2. O'Neil, C., & Schutt, R. (2013). Doing Data Science: Straight Talk from the Frontline O'Reilly Media.


**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Data literacy |
| SDG 9 | Innovation in analytics |
| SDG 10 | Reducing inequality through transparent data |
| SDG 13 | Climate data visualization |

# Course Title: Research and Publication Ethics

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| RE50003 | Research and Publication Ethics | 2 | 2-0-0 |

**Course Objectives**:

1. This course is focusing on basics of philosophy of science and ethics, research integrity, publication ethics, Hands on sessions are designed to identify research misconduct and predatory publications.
2. Indexing and citation databases, open access publications, research metrics (citation, hi-index, impact factor etc.) and plagiarism tools will be taught in this course.

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Learn about basics of philosophy of science and ethics, research integrity
- **CO2 (Understanding):** Have awareness about the publication ethics and publication misconducts.
- **CO3 (Application):** Learn about the publication related databases and various research related tools.
- **CO4 (Analysis):** Develop knowledge about indexation and citation of publications.
- **CO5 (Synthesis/Evaluation):** Learn in and out of research publications.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 | - | 2 |
| CO2 | - | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 |
| CO3 | - | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - | 2 | - |
| CO4 | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| CO5 | - | - | 3 | - | - | 2 | - | - | - | - | - | - | - | 2 | - | - |

**Course Duration: 30 hours**

**Course Syllabus**

**Unit 1: Philosophy and Ethics** [3 Classroom Contact Hours]

Introduction of philosophy: Definition, nature and scope, concept, branches, Ethics: Definition, moral philosophy, nature of moral judgments and reactions.

**Unit 2: Scientific Conduct** [5 Classroom Contact Hours]

Ethics with respect to science and research, Intellectual honesty and research Integrity , Scientific Misconducts: Falsification, Fabrication and Plagiarism (FFP), Redundant Publications: duplicate and overlapping publications, salami slicing, Selective Reporting and misrepresentation of data

**Unit 3: Publication Ethics** [7 Classroom Contact Hours]

Publication Ethics: Definition, introduction and importance, Best practices/standards setting initiatives and guidelines: COPE, WAME etc.Conflicts of interest, Publication misconduct: definition, concepts, problems that lead to unethical behaviour and *vice versa*, types, Violation of publication ethics, authorship and contributor-ship, Identification of publication, misconduct, complaints and appeals, Predatory publishers and journals

**Unit 4: Open Access Publishing** [4 Classroom Contact Hours]

Open access Publications and Initiatives, SHERPA/RoMEO online resource to check publisher copyright and 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.

**Unit 5: Publication Misconduct** [4 Classroom Contact Hours]

Ethical implications of emerging technologies in research, Environmental and sustainability considerations in research, Ethical issues in big data and AI research, Future trends and challenges in research ethics, Developing a personal ethical framework for research

**Unit 6: Data Bases and Research Metrics** [7 Classroom Contact Hours]

A. Databases

i.Indexing Databases

ii.Citation Databases: Web of Science, Scopus etc.

B. Research Metrics

i.Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP,Cite Score

ii.Metrics: h-index, g index, I 10 index, alt metrics

- **Textbook:**

1. S. B. Kishor, A.S. Kushwaha, Research and Publication Ethics, Das Ganu Prakashan, Nagpur,
2. Y. Sharma., A. Sharma, Textbook of Research and Publication Ethics, Kalyani Publishers.

- **Reference Books:**

1. The students' guide to Research Ethics by Paul Oliver Open University Press, 2003
2. Responsible conduct of Research by Adil E. Shamoo; David B. Resnik Oxford University Press, 2003
3. Anderson B.H., Dursaton, and Poole M.: Thesis and Assignment writing, Wiley Eastern 1997.

**Swayam Link**

https://onlinecourses.swayam2.ac.in/nou24_ge73/preview

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Quality research education |
| SDG 5 | Gender-fair authorship |
| SDG 9 | Ethical innovation |
| SDG 16 | Justice, transparency, strong institutions |

# Course Title: Recommender Systems

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS50031 | Recommender Systems | 4 | 3-0-1 |

**Course Objectives**:

1. To provide students with an in-depth understanding of recommender systems.
2. Enabling them to design, implement, and evaluate recommendation algorithms for various applications.
3. Fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of recommender systems, recommendation techniques, user profiling, item profiling, and evaluation methods.
- **CO2 (Understanding):** Explain and interpret the principles of collaborative filtering, content-based filtering, hybrid recommendation approaches, knowledge-based recommendation, and recommendation evaluation metrics.
- **CO3 (Application):** Apply recommendation algorithms, machine learning techniques, and appropriate software tools to design and implement recommender systems for personalized recommendation applications.
- **CO4 (Analysis):** Analyze and compare different recommendation algorithms, similarity measures, evaluation metrics, and optimization techniques to identify suitable approaches for diverse recommendation scenarios.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate scalable, accurate, and intelligent recommender systems by integrating collaborative filtering, content-based methods, hybrid approaches, and emerging artificial intelligence techniques to address real-world personalization challenges.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 | - | 2 |
| CO2 | - | 3 | - | 2 | 3 | - | - | - | - | - | - | - | 2 | 3 | 2 | - |
| CO3 | - | 3 | - | 2 | - | - | - | - | - | - | - | - | - | 2 | - | 2 |
| CO4 | - | - | 3 | - | - | - | 2 | - | - | - | - | - | 2 | 2 | - | - |
| CO5 | - | - | 3 | - | - | 3 | - | - | - | - | - | - | 2 | - | 2 | 2 |

**Course Duration: 45 Hours**

**Course Syllabus:**

**Unit 1: Introduction to Recommender Systems** [8 Classroom Contact Hours]
Overview of recommender systems and their importance, Types of recommender systems: Collaborative filtering, content-based, hybrid, Data collection and preprocessing for recommendations, Evaluation metrics: Precision, recall, F1 score, RMSE, MAE, Case studies of recommender systems in various domains

**Unit 2: Collaborative Filtering Techniques** [9 Classroom Contact Hours]
User-based and item-based collaborative filtering, Similarity measures: Cosine, Pearson, Jaccard, Matrix factorization techniques: SVD, SVD++, Implicit feedback and its handling, Scalability and performance considerations

**Unit 3: Content-Based Recommender Systems** [9 Classroom Contact Hours]
Feature extraction and representation, TF-IDF, word embeddings, and other feature engineering techniques, Content-based filtering algorithms, Hybrid recommender systems: Combining collaborative and content-based methods, Practical implementation using Python libraries

**Unit 4: Advanced Recommender System Techniques** [10 Classroom Contact Hours]
Context-aware recommender systems, Sequence-aware and session-based recommendations, Deep learning for recommender systems: Autoencoders, neural collaborative filtering, Explainability and interpretability in recommender systems, Ethical considerations and bias in recommendations

**Unit 5: Applications and Future Directions** [9 Classroom Contact Hours]
Recommender systems in e-commerce, social media, and entertainment, Personalized recommendations and user profiling, Real-time and online recommendation systems, Emerging trends and research directions in recommender systems, Sustainability and environmental impact of recommender systems

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Implement a user-based collaborative filtering algorithm.
2. Develop an item-based collaborative filtering system.
3. Calculate similarity measures for a given dataset.
4. Perform matrix factorization using SVD on a recommendation dataset.
5. Handle implicit feedback in a recommendation system.
6. Extract features from text data using TF-IDF.
7. Implement a content-based recommender system.
8. Combine collaborative and content-based methods to create a hybrid recommender.
9. Develop a context-aware recommendation system.
10. Implement a session-based recommendation algorithm.
11. Use autoencoders for collaborative filtering.
12. Develop a neural collaborative filtering model.
13. Evaluate the performance of different recommendation algorithms.
14. Implement a real-time recommendation system.
15. Analyze the ethical implications of recommender systems.
16. Collaborate on a group project to develop a comprehensive recommender system.
17. Write a report on the application of recommender systems in a specific domain.
18. Present a case study on the use of recommender systems in e-commerce.
19. Research and present on the future trends in recommender systems.
20. Participate in a debate on the environmental impact of recommender systems.

- **Textbook:**
  1. **“**Recommender Systems: An Introduction” by Dietmar Jannach, Markus Zanker, Alexander Felfernig, and Gerhard Friedrich

- **Reference Books:**
  1. **“**Recommender Systems Handbook” by Francesco Ricci, Lior Rokach, and Bracha Shapira
  2. “Practical Recommender Systems” by Kim Falk
  3. “Deep Learning for Recommender Systems” by Alexandros Karatzoglou, Balázs Hidasi, and Domonkos Tikk

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Personalized learning systems |

| | |
|---|---|
| SDG 9 | Intelligent systems innovation |
| SDG 10 | Reducing bias in recommendations |
| SDG 12 | Sustainable consumption recommendations |

# Course Title: Machine Learning for Predictive Analytics

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS50033 | Machine Learning for Predictive Analytics | 4 | 3-0-1 |

**Course Objective:**

1. To provide students with advanced knowledge and skills in machine learning techniques for predictive analytics.
2. Eabling them to analyze data, build predictive models, and apply these models to solve complex problems, while fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of predictive analytics, machine learning, data preprocessing, feature engineering, and predictive modeling techniques.
- **CO2 (Understanding):** Explain and interpret the principles of supervised and unsupervised learning, model training, validation techniques, feature selection, and performance evaluation metrics used in predictive analytics.
- **CO3 (Application):** Apply machine learning algorithms, statistical methods, and appropriate software tools and frameworks to develop predictive models for classification, regression, forecasting, and decision-making applications.
- **CO4 (Analysis):** Analyze and compare different predictive models, feature selection methods, validation techniques, and evaluation metrics to identify the most suitable approaches for diverse predictive analytics problems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate robust and scalable predictive analytics solutions by integrating machine learning algorithms, data

preprocessing techniques, model optimization, and performance evaluation to solve real-world data-driven problems.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 | 2 | - |
| **CO2** | - | 3 | - | 2 | 3 | - | - | - | - | - | - | - | 3 | 3 | - | 3 |
| **CO3** | - | 3 | - | 2 | - | - | - | 3 | - | - | - | - | - | - | 3 | - |
| **CO4** | - | - | 3 | - | - | - | 2 | - | - | - | - | - | 2 | 3 | - | - |
| **CO5** | - | - | 3 | - | - | 3 | - | - | - | - | - | - | 3 | 2 | - | 2 |

**Course Duration: 45 Hours**

**Course Syllabus:**

**Unit 1: Introduction to Predictive Analytics and Machine Learning** [8 Classroom Contact Hours]

Overview of predictive analytics and its importance, Basic concepts of machine learning: Supervised, unsupervised, and reinforcement learning, Data pre-processing and feature engineering, Introduction to Python libraries for machine learning: scikit-learn, pandas, numpy, Case studies of predictive analytics applications

**Unit 2: Regression and Classification Techniques** [9 Classroom Contact Hours]

Linear regression and logistic regression, Decision trees and random forests, Support vector machines (SVM), k-Nearest Neighbors (k-NN), Model evaluation metrics: Accuracy, precision, recall, F1 score, ROC-AUC

**Unit 3: Ensemble Methods and Model Optimization** [10 Classroom Contact Hours]

Bagging and boosting techniques: AdaBoost, Gradient Boosting, XGBoost, Hyper parameter tuning and model selection, Cross-validation and grid search, Feature selection and dimensionality reduction, Practical implementation using Python

**Unit 4: Advanced Machine Learning Techniques** [9 Classroom Contact Hours]

Neural networks and deep learning basics, Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), Time series forecasting and analysis, Anomaly detection and outlier analysis, Practical implementation using TensorFlow and Keras

**Unit 5: Applications and Future Directions** [9 Classroom Contact Hours]

Predictive analytics in finance, healthcare, and marketing, Ethical considerations and bias in predictive models, Explainability and interpretability of machine learning models, Emerging trends and research directions in predictive analytics, Sustainability and environmental impact of machine learning

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Preprocess a dataset and perform feature engineering.
2. Implement linear regression and evaluate its performance.
3. Develop a logistic regression model for binary classification.
4. Build a decision tree classifier and analyze its results.
5. Implement a random forest model and compare it with a decision tree.
6. Train a support vector machine (SVM) for a classification task.
7. Implement k-Nearest Neighbors (k-NN) for a given dataset.
8. Perform hyperparameter tuning using grid search.
9. Apply cross-validation techniques to evaluate model performance.
10. Implement AdaBoost and evaluate its effectiveness.
11. Develop a gradient boosting model using XGBoost.
12. Perform feature selection and dimensionality reduction.
13. Build a neural network using TensorFlow or Keras.
14. Implement a Convolutional Neural Network (CNN) for image classification.
15. Develop a Recurrent Neural Network (RNN) for time series forecasting.
16. Detect anomalies in a dataset using machine learning techniques.
17. Analyze the ethical implications of a predictive model.
18. Collaborate on a group project to develop a predictive analytics solution.
19. Write a report on the application of predictive analytics in a specific industry.
20. Present a case study on the use of machine learning for predictive analytics.

- **Textbook:**
  1. **“**Introduction to Machine Learning with Python: A Guide for Data Scientists” by Andreas C. Müller and Sarah Guido.
- **Reference Books:**
  1. “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow” by Aurélien Géron.
  2. “Pattern Recognition and Machine Learning” by Christopher M. Bishop.
  3. “Machine Learning: A Probabilistic Perspective” by Kevin P. Murphy.

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 3 | Health predictions |
| SDG 8 | Business forecasting |
| SDG 9 | AI innovation |
| SDG 13 | Climate forecasting |

# Course Title: Big Data Technologies

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS50035 | Big Data Technologies | 4 | 3-1-0 |

**Course Objectives**:

1. To provide students with advanced knowledge and skills in big data technologies.
2. Enabling them to analyze, process, and manage large datasets using modern tools and techniques.
3. Fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of big data, big data architecture, distributed computing, Hadoop ecosystem, and data storage technologies.

- **CO2 (Understanding):** Explain and interpret the principles of distributed file systems, MapReduce, Apache Spark, NoSQL databases, and big data processing frameworks.
- **CO3 (Application):** Apply big data tools, distributed computing frameworks, and analytics techniques to design and implement scalable data processing pipelines for large-scale datasets.
- **CO4 (Analysis):** Analyze and compare different big data architectures, storage models, processing frameworks, and performance evaluation techniques to identify suitable solutions for diverse data-intensive applications.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate efficient, scalable, and fault-tolerant big data analytics solutions by integrating distributed computing frameworks, data management techniques, and advanced analytics to solve real-world business and research problems.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 | - | - |
| CO2 | - | 3 | - | 3 | 3 | - | - | - | - | - | - | - | 2 | 3 | 2 | 2 |
| CO3 | - | 3 | - | 2 | - | - | - | 3 | - | - | - | - | - | 2 | - | - |
| CO4 | - | - | 3 | - | - | - | 2 | - | - | - | - | - | 2 | 2 | - | 2 |
| CO5 | - | - | 3 | - | - | 3 | - | - | - | - | - | - | - | 3 | 2 | 2 |

**Course Duration: 45 Hours**

**Tutorial**: 30 hours

**Course syllabus:**

**Unit 1: Introduction to Big Data** [9 Classroom Contact Hours]

Overview of big data and its importance, Characteristics of big data: Volume, velocity, variety, veracity, and value, Big data architecture and ecosystem, Data storage and management in big data, Case studies of big data applications

**Unit 2: Big Data Processing Frameworks** [9 Classroom Contact Hours]

Hadoop ecosystem: HDFS, MapReduce, YARN, Apache Spark: Architecture, RDDs, DataFrames, and Datasets, Real-time data processing with Apache Storm and Apache Flink, Batch vs. stream processing, Practical implementation using Hadoop and Spark

**Unit 3: Data Ingestion and Storage** [10 Classroom Contact Hours]
Data ingestion tools: Apache Kafka, Apache Flume, Sqoop, NoSQL databases: HBase, Cassandra, MongoDB, Data warehousing solutions: Hive, Impala, Data lake architecture and implementation, Practical implementation using Kafka and NoSQL databases

**Unit 4: Big Data Analytics and Machine Learning** [8 Classroom Contact Hours]
Data preprocessing and cleaning, Exploratory data analysis (EDA) with big data, Machine learning with big data: MLlib, H2O.ai, Graph processing with GraphX and Neo4j, Practical implementation of big data analytics

**Unit 5: Advanced Topics and Future Directions** [9 Classroom Contact Hours]
Big data security and privacy, Cloud-based big data solutions: AWS, Azure, Google Cloud, Big data governance and compliance, Emerging trends and research directions in big data, Sustainability and environmental impact of big data technologies
**Total Practical / Lab Experiments**: [22 Lab Contact Hours]

1. Set up a Hadoop cluster and perform basic HDFS operations.
2. Implement a MapReduce job to process a large dataset.
3. Develop a data processing pipeline using Apache Spark.
4. Perform real-time data processing using Apache Storm.
5. Ingest data into HDFS using Apache Flume.
6. Transfer data between Hadoop and relational databases using Sqoop.
7. Store and retrieve data using HBase.
8. Implement a data warehousing solution using Hive.
9. Analyze a large dataset using Spark SQL.
10. Perform exploratory data analysis (EDA) on a big dataset.
11. Develop a machine learning model using MLlib.
12. Implement a graph processing task using GraphX.
13. Set up a Kafka cluster and perform data ingestion.
14. Store and query data using MongoDB.

15. Develop a real-time analytics application using Apache Flink.
16. Evaluate the performance of different big data processing frameworks.
17. Implement a cloud-based big data solution using AWS.
18. Analyze the security and privacy aspects of a big data system.
19. Collaborate on a group project to develop a comprehensive big data application.
20. Write a report on the future trends in big data technologies.

- **Textbook:**
  1. "Big Data: Principles and Best Practices of Scalable Real-Time Data Systems" by Nathan Marz and James Warren.

2. **Reference Books:**
   1. "Hadoop: The Definitive Guide" by Tom White.
   2. "Spark: The Definitive Guide" by Bill Chambers and Matei Zaharia.
   3. "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage and Martin Fowler.

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 9 | Data-driven innovation |
| SDG 11 | Smart cities |
| SDG 13 | Climate analytics |
| SDG 17 | Data for global partnerships |

# Course Title: Soft Computing

| Code | Course Title | Credit | L-T-P |
|---|---|---|---|
| CS50037 | Soft Computing | 4 | 3-0-1 |

**Course Objectives**:

1. To provide students with advanced knowledge and skills in soft computing techniques.
2. Enabling them to solve complex problems using fuzzy logic, neural networks, genetic algorithms, and other soft computing methods, while fostering critical thinking, analytical reasoning, and collaborative skills.

**Course Outcomes:**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of soft computing, fuzzy logic, artificial neural networks, evolutionary computing, genetic algorithms, and swarm intelligence.
- **CO2 (Understanding):** Explain and interpret the principles of fuzzy inference systems, neural network learning algorithms, evolutionary optimization techniques, and hybrid soft computing models.
- **CO3 (Application):** Apply soft computing techniques, algorithms, and appropriate software tools to design and implement intelligent solutions for classification, optimization, prediction, and decision-making problems.
- **CO4 (Analysis):** Analyze and compare different soft computing techniques, optimization algorithms, learning models, and performance evaluation methods to determine suitable approaches for solving complex computational problems.
- **CO5 (Synthesis/Evaluation):** Design, implement, and evaluate intelligent soft computing systems by integrating fuzzy logic, neural networks, evolutionary algorithms, and hybrid models to solve real-world engineering, business, and research problems.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO2 | - | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | 2 | - | 2 |
| CO3 | - | 3 | - | - | - | - | - | 3 | - | - | - | - | 3 | 2 | - | - |
| CO4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | - | - | 3 | - | - | 2 | - | - | - | - | - | - | 2 | - | - | 2 |

**Course Duration: 45 Hours**

**Course syllabus:**

**Unit 1: Introduction to Soft Computing** [8 Classroom Contact Hours]

Overview of soft computing and its importance, Differences between hard computing and soft computing, Components of soft computing: Fuzzy logic, neural networks, genetic

algorithms, Applications of soft computing in various domains, Case studies of soft computing applications

**Unit 2: Fuzzy Logic** [10 Classroom Contact Hours]

Introduction to fuzzy sets and fuzzy logic, Fuzzy set operations and properties, Fuzzy relations and fuzzy inference systems, Fuzzy rule-based systems and fuzzy control systems, Applications of fuzzy logic in decision making and control

**Unit 3: Neural Networks** [10 Classroom Contact Hours]

Introduction to artificial neural networks (ANN), Architecture of neural networks: Perceptron, multilayer perceptron, and backpropagation, Training and learning in neural networks, Deep learning and convolutional neural networks (CNN), Applications of neural networks in pattern recognition and classification

**Unit 4: Genetic Algorithms** [8 Classroom Contact Hours]

Introduction to genetic algorithms (GA), Genetic operators: Selection, crossover, and mutation, Fitness function and genetic algorithm optimization, Hybrid approaches: Combining GA with other soft computing techniques, Applications of genetic algorithms in optimization and search problems.

**Unit 5: Advanced Topics and Applications** [9 Classroom Contact Hours]

Hybrid soft computing techniques: Neuro-fuzzy systems, genetic fuzzy systems, Swarm intelligence and particle swarm optimization (PSO), Evolutionary algorithms and their applications, Ethical considerations and sustainability in soft computing, Future trends and research directions in soft computing

**Total Practical / Lab Experiments**: [30 Lab Contact Hours]

1. Implement basic fuzzy set operations using Python.
2. Develop a fuzzy inference system for a decision-making problem.
3. Design a fuzzy control system for a real-world application.
4. Implement a perceptron model for a classification task.
5. Train a multilayer perceptron using backpropagation.
6. Develop a convolutional neural network (CNN) for image recognition.
7. Implement a genetic algorithm for an optimization problem.
8. Perform selection, crossover, and mutation operations in a GA.

9. Develop a hybrid neuro-fuzzy system for a complex problem.
10. Implement particle swarm optimization (PSO) for a search problem.
11. Evaluate the performance of different soft computing techniques.
12. Analyze the ethical implications of using soft computing in decision making.
13. Collaborate on a group project to develop a soft computing application.
14. Write a report on the application of soft computing in a specific domain.
15. Present a case study on the use of fuzzy logic in control systems.
16. Develop a neural network model for a pattern recognition task.
17. Implement a genetic algorithm for a real-world optimization problem.
18. Analyze the sustainability aspects of soft computing techniques.
19. Research and present on the future trends in soft computing.
20. Participate in a debate on the ethical considerations of soft computing.

- **Textbook:**
  1. "Soft Computing and Intelligent Systems Design" by Fakhreddine O. Karray and Clarence De Silva
- **Reference Books:**
  1. "Neural Networks and Learning Machines" by Simon Haykin
  2. "Fuzzy Logic with Engineering Applications" by Timothy J. Ross
  3. "Genetic Algorithms in Search, Optimization, and Machine Learning" by David E. Goldberg.

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Advanced computational education |
| SDG 9 | Intelligent optimization systems |
| SDG 13 | Energy and climate optimization |
| SDG 15 | Ecological modelling |

# Course Title: Indigenous Knowledge and Intellectual Property Rights

| Subject Code | Name of the Subject | L | T | P | Credit |
|---|---|---|---|---|---|
| IK-5052 | Indigenous Knowledge and Intellectual | **3** | **1** | **0** | **4** |

| | | | | | |
|---|---|---|---|---|---|
| | Property Rights | | | | |

**Course Objectives**:

1. Intellectual Property Rights: Concept and meaning.
2. Indian Patent Law (a) The Patents Acts
3. Copyright, Neighbouring Rights and Industrial Designs. Introduction to Copyright
4. Geographical Indications: Concept of Appellations of Origin.

**Course Outcomes**

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of Intellectual Property Rights (IPR), its types, significance, and the legal framework governing intellectual property.
- **CO2 (Understanding):** Explain and interpret the provisions of the Indian Patent Law, Patent Act, patent filing procedures, and the rights and obligations of patent holders.
- **CO3 (Application):** Apply the principles of copyright, neighbouring rights, industrial designs, trademarks, and related intellectual property laws to protect creative and innovative works.
- **CO4 (Analysis):** Analyze and compare geographical indications, industrial designs, patents, and other forms of intellectual property to determine their legal protection and commercial significance.
- **CO5 (Synthesis/Evaluation):** Evaluate intellectual property case studies, patent applications, industrial designs, and legal issues to recommend appropriate strategies for protecting innovation and ensuring compliance with intellectual property laws.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO2 | - | 3 | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - |
| CO3 | - | 2 | - | - | - | - | - | 2 | - | - | - | - | - | 2 | - | 2 |
| CO4 | 2 | - | - | 2 | - | - | - | - | - | - | - | - | 3 | - | 2 | - |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | - | - | 3 | - | - | 2 | - | - | - | - | - | - | 2 | - | - | 2 |

**Course Duration**: 45 hours

**Tutorial**: 30 hours

**Course Syllabus**

**UNIT I: Introduction to Intellectual Property Rights** [12 Classroom Contact Hours]
Concept and meaning, Theories of Property - An Overview, Intellectual Property as an Instrument of Development, Introduction to Patent Law (a) Paris Convention (b) Patent Cooperation Treaty (c) WTO- TRIPS (d) Harmonisation of CBD and TRIPs

**UNIT 2: Indian Patent Law** [12 Classroom Contact Hours]
Indian Patent Law (a) The Patents Act, 1970 (b) Amendments to the Patents Act (c) Patentable Subject Matter, Patentability Criteria (d) Procedure for Filing Patent Applications, Patent Granting Procedure (e) Revocation, Patent Infringement and Remedies (f) Relevant Provisions of the Biological Diversity Act, 2002 (g) Access and Benefit Sharing Issues

**UNIT 3: Copyright, Neighbouring Rights and Industrial Designs** [12 Classroom Contact Hours]
Copyright, Neighbouring Rights and Industrial Designs. Introduction to Copyright, Indian Copyright Law: (a) The Copyright Act, 1957 with its amendments (b) Copyright works (c) Ownership, transfer and duration of Copyright (d) Renewal and Termination of Copyright (e) Neighbouring Rights (f) Infringement of copyrights and remedies

**UNIT 4: Geographical Indications** [9 Classroom Contact Hours]
Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights, Geographical Indications: Concept of Appellations of Origin, Indication of Source and Geographical Indication, The Geographical Indications of Goods, Infringement, Penalties and Remedies, Layout-Designs of Integrated Circuits: Conditions and Procedure for Registration, Duration and Effect of Registration, Assignment and Transmission, The Protection of Plant Varieties and Farmers' Rights: The Protection of Plant Varieties and Farmer's Rights Act, 2001., Protection of Plant Varieties and Farmers' Rights, Registration of Plant Varieties and Essentially derived variety, Duration, Effect of Registration and Benefit Sharing, Farmers' Rights, Plant Varieties Protection Appellate

Tribunal, Infringement, Offences, Penalties and Procedure, Industrial Designs (a) Need for Protection of Industrial Designs (b) Subject Matter of Protection and Requirements (c) The Designs Act, 2000 (d) Procedure for obtaining Design Protection (e) Revocation, Infringement and Remedies

- **Text Books:**


1. Arai, Hisamitsu. "Intellectual Property Policies for the Twenty-First Century: The Japanese Experience in Wealth Creation", WIPO Publication Number 834 (E). 2000. wipo.int
2. Bettig, R. V. (1996). Critical Perspectives on the History and Philosophy of Copyright. In R. V. Bettig, Copyrighting Culture: The Political Economy of Intellectual Property. (pp. 9–32). Boulder, CO: Westview Press.
3. Boldrin, Michele and David K. Levine. "Against Intellectual Monopoly", 2008. dkleving.com
4. Branstetter, Lee, Raymond Fishman and C. Fritz Foley. "Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-Level Data". NBER Working Paper 11516. July 2005. weblog.ipcentral.info
5. Burk, Dan L. and Mark A. Lemley (2009). The Patent Crisis and How the Courts Can Solve It. University of Chicago Press. ISBN 978-0-226-08061-1.
6. Connell, Shaun. "Intellectual Ownership". October 2007. rebithofffreedom.org
7. De George, Richard T. "14. Intellectual Property Rights." In The Oxford Handbook of Business Ethics, by George G. Brenkert and Tom L. Beauchamp, 1:408-439. 1st ed. Oxford, England: Oxford University Press, n.d.
8. Farah, Paolo and Cima, Elena. "China's Participation in the World Trade Organization: Trade in Goods, Services, Intellectual Property Rights and Transparency Issues" in Aurelio Lopez-Tarruella Martinez (ed.), El comercio con China. Oportunidades empresariales, incertidumbres jurídicas, Tirant lo Blanch, Valencia (Spain) 2010, pp. 85–121. ISBN 978-84-8456-981-7. Available at SSRN.com
9. Farah, Paolo Davide, Tremolada Riccardo, Desirability of Commodification of Intangible Cultural Heritage: The Unsatisfying Role of IPRs, in TRANSNATIONAL DISPUTE MANAGEMENT, Special Issues "The New Frontiers of Cultural Law:

Intangible Heritage Disputes", Volume 11, Issue 2, March 2014, ISSN 1875-4120Available at SSRN.comFarah, Paolo Davide, Tremolada Riccardo, Intellectual

10. Property Rights, Human Rights and Intangible Cultural Heritage, Journal of Intellectual Property Law, Issue 2, Part I, June 2014, ISSN 0035-614X, Giuffre, pp. 21–47. Available at SSRN.com

**SDG Mapping for this Course**

| SDG | Rationale |
|---|---|
| SDG 4 | Education rooted in Indigenous knowledge |
| SDG 5 | Gender roles in knowledge transmission |
| SDG 10 | Empowering Indigenous communities |
| SDG 12 | Sustainable resource use |
| SDG 15 | Biodiversity and ecosystem protection |
| SDG 16 | Justice and rights protection |
| SDG 17 | Partnerships with Indigenous communities |

## SEMESTER – IV

| Paper Code | Paper Name | Credits | | | Credits |
|---|---|---|---|---|---|
| | | L | T | P | |
| RT50082 | Research Thesis | 0 | 0 | 20 | 20 |
| **Total Credits: 20** | | | | | |

**Course Objectives**:

*Upon successful completion of this course, students will be able to:*

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of computational research, research methodology, data collection methods, data interpretation, and data presentation techniques.
- **CO2 (Understanding):** Explain and interpret the principles of problem identification, research design, fieldwork, data collection, data analysis, and report writing for addressing societal and scientific issues.
- **CO3 (Application):** Apply appropriate research methods, data analysis techniques, and computational tools to investigate technical and societal problems and prepare structured research reports.

- **CO4 (Analysis):** Analyze and evaluate research data, documentation methods, and presentation techniques to ensure accurate interpretation and effective communication of research findings.
- **CO5 (Synthesis/Evaluation):** Design, prepare, and evaluate academic manuscripts, research reports, and scholarly publications by integrating ethical research practices, scientific writing standards, and publication guidelines.

**CO-PO-PSO Mapping**

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 | 2 | 2 |
| CO2 | - | - | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 | 2 |
| CO3 | - | - | - | - | 3 | 3 | - | - | - | - | - | - | 2 | 3 | 2 | 2 |
| CO4 | - | - | - | - | - | - | 2 | - | 3 | - | - | - | 2 | 3 | 2 | 2 |
| CO5 | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 2 | 3 | 2 | 2 |

## Mode of Evaluation

| Sl. No | Mode of Evaluation | Credits |
|---|---|---|
| 1 | Selection of Research Topic and Synopsis Presentation | 4 |
| 2 | Literature Review and Preparation of Research Tools (Questionnaires and schedule) | 4 |
| 3 | Data Collection (Primary/ Secondary) | 4 |
| 4 | Data Analysis, Model building and Report Writing | 4 |
| 5 | Seminar Presentation and Viva voce test on dissertation | 4 |

- **References / Suggested Readings**


1. Kothari, C. R., & Garg, G. (2019). Research Methodology: Methods and Techniques (4th ed.). New Delhi, India: New Age International Publishers.
2. Creswell, J. W., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.) Thousand Oaks, CA: SAGE Publications.

3. Mbanaso, U. M., Kumar, A., Mishra, D., & Sharma, R. (2023). Research Techniques for Computer Science, Information Systems and Cybersecurity. Cham, Switzerland: Springer Nature.
4. Booth, W. C., Colomb, G. G., Williams, J. M., Bizup, J., & Fitzgerald, W. T. (2016). The Craft of Research (4th ed.). Chicago, IL: University of Chicago Press.
5. Zobel, J. (2014). Writing for Computer Science (3rd ed.). London, UK: Springer.

**SDG Mapping for this Course**

| SDG | Relevance to Research Thesis / Project / Patent |
|---|---|
| **SDG 4** | Strengthens advanced research capability, innovation, and higher-order learning. |
| **SDG 5** | Encourages gender-inclusive research and equitable representation in data and analysis. |
| **SDG 8** | Builds employability, innovation, entrepreneurship, and patent-oriented skills. |
| **SDG 9** | Directly contributes through prototypes, models, systems, and patentable technologies. |
| **SDG 10** | Supports inclusive research, Indigenous knowledge protection, and equitable technology design. |
| **SDG 12** | Encourages sustainable research practices and resource-efficient computing. |
| **SDG 13** | Enables climate modelling, environmental analytics, and sustainability-focused research. |
| **SDG 15** | Supports Indigenous ecological knowledge, biodiversity studies, and environmental monitoring. |
| **SDG 16** | Reinforces ethical research, transparency, and responsible knowledge creation. |
| **SDG 17** | Encourages collaboration with communities, industries, research labs, and Indigenous groups. |

KISS

KALINGA INSTITUTE OF SOCIAL SCIENCES

# KALINGA INSTITUTE OF SOCIAL SCIENCES (KISS)

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