KANNUR UNIVERSITY

(Abstract)

Integrated M.Sc. in Computer Science with Specialization in Artificial Intelligence and Machine Learning Programme under CBCSS, offered at NAS College Kanhangad w.e.f.2020 Admission- Syllabus of 7th Semester Courses with Model Question Papers- Approved - Orders issued.

ACADEMIC C SECTION

Acad/C2/16586/NGCI/2021 Dated: 05.10.2023

Read:-1. U.O Acad/C2/16586/NGCI/2021(I) dated 30.07.2021
2. U.O Acad/C2/16586/NGCI/2021(1) dated 11.08.2021
3. U.O Acad/C2/16586/NGCI/2021 dated 17.03.2022
4. U.O Acad/C2/16586/NGCI/2021 dated 19.10.2022
5. U.O Acad/C2/16586/NGCI/2021 dated 24.05.2023
6. Syllabus of 7th Semester Course & Model Question Papers submitted by the Expert Committee Convenor, vide e-mail dtd. 25.09.2023

ORDER

1. As per paper read (1) above, the Scheme of 1 to 10 semesters, Syllabus of the Ist and 2nd Semester Core courses and the Pattern of Question Papers of the New Generation programme viz, integrated M.Sc.in Computer Science with Specialization in Artificial Intelligence and Machine Learning (CBCSS) , offered at Nehru Arts & Science College Kanhangad, was implemented w.e.f 2020 admission.
2. As per the papers (2), (3), (4) & (5) above, the Syllabus of 3rd , 4th , 5th & 6th Semester Core Courses and Model Question Papers of integrated M.Sc.in Computer Science with Specialization in Artificial Intelligence and Machine Learning (CBCSS) programme was implemented w.e.f 2020 admission.
3. As per paper read (6) above, the Convenor, Expert Committee submitted the syllabus of 7th Semester Courses & Model Question Papers of Integrated M.Sc.in Computer Science with Specialization in Artificial Intelligence and Machine Learning Programme prepared by the Expert Committee.
4. The Vice-Chancellor, after considering matter in detail and in exercise of the power of the Academic Council conferred under section 11(1) Chapter III of the Kannur University Act 1996, ***accorded sanction to approve and implement the syllabus of 7th Semester Courses & Model Question Paper of Integrated M.Sc.in Computer Science with Specialization in Artificial Intelligence and Machine Learning Programme (CBCSS) , offered at Nehru Arts & Science College Kanhangad, w.e.f 2020 admission***, and to report the same to the Academic Council.
5. The Syllabus of 7th Semester Courses & Model Question Papers for Integrated M.Sc.in Computer Science with Specialization in Artificial Intelligence and Machine Learning Programme (CBCSS), w.e.f 2020 admission, are appended and uploaded in the university website (www.kannuruniversity.ac.in).

6 .Orders are issued accordingly.

Sd/-
Narayanadas K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: The Principal
Nehru Arts & Science College, Kanhangad

Copy To: 1.The Examination Branch (Through PA to CE)
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SECTION OFFICER

KANNUR UNIVERSITY CIVIL STATION P.O. KANNUR Pin-670 002 THAVAKKARA

KV

7B26ICSC: Mathematical Models of Machine Learning - I

Semester	Course Code	Hours per Week	Exam Hours	Credits
7	7B26ICSC	4	3	3

Course Outcome

CO 1: Understand Linear Algebra concepts for Machine Learning
CO 2: Understand analytic geometry concepts
CO 3: Understand Matrix decomposition concepts for Machine Learning
CO 4: Understand basics of Vector Calculus for Machine Learning

Unit I

Linear Algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings

(10 Hours)

Unit II

Analytic Geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product and Functions, Orthogonal Projections, Rotations

(16 Hours)

Unit III

Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.

(16 Hours)

Unit IV

Vector Calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued functions, Gradients of Matrices, Useful identities, Backpropagation and Automatic Differentiation.

(12 Hours)

References

[1] Marc Peter Deisenroth, A Aldo Faisal and Cheng Soon Ong (2021). *Mathematics for Machine Learning*, Cambridge University Press.
https://mml-book.github.io/

[2] Lieven Vandenberghe, Stephen P. Boyd (2018). *Introduction to Applied Linear Algebra Vectors, Matrices, and Least Squares*, Cambridge University Press.
https://web.stanford.edu/~boyd/vmls/

[3] Kuldeep Singh (2020). *Linear Algebra: Step by Step*. Oxford University Press..
[4] Gilbert Strang (2020). *Linear Algebra and Learning from Data*, Wellesley Publishers.
[5] David Lay, Steven Lay, Judi McDonald (2015). *Linear Algebra and Its Applications*, Pearson Education.

Marks Including Choice

Unit	Marks
I	28
II	36
III	36
IV	24

Model Question Paper

7B26ICSC: Mathematical Models of Machine Learning - I

Time: 3 Hours **Max. Marks: 80**

Section A

Answer any 5 questions. Each question carries 4 marks

1. Explain the vector space with the concept of group.
2. What is Linear independence property?
3. Explain Manhattan and Euclidean norms.
4. Explain Symmetric, Positive Definite Matrices in terms of inner products.
5. Explain Eigenvalues and Eigenvectors with example.
6. Briefly explain Jacobian in terms of partial derivative.

(5 x 4 = 20 Marks)

Section B

Answer any 3 questions. Each question carries 8 marks

7. Find the inverse of the matrix

$$\begin{bmatrix} 1 & 0 & 2 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 2 & 0 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

8. Explain Norm with an example.
9. Explain automatic differentiation
10. Explain orthogonal projection.
11. Differentiate between basis and rank.

(3 x 8 = 24 Marks)

Section C

Answer any 3 questions. Each question carries 12 marks

12. Prove that For any square matrix A $\in$ $R_{n\times n}$ it holds that A is invertible if and only if det(A)$\neq$ 0
13. Explain Gram-Schmidt orthogonalization
14. Given a set of linearly independent vectors b1,b2,b3,b4 $\in$ RExplain.

$$\begin{aligned} x_1 &= b_1 - 2b_2 + b_3 - b_4 \\ x_2 &= -4b_1 - 2b_2 + 4b_4 \\ x_3 &= 2b_1 + 3b_2 - b_3 - 3b_4 \\ x_4 &= 17b_1 - 10b_2 + 11b_3 + b_4 \end{aligned}$$

Are the vectors $x_1, \ldots, x_4 \in R^n$ linearly independent?

15. Explain back propagation algorithm using gradient descent
16. Explain linear mapping and its types.

(3 x 12 = 36 Marks)

7B27ICSC: Theory of Computation

Semester	Course Code	Hours per Week	Exam Hours	Credits
7	7B27ICSC	4	3	3

Course Outcome

CO 1: Outline the concept of Finite Automata and Regular Expression
CO 2: Illustrate the design of Context Free Grammar for any language set
CO 3: Demonstrate the push down automaton model for the given language
CO 4: Make use of Turing machine concept to solve the simple problems
CO 5: Familiarize decidability or undecidability of various problems

Unit I

Introduction: Introduction to the Theory of computation and Finite Automata: Mathematical preliminaries and notation, Proof techniques, Three basic concepts: languages, grammar & automata. Finite automata: Deterministic Finite Acceptors, Nondeterministic Finite Acceptors, Equivalence of deterministic and nondeterministic finite acceptors, Reduction of the number of states in finite automata. Mealy Machines,Moore Machines and Inter conversion.

(14 Hours)

Unit II

Regular Expression: Regular Languages and Regular grammars: Regular expressions, connection between regular expressions and regular languages, regular grammars. Properties of Regular Languages: closure properties of regular languages, identifying non regular Language. Context-free grammars and languages Context-free grammars, parsing and ambiguity. Simplification of Context free Grammars, Normal forms: methods of transforming grammars,normal forms.

(12 Hours)

Unit III

Pushdown Automata: Pushdown automata for context-free languages.Non deterministic pushdown automata, PDA and context-free languages, deterministic pushdown automata and deterministic context-free languages.Properties of Context-Free Languages: pumping lemmas for context free languages and linear languages, closure properties for context-free languages.

(16 Hours)

Unit IV

Turing Machines: Standard Turing machine, combining Turing machines for complicated tasks, Turing's thesis. Other models of Turing machine: Minor variations on the Turing machine theme, Turing machine with complex storage, nondeterministic Turing machine, a universal Turing machine, Linear bounded automata. Limits of Algorithmic computation: Problems that cannot be solved by Turing machines, Undecidable Problems for Recursively enumerable Languages, The Post Correspondence problem. Computational Complexity :The class P, Examples of Problems,Boolean Satisfiability, The class NP, NP-completeness.

(12 Hours)

References

[1] Peter Linz (2016), *An introduction to Formal Languages and Automata*, 6th edn, Jones & Bartlett.

[2] John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman (2007), *Introduction to Automata Theory Languages and Computation*, 3rd edition, Pearson Education, India.

[3] John C Martin (1997), *Introduction to Languages and the Theory of Automata*, McGraw Hill.

Marks Including Choice

Unit	Marks
I	28
II	28
III	32
IV	36

Model Question Paper

7B27ICSC: Theory of Computation

Time: 3 Hours **Max. Marks: 80**

Section A

Answer any 5 questions. Each question carries 4 marks

1. Is the language ww^R where w is a string of zeros and ones, accepted by DPDA?Why?
2. Explain Chomsky hierarchy
3. Is the following grammar ambiguous?
   E→E+E|E*E|I
   I →0|1|a|b
4. State the closure properties of regular sets.
5. Compare recursive and recursively enumerable languages.
6. State pumping lemma for context free languages.

(5 x 4 = 20 Marks)

Section B

Answer any 3 questions. Each question carries 8 marks

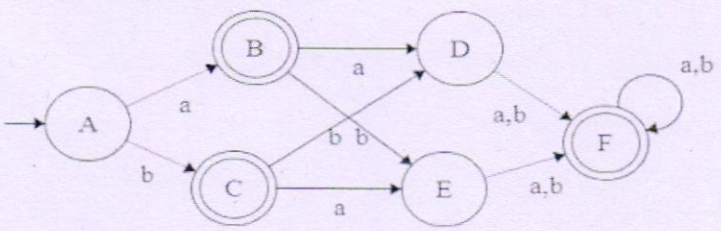
7. Design a Moore machine to determine the residue of mod 2 of the input treated as a binary string.
8. Convert the following grammar to Chomsky Normal Form.
   S→0S0|1S1| ε
9. Find a DFA for the language on Σ = {a, b} L = {w: |w| mod 2 = 0}
10. Write a note on Universal Turing machines.
11. Construct the PDA for the language {0^n1^n}*

(3 x 8 = 24 Marks)

Section C

Answer any 3 questions. Each question carries 12 marks

12. Minimize the following DFA.



13. (i)Define PDA. Give an Example for a language accepted by PDA by empty stack (6)
    (ii) Convert the following grammar into PDA that accepts the same language by the empty stack (6)
    S→0S1|A
    A→1A0|S| ε
14. Consider the grammar
    S→aAa|bBb|ϵ
    A→C|a
    B→C|b

C→CDE|ϵ

D→A|B|ab

a)Eliminate ϵ-production

b)Eliminate any unit production in the resulting grammar

c) Eliminate any useless symbols in the resulting grammar

15. Write notes on the following:

    i) decidable and undecidable problems

    ii) Halting Problem of Turing machine.

16. Explain the different types of Turing Machine. Design a turing machine that accepts the language of all strings over the alphabet $\sum=\{a,b\}$ whose second letter is b

(3 x 12 = 36 Marks)

7B28ICSC: Soft Computing Techniques

Semester	Course Code	Hours per Week	Exam Hours	Credits
7	7B28ICSC	4	3	3

Course Outcome

CO 1: To learn the basic concepts of Soft Computing
CO 2: To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems.
CO 3: To apply soft computing techniques to solve problems.

Unit I

Soft Computing and Conventional Artificial Intelligence: Hard Computing Vs. Soft Computing. Soft Computing Methods: Artificial Neural Network, Fuzzy Sets and Fuzzy Logic, Intuitionistic Fuzzy Sets, Rough Set Theory . Applications of Soft Computing.

(12 Hours)

Unit II

Fuzzy Set theory: Fuzzy versus Crisp set. Fuzzy Sets: Fuzzy Set Operations, Properties of Fuzzy Sets, Non-interactive Fuzzy Sets, Alternative Fuzzy Set Operations. Fuzzy Relations: Fuzzy Relations, Cardinality of Fuzzy Relations , Operations on Fuzzy Relations , Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition , Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

(16 Hours)

Unit III

Genetic algorithms (GA): History of Genetic Algorithms-working principle, Various Encoding methods, Fitness function,, GA Operators: Reproduction, Crossover, Mutation, A Simple Genetic Algorithm. Convergence of GA, Bit wise operation in GA, Multi-level Optimization, TSP problem using GA.

(14 Hours)

Unit IV

Evolutionary Computing, Simulated Annealing, Random Search, Downhill Simplex Search, Swarm optimization. Hybrid Systems: Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.

(12 Hours)

References

[1] Roy, S. and Chakraborty, U. (2013). *Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms*, Pearson India.

[2] Timothy J. Ross (2010), *Fuzzy Logic with Engineering Applications* (3rd Edn.), Willey.
[3] F. Martin, Mc Neill, and Ellen Thro (2000), *Fuzzy Logic: A Practical Approach*, AP Professional.
[4] Melanie Mitchell (2000), *An Introduction to Genetic Algorithms*, MIT Press.

Marks Including Choice

Unit	Marks
I	28
II	48
III	24
IV	24

Model Question Paper

7B28ICSC: Soft Computing Techniques

Time: 3 Hours **Max. Marks: 80**

Section A

Answer any 5 questions. Each question carries 4 marks

17. Explain Hard Computing.
18. What is fuzzy logic?
19. Explain cross over.
20. Differentiate between Fuzzy set versus Crisp set.
21. Explain Predicate logic.
22. Briefly explain Random Search.

(5 x 4 = 20 Marks)

Section B

Answer any 3 questions. Each question carries 8 marks

23. Differentiate between soft computing and hard computing.
24. Explain Fuzzy Cartesian product and Composition.
25. Explain Defuzzification Method with example.
26. Explain the working principle of genetic algorithms.
27. Explain Downhill Simplex Search algorithm.

(3 x 8 = 24 Marks)

Section C

Answer any 3 questions. Each question carries 12 marks

28. Explain the applications of soft computing.
29. Explain Fuzzy Set Operations with examples.
30. Explain Minmax Composition with example.
31. Explain genetic algorithms with TSP problem.
32. Explain different hybrid systems.

(3 x 12 = 36 Marks)

7B29ICSC: Digital Image Processing

Semester	Course Code	Hours per Week	Exam Hours	Credits
7	7B29ICSC	4	3	4

Course Outcome

CO 1: Integrate concepts of various image processing steps.
CO 2: Evaluate current technologies and issues in Image processing.
CO 3: Familiar the basic python libraries and functions that support IP
CO 4: Aware about developing efficient Image Processing programs using Python..

Unit I

Digital Image Fundamentals: Definition of digital image, pixels, representation of digital image - spatial domain and matrix form. Block diagram of fundamentals steps in digital image processing, application of digital image processing system, Components of Digital Image processing, Processing systems-Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, CMY models.

(12 Hours)

Unit II

Image Enhancement Spatial Domain: Gray level transformations - Histogram processing ,histogram equalization, Smoothing and Sharpening - Gaussian Smoothing, Mean Smoothing, Median Smoothing, Basics of Spatial Filtering– Basics of Spatial Filtering, Linear filters, Spatial Low pass smoothing filters, Averaging, Weighted Averaging, Non-Linear filters, Median filter, Maximum and Minimum filters..

(16 Hours)

Unit III

Image Restoration: degradation model, Properties, Noise models, Salt-and-Pepper Noise, Mean Filters, Order Statistics, Adaptive filters, Band reject Filters, Band pass Filters, Notch Filters, Frequency Rejection - Applications.
Image Segmentation: Point Detection, Line Detection, Edge detection, Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation.

(14 Hours)

Unit IV

Feature Extraction: Edge linking and Boundary detection- Thresholding- -Edge based segmentation-Region based Segmentation, DIP basic libraries and methods in Python- OpenCV, Numpy and Scipy libraries, Scikit, Python Imaging Library (PIL), methods-Open() and show(), imread(), imshow() Convert and Save(), thumbnails(), convert()

(12 Hours)

References

[1] Rafael C. Gonzalez, Richard E. Woods (2018), Digital Image Processing, 4th Edition, Pearson Education.

[2] William K. Pratt (2010), *Digital Image Processing*, 4th Edition, Wiley India.

[3] Kenneth R. Castleman (2007), *Digital Image Processing*, Pearson India.

[4] D,E. Dudgeon and RM. Mersereau (1990), *Multidimensional Digital Signal Processing*, Prentice Hall Professional Technical Reference.

[5] Anil K. Jain (2015), *Fundamentals of Digital Image Processing*, Pearson.

[6] Sandipan Dey (2018), *Hands-On Image Processing with Python: Expert techniques for advanced image analysis and effective interpretation of image data*, Packt Publishing.

Marks Including Choice

Unit	Marks
I	30
II	35
III	35
IV	24

Model Question Paper

7B29ICSC: Digital Image Processing

Time: 3 Hours **Max. Marks: 80**

Section A

Answer any 5 questions. Each question carries 4 marks

1. Differentiate between Smoothing and Sharpening.
2. Compare RGB and HSI.
3. What do you mean Thresholding in segmentation?
4. Explain any 5 applications of DIP.
5. Explain Image Sampling and Quantization.
6. Give the methods for Morphological processing.

(5 x 4 = 20 Marks)

Section B

Answer any 3 questions. Each question carries 8 marks

7. Explain importance of Feature Extraction .
8. What are Non-Linear filters in image enhancement? Explain any 3 techniques.
9. Explain different predefined methods for handling images in Python?
10. Describe Image Restoration.
11. Write about the importance of image segmentation.

(3 x 8 = 24 Marks)

Section C

Answer any 3 questions. Each question carries 12 marks

12. Explain the Steps of DIP.
13. Give a detailed account of Segmentation techniques
14. Explain Histogram equalization with suitable example
15. Explain importance of image restoration
16. Explain Spatial Filtering for image enhancement..

(3 x 12 = 36 Marks)

7B31ICSC: Lab-9: Digital Image Processing

Semester	Course Code	Hours per Week	Exam Hours	Credits
7	7B31ICSC	4	3	4

Exercises

1. Simulation and Display of an Image, Negative of an Image(Binary & Gray Scale)
2. Implementation of Relationships between Pixels
3. Implementation of Transformations of an Image
4. Contrast stretching of a low contrast image, Histogram, and Histogram Equalization
5. Display of bit planes of an Image
6. Display of FFT(1-D & 2-D) of an image
7. Computation of Mean, Standard Deviation, Correlation coefficient of the given Image
8. Implementation of Image Smoothening Filters(Mean and Median filtering of an Image)
9. Implementation of image sharpening filters and Edge Detection using Gradient Filters
10. Implementation of Image Intensity slicing technique for image enhancement
11. Canny edge detection Algorithm

7B32ICSC: Lab-10: Soft Computing Techniques

Semester	Course Code	Hours per Week	Exam Hours	Credits
7	7B32ICSC	5	3	4

Exercises

1. Write a Program to implement Multiple Perceptron Model.
2. Write a Program to implement XOR with backpropagation algorithm.
3. Write a Program to implement Union, Intersection and Complement operations.
4. Write a Program to implement De-Morgan's Law.
5. Write a Program to implement Fuzzy Relations (Max-min Composition).
6. Write a Program to implement Fuzzy Controller (Washing Machine).
7. Write a program for Genetic algorithm to maximize the function f(x)=x2.
8. Write a Program to implement Simple Genetic Application.
9. Programming exercises on maximizing a function using Genetic algorithm.
10. Write a program to show Multi objective optimization in Genetic Algorithm.