CO-PO &CO-PSO Mapping for the academic Year 2024-25

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| Subject Name with Code | |  | | --- | | **DISCRETE MATHEMATICAL STRUCTURES –BCS405A** | |
| **Course Coordinator/s** |  |

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| **List of Course Outcomes** | **Program Outcomes** | | | | | | | | | | | | | **Program Specific Outcomes** | | | | |
| **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **Total** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **Total** |
| **CO-1** | 3 | 2 | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **5** | - | - | - | **-** | - |
| **CO-2** | 3 | 2 | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | 1 | **6** | - | - | - | **-** | - |
| **CO-3** | 2 | 2 | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | 1 | **5** | - | - | - | **-** | - |
| **CO-4** | 2 | 2 | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | 1 | **5** | - | - | - | **-** | - |
| **CO-5** | 2 | 2 | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | 1 | **5** | - | - | - | **-** | - |
| **Total** | **12** | **9** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **5** | **27** | **-** | **-** | **-** | **-** | **-** |

**PO 1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and anengineering specialisation for the

solution of complex engineering problems.

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| **Cos** | Competency | **Performance Indicators** |  |
| **CO-1.**  Apply concepts of logical reasoning and mathematical proof techniques in proving theorems and statements.  . | 1.1 Demonstrate the knowledge of Mathematics | 1.1.1 Apply mathematical techniques such as calculus, linear algebra, Probability, statistics and discrete mathematics to solve problems | Logic Theory |
| 1.1.2 Apply advanced mathematical techniques to model and solve Computer Science engineering problems | Logic(AND, OR, NOR) |
| 1.2 Demonstrate competence in basic sciences | 1.2.1 Apply laws of natural science to an engineering problem | Logic gates(AND, OR, NOR) |
| 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply fundamental engineering concepts to solve engineering problems | Logics and truth table |
| 1.4 Demonstrate competence in engineering fundamentals and specialized engineering knowledge to the program | 1.4.1 Apply Computer Science engineering concepts to solve engineering problems. | laws of logics concepts |
| **CO-2.**  Demonstrate the application of discrete structures in different fields of computer science. | 1.1 Demonstrate the knowledge of Mathematics | 1.1.1 Apply mathematical techniques such as calculus, linear algebra, Probability, statistics and discrete mathematics to solve problems |  |
| 1.1.2 Apply advanced mathematical techniques to model and solve Computer Science engineering problems |  |
| 1.2 Demonstrate competence in basic sciences | 1.2.1 Apply laws of natural science to an engineering problem |  |
| 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply fundamental engineering concepts to solve engineering problems |  |
| 1.4 Demonstrate competence in engineering fundamentals and specialized engineering knowledge to the program | 1.4.1 Apply Computer Engineering concepts to solve engineering problems. |  |
| **CO-3.**  Apply the basic concepts of relations, functions and partially ordered sets for computer representations. | 1.1 Demonstrate the knowledge of Mathematics | 1.1.1 Apply mathematical techniques such as calculus, linear algebra, Probability, statistics and discrete mathematics to solve problems | Relations , functions and graph thoery |
| 1.1.2 Apply advanced mathematical techniques to model and solve Computer Science engineering problems | Linear Algebra, Set theory, |
| 1.2 Demonstrate competence in basic sciences | 1.2.1 Apply laws of natural science to an engineering problem |  |
| 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply fundamental engineering concepts to solve engineering problems | relations,functions, graphs, trees |
| 1.4 Demonstrate competence in engineering fundamentals and specialized engineering knowledge to the program | 1.4.1 Apply Computer Science engineering concepts to solve engineering problems | recurrence relations and generating functions |
| **CO-4.**  Solve problems involving recurrence relations and generating functions. | 1.1 Demonstrate the knowledge of Mathematics | 1.1.1 Apply mathematical techniques such as calculus, linear algebra, Probability, statistics and discrete mathematics to solve problems |  |
| 1.1.2 Apply advanced mathematical techniques to model and solve Computer Science engineering problems |  |
| 1.2 Demonstrate competence in basic sciences | 1.2.1 Apply laws of natural science to an engineering problem |  |
| 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply fundamental engineering concepts to solve engineering problems |  |
| 1.4 Demonstrate competence in engineering fundamentals and specialized engineering knowledge to the program | 1.4.1 Apply Computer Science engineering concepts to solve engineering problems. |  |
| **CO-5.**  Illustrate the fundamental principles of Algebraic structures with the problems related to computer science & engineering.  . | 1.1 Demonstrate the knowledge of Mathematics | 1.1.1 Apply mathematical techniques such as calculus, linear algebra, Probability, statistics and discrete mathematics to solve problems |  |
| 1.1.2 Apply advanced mathematical techniques to model and solve Computer Science engineeringproblems |  |
| 1.2 Demonstrate competence in basic sciences | 1.2.1 Apply laws of natural science to an engineering problem |  |
| 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply fundamental engineering concepts to solve engineering problems |  |
| 1.4 Demonstrate competence in engineering fundamentals and specialized engineering knowledge to the program | 1.4.1 Apply Computer Science engineering concepts to solve engineering problems. |  |

**PO 2: Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using

first principles of mathematics, natural sciences, and engineering sciences.

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| **COs** | Competency | **Performance Indicators** |  |
| **CO-1.** Apply concepts of logical reasoning and mathematical proof techniques in proving theorems and statements. | 2.1 Demonstrate an ability to identify and formulate complex engineering problem | 2.1.1 Articulate problem statements and identify objectives | converse , inverse, contapositive |
| 2.1.2 Identify engineering systems, variables, and parameters to solve the problems | P,Q, Negation(~) |
| 2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem | De Morgans Law, Associative, Distributive |
| 2.2 Demonstrate an ability to  formulate a solution plan and  methodology for an engineering  problem | 2.2.1 Reframe complex problems into interconnected sub-problems | To check validity of the statements using modus pones, tollens |
| 2.2.2 Identify, assembleand evaluate information and resources. | Tautology, contradictions, contingency |
| 2.2.3 Identify existing processes/solution methods for solving theproblem, including forming justified approximations andassumptions |  |
| 2.2.4 Compare and contrast alternative solution processes to select the best process. |  |
| 2.3 Demonstrate an ability to formulate and interpret a model | 2.3.1 Combine scientific principles and engineering concepts toformulate model/s (mathematical or otherwise) of a system orprocess that is appropriate in terms of applicability and required accuracy. |  |
| 2.3.2 Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required. |  |
|  | 2.4 Demonstrate an ability to execute a solution process and analyse results | 2.4.1 Apply engineering mathematics and computations to solve mathematical models |  |
| 2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models |  |
| 2.4.3 Identify sources of error in the solution process, and limitations of the solution. |  |
| 2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis | Based on truth values we conclude it’s a tautology, contradiction otr contingency(logically equivalent) |

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| **CO-2.**.  Demonstrate the application of discrete structures in different fields of computer science. | 2.1 Demonstrate an ability to identify and formulate complex engineering problem | 2.1.1 Articulate problem statements and identify objectives |  |
| 2.1.2 Identify engineering systems, variables, and parameters to solve the problems |  |
| 2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |  |
| 2.2 Demonstrate an ability to  formulate a solution plan and  methodology for an engineering  problem | 2.2.1 Reframe complex problems into interconnected sub-problems |  |
| 2.2.2 Identify, assemble and evaluate information and resources. |  |
| 2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |  |
| 2.2.4 Compare and contrast alternative solution processes to select the best process. |  |
| 2.3 Demonstrate an ability to execute a solution process and analyse results | 2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy. |  |
| 2.3.2 Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required. |  |
|  | 2.4 Demonstrate an ability to execute a solution process and analyse results | 2.4.1 Apply engineering mathematics and computations to solve mathematical models |  |
| 2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models |  |
| 2.4.3 Identify sources of error in the solution process, and limitations of the solution. |  |
| 2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |  |

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| **CO-3.**  Apply the basic concepts of relations, functions and partially ordered sets for computer representations | 2.1 Demonstrate an ability to identify and formulate complex engineering problem | 2.1.1 Articulate problem statements and identify objectives | Transitive, symmetry, reflexive |
| 2.1.2 Identify engineering systems, variables, and parameters to solve the problems | p,q(vertices,edges) |
| 2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem | Isomorphism, pigeon hole principle, hasse diagram |
| 2.2 Demonstrate an ability to formulate a solution plan and  methodology for an engineering problem | 2.2.1 Reframe complex problems into interconnected sub-problems |  |
| 2.2.2 Identify, assemble and evaluate information and resources. | Types of graphs and trees |
| 2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |  |
| 2.2.4 Compare and contrast alternative solution processes to select the best process. |  |
| 2.3 Demonstrate an ability to execute a solution process and analyse results | 2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy. |  |
| 2.3.2 Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required. |  |
|  | 2.4 Demonstrate an ability to execute a solution process and analyse results | 2.4.1 Apply engineering mathematics and computations to solve mathematical models | * + 1. to solve recurrence relation , function, graphs and trees |
| 2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models |  |
| 2.4.3 Identify sources of error in the solution process, and limitations of the solution. |  |
| 2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis. | Whether the graphs are bipartite, isomorphism |

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| **CO-4.**  Solve problems involving recurrence relations and generating functions. | 2.1 Demonstrate an ability to identify and formulate complex engineering problem | 2.1.1 Articulate problem statements and identify objectives. |  |
| 2.1.2 Identify engineering systems, variables, and parameters to solve the problems |  |
| 2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem. |  |
| 2.2 Demonstrate an ability to  formulate a solution plan and  methodology for an engineering  problem | 2.2.1 Reframe complex problems into interconnected sub-problems. |  |
| 2.2.2 Identify, assemble and evaluate information and resources. |  |
| 2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions. |  |
| 2.2.4 Compare and contrast alternative solution processes to select the best process. |  |
| 2.3 Demonstrate an ability to execute a solution process and analyse results | 2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy. |  |
| 2.3.2 Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required. |  |
|  | 2.4 Demonstrate an ability to execute a solution process and analyse results | 2.4.1 Apply engineering mathematics and computations to solve mathematical models |  |
| 2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models |  |
| 2.4.3 Identify sources of error in the solution process, and limitations of the solution. |  |
| 2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis | . |
| **CO-5.**  Illustrate the fundamental principles of Algebraic structures with the problems related to computer science & engineering. | 2.1 Demonstrate an ability to identify and formulate complex engineering problem | 2.1.1 Articulate problem statements and identify objectives |  |
| 2.1.2 Identify engineering systems, variables, and parameters to solve the problems |  |
| 2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |  |
| 2.2 Demonstrate an ability to  formulate a solution plan and  methodology for an engineering  problem | 2.2.1 Reframe complex problems into interconnected sub-problems |  |
| 2.2.2 Identify, assemble and evaluate information and resources. |  |
| 2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions. |  |
| 2.2.4 Compare and contrast alternative solution processes to select the best process. |  |
| 2.3 Demonstrate an ability to execute a solution process and analyze results | 2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy. |  |
| 2.3.2 Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required. |  |
|  | 2.4 Demonstrate an ability to execute a solution process and analyse results | 2.4.1 Apply engineering mathematics and computations to solve mathematical models |  |
| 2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models |  |
| 2.4.3 Identify sources of error in the solution process, and limitations of the solution. |  |
| 2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |  |

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| **PO 12: Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. | | | | |
| **Cos** |  | Competency | **Performance Indicators** |  |
| **CO-1.** Apply concepts of logical reasoning and mathematical proof techniques in proving theorems and statements |  | 12.1 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps. | 12.1.1 Describe the rationale for requirement for continuing professional development | Analysis of algorithms and implementation |
| 12.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |  |
| 12.2 Demonstrate an ability to identify changing trends in engineering knowledge and practice | 12.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current | ----- |
| 12.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field | ------ |
| 12.3 Demonstrate an ability to identify and access sources for new information | 12.3.1 Source and comprehend technical literature and other credible sources of information | ------- |
| 12.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc. | --------- |

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| **CO-2.**  Demonstrate the application of discrete structures in different fields of computer science. |  | 12.1 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps. | 12.1.1 Describe the rationale for requirement for continuing professional development |  |
| 12.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |  |
| 12.2 Demonstrate an ability to identify changing trends in engineering knowledge and practice | 12.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current |  |
| 12.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field |  |
| 12.3 Demonstrate an ability to identify and access sources for new information | 12.3.1 Source and comprehend technical literature and other credible sources of information |  |
| 12.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc. |  |
| **CO-3.**  Apply the basic concepts of relations, functions and partially ordered sets for computer representations |  | 12.1 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps. | 12.1.1 Describe the rationale for requirement for continuing professional development | Used in google maps, social networks like facebook, transportation, navigation etc |
| 12.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |  |
| 12.2 Demonstrate an ability to identify changing trends in engineering knowledge and practice | 12.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current |  |
| 12.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field | graph theory is used in connectivity, finding shortest path, to construct spanning tree |
| 12.3 Demonstrate an ability to identify and access sources for new information | 12.3.1 Source and comprehend technical literature and other credible sources of information |  |
| 12.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc. |  |
| **CO-4.**  Solve problems involving recurrence relations and generating functions. |  | 12.1 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps. | 12.1.1 Describe the rationale for requirement for continuing professional development | . |
| 12.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |  |
| 12.2 Demonstrate an ability to identify changing trends in engineering knowledge and practice | 12.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current |  |
| 12.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field |  |
| 12.3 Demonstrate an ability to identify and access sources for new information | 12.3.1 Source and comprehend technical literature and other credible sources of information |  |
| 12.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc. |  |

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| **CO-5.**  Illustrate the fundamental principles of Algebraic structures with the problems related to computer science & engineering.  . |  | 12.1 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps. | 12.1.1 Describe the rationale for requirement for continuing professional development | Used to audit and optimize analytical measurement protocols.(for process control, product quality control for consumer safety) |
| 12.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |  |
| 12.2 Demonstrate an ability to identify changing trends in engineering knowledge and practice | 12.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current. |  |
| 12.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field |  |
| 12.3 Demonstrate an ability to identify and access sources for new information | 12.3.1 Source and comprehend technical literature and other credible sources of information |  |
| 12.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc. |  |