

**OSMANIA UNIVERSITY
HYDERABAD, TELANGANA**



Mathematics Course Structure

(B.Sc. Common Core Syllabus for All Universities of Telangana State for the Students
Admitted from the Academic Year 2019-2020 Batch onwards)

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1 B.Sc. Course Structure Template

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B.A/B.Sc. Mathematics Course Structure

(Common Core Syllabus for All Universities of Telangana State for the Students Admitted from the Academic Year 2019-20 Batch onwards)

Paper	Semester	Subject	Hours/ per week	Hours/per week		Max. Marks	Credits
				Theory	*Tutorials		
DSC - I	I	Differential & Integral Calculus	6	5	1	100	5
DSC - II	II	Differential Equations	6	5	1	100	5
DSC - III	III	Real Analysis	6	5	1	100	5
DSC - IV	IV	Algebra	6	5	1	100	5
DSC - V	V	Linear Algebra	6	5	1	100	5
DSE – VI(A)	VI	(A) Numerical Analysis	6	5	1	100	5
DSE – VI(B)	VI	(B) Integral Transforms	6	5	1	100	5
DSE – VI(C)	VI	(C) Analytical Solid Geometry	6	5	1	100	5
SEC-I	III	Communication Skills (OR) Professional Skills	2	2	-	50	2
SEC-II	III	Theory of Equations (OR) Logic & Sets	2	2	-	50	2
SEC-III	IV	Leadership & Management Skill (OR) Universal Human Values	2	2	-	50	2
SEC-IV	IV	Number Theory (OR) Vector Calculus	2	2	-	50	2
Generic Elective	V-A or V-B	Basic Mathematics or Mathematics for Economics & Finance	4	4	-	100	4
Project/ Optional	VI**	Mathematical Modelling	4	4	-	100	4

***Tutorials:** Problems solving session for each 20 student's one batch.

The students are required to opt either the optional paper **Mathematical Modeling or **Project**.

SEMESTER-I

1.1 Differential and Integral Calculus

(w.e.f. academic year 2019-20)

DSC-1A

BS:101

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to some basic notions in differential calculus.

Outcome: By the time students complete the course they realize wide ranging applications of the subject.

Unit- I

Partial Differentiation: Introduction - Functions of two variables - Neighborhood of a point (a, b) - Continuity of a Function of two variables, Continuity at a point - Limit of a Function of two variables - Partial Derivatives - Geometrical representation of a Function of two Variables - Homogeneous Functions.

Unit- II

Theorem on Total Differentials - Composite Functions - Differentiation of Composite Functions - Implicit Functions - Equality of $f_{xy}(a, b)$ and $f_{yz}(a, b)$ - Taylor's theorem for a function of two Variables - Maxima and Minima of functions of two variables - Lagrange's Method of undetermined multipliers.

Unit- III

Curvature and Evolutes: Introduction - Definition of Curvature - Radius of Curvature - Length of Arc as a Function, Derivative of arc - Radius of Curvature - Cartesian Equations - Newtonian Method - Centre of Curvature - Chord of Curvature.

Evolutes: Evolutes and Involutives - Properties of the evolute.

Envelopes: One Parameter Family of Curves - Consider the family of straight lines - Definition - Determination of Envelope.

Unit- IV

Lengths of Plane Curves: Introduction - Expression for the lengths of curves $y = f(x)$ - Expressions for the length of arcs $x = f(y)$; $x = f(t)$, $y = \phi(t)$; $r = f(\theta)$

Volumes and Surfaces of Revolution: Introduction - Expression for the volume obtained by revolving about either axis - Expression for the volume obtained by revolving about any line - Area of the surface of the frustum of a cone - Expression for the surface of revolution - Pappus Theorems - Surface of revolution.

Text:

- Shanti Narayan, P.K. Mittal *Differential Calculus*, S.CHAND, NEW DELHI

- Shanti Narayan *Integral Calculus*, S.CHAND, NEW DELHI
 - References:
 - William Anthony Granville, Percy F Smith and William Raymond Longley; *Elements of the differential and integral calculus*
 - Joseph Edwards , *Differential calculus for beginners*
 - Smith and Minton, *Calculus*
 - Elis Pine, *How to Enjoy Calculus*
 - Hari Kishan, *Differential Calculus*
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SEMESTER-II

1.2 Differential Equations

(w.e.f. academic year 2019-20)

DSC-1B

BS:201

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The main aim of this course is to introduce the students to the techniques of solving differential equations and to train to apply their skills in solving some of the problems of engineering and science.

Outcome: After learning the course the students will be equipped with the various tools to solve few types differential equations that arise in several branches of science.

Unit- I

Differential Equations of first order and first degree: Introduction - Equations in which Variables are Separable - Homogeneous Differential Equations - Differential Equations Reducible to Homogeneous Form - Linear Differential Equations - Differential Equations Reducible to Linear Form - Exact differential equations - Integrating Factors - Change in variables - Total Differential Equations - Simultaneous Total Differential Equations - Equations of the form $\frac{dx}{P} = \frac{du}{Q} = \frac{dz}{R}$.

Unit- II

Differential Equations first order but not of first degree: Equations Solvable for p - Equations Solvable for y - Equations Solvable for x - Equations that do not contain x (or y) - Equations Homogeneous in x and y - Equations of the First Degree in x and y - Clairaut's equation.
Applications of First Order Differential Equations : Growth and Decay - Dynamics of Tumour Growth - Radioactivity and Carbon Dating - Compound Interest - Orthogonal Trajectories

Unit- III

Higher order Linear Differential Equations: Solution of homogeneous linear differential equations with constant coefficients - Solution of non-homogeneous differential equations $P(D)y = Q(x)$ with constant coefficients by means of polynomial operators when $Q(x) = be^{ax}, b \sin ax/b \cos ax, bx^k, Ve^{ax}$ - Method of undetermined coefficients.

Unit- IV

Method of variation of parameters - Linear differential equations with non constant coefficients - The Cauchy - Euler Equation - Legendre's Linear Equations - Miscellaneous Differential Equations.
Partial Differential Equations: Formation and solution- Equations easily integrable - Linear equations of first order.

Text:

- Zafar Ahsan, *Differential Equations and Their Applications*

References

Frank Ayres Jr, *Theory and Problems of Differential Equations.*

- Ford, L.R ; *Differential Equations*.
 - Daniel Murray, *Differential Equations*.
 - S. Balachandra Rao, *Differential Equations with Applications and Programs*.
 - Stuart P Hastings, J Bryce McLead; *Classical Methods in Ordinary Differential Equations*.
-

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SEMESTER-III

1.3 Real Analysis

(w.e.f. academic year 2020-21)

DSC-1C

BS:301

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours/week

Objective: The course is aimed at exposing the students to the foundations of analysis which will be useful in understanding various physical phenomena.

Outcome: After the completion of the course students will be in a position to appreciate beauty and applicability of the course.

Unit- I

Sequences: Limits of Sequences- A Discussion about Proofs-Limit Theorems for Sequences- Monotone Sequences and Cauchy Sequences -Subsequences-Lim sup' s and Lim inf' s-Series-Alternating Series and Integral Tests .

Unit- II

Continuity: Continuous Functions -Properties of Continuous Functions -Uniform Continuity - Limits of Functions

Unit- III

Differentiation: Basic Properties of the Derivative - The Mean Value Theorem - *L' Hospital Rule - Taylor' s Theorem.

Unit- IV

Integration : The Riemann Integral - Properties of Riemann Integral-Fundamental Theorem of Calculus.

Text:

- Kenneth A Ross, *Elementary Analysis-The Theory of Calculus*

References:

- S.C.Malik and Savita Arora, *Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International (P) Limited, New Delhi, 1994.*
- William F. Trench, *Introduction to Real Analysis*
- Lee Larson , *Introduction to Real Analysis I*
- Shanti Narayan and Mittal, *Mathematical Analysis*
- Brian S. Thomson, Judith B. Bruckner, Andrew M. Bruckner; *Elementary Real analysis*
- Sudhir R., Ghorpade, Balmohan V., Limaye; *A Course in Calculus and Real Analysis*

1.4 Algebra

(w.e.f. academic year 2020-21)

DSC-1D

BS:401

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and
Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to learn some basic algebraic structures like groups, rings etc.

Outcome: On successful completion of the course students will be able to recognize algebraic structures that arise in matrix algebra, linear algebra and will be able to apply the skills learnt in understanding various such subjects.

Unit- I

Groups: Definition and Examples of Groups- Elementary Properties of Groups-Finite Groups - Subgroups -Terminology and Notation -Subgroup Tests - Examples of Subgroups.

Cyclic Groups: Properties of Cyclic Groups - Classification of Subgroups Cyclic Groups.

Unit- II

Permutation Groups: Definition and Notation -Cycle Notation-Properties of Permutations -A Check Digit Scheme Based on D_5 . Isomorphisms ; Motivation- Definition and Examples -Cayley' s Theorem Properties of Isomorphisms -Automorphisms-Cosets and Lagrange' s Theorem Properties of Cosets 138 - Lagrange' s Theorem and Consequences-An Application of Cosets to Permutation Groups -The Rotation Group of a Cube and a Soccer Ball.

Unit- III

Normal Subgroups and Factor Groups: Normal Subgroups-Factor Groups -Applications of Factor Groups -Group Homomorphisms - Definition and Examples -Properties of Homomorphisms -The First Isomorphism Theorem.

Introduction to Rings: Motivation and Definition -Examples of Rings -Properties of Rings - Subrings.

Integral Domains: Definition and Examples - Fields - Characteristics of a Ring.

Unit- IV

Ideals and Factor Rings: Ideals -Factor Rings -Prime Ideals and Maximal Ideals.

Ring Homomorphisms: Definition and Examples-Properties of Ring- Homomorphisms.

Text:

- Joseph A Gallian, *Contemporary Abstract algebra (9th edition)*

References:

- Bhattacharya, P.B Jain, S.K.; and Nagpaul, S.R, *Basic Abstract Algebra*
- Fraleigh, J.B, *A First Course in Abstract Algebra.*

- Herstein, I.N, *Topics in Algebra*
 - Robert B. Ash, *Basic Abstract Algebra*
 - I Martin Isaacs, *Finite Group Theory*
 - Joseph J Rotman, *Advanced Modern Algebra*
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SEMESTER-V

1.5 Linear Algebra

(w.e.f. academic year 2021-22)

DSC-E

BS:501

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The students are exposed to various concepts like vector spaces , bases , dimension, Eigen values etc.

Outcome: After completion this course students appreciate its interdisciplinary nature.

Unit- I

Vector Spaces: Vector Spaces and Subspaces -Null Spaces, Column Spaces, and Linear Transformations -Linearly Independent Sets; Bases -Coordinate Systems -The Dimension of a Vector Space

Unit- II

Rank-Change of Basis - Eigenvalues and Eigenvectors - The Characteristic Equation

Unit- III

Diagonalization -Eigenvectors and Linear Transformations -Complex Eigenvalues - Applications to Differential Equations.

Unit- IV

Orthogonality and Least Squares : Inner Product, Length, and Orthogonality -Orthogonal Sets -Orthogonal Projections - The Gram-Schmidt Process.

Text:

- David C Lay, *Linear Algebra and its Applications 4e*

References:

- S Lang, *Introduction to Linear Algebra*
- Gilbert Strang , *Linear Algebra and its Applications*
- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence; *Linear Algebra*
- Kuldeep Singh; *Linear Algebra*
- Sheldon Axler; *Linear Algebra Done Right*

1.6 Numerical Analysis

(w.e.f. academic year 2021-22)

DSE-1F/A

BS:601/A

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: Students will be made to understand some methods of numerical analysis.

Outcome: Students realize the importance of the subject in solving some problems of algebra and calculus.

Unit- I

Errors in Numerical Calculations - **Solutions of Equations in One Variable:** The Bisection Method - The Iteration Method - The Method of False Position-Newton's Method - Muller's Method - solution of Systems of Nonlinear Equations.

Unit- II

Interpolation and Polynomial Approximation: Interpolation - Finite Differences - Differences of Polynomials - Newton's formula for Interpolation - Gauss' s central differences formulae - Stirling' s and Bessel' s formula - Lagrange' s Interpolation Polynomial - Divided Differences - Newton' s General Interpolation formula - Inverse Interpolation.

Unit- III

Curve Fitting: Least Square Curve Fitting: Fitting a Straight Line-Nonlinear Curve Fitting.

Numerical Differentiation and Integration: Numerical Differentiation - Numerical Integration: Trapezoidal Rule-Simpson' s 1/3rd-Rule and Simpson' s 3/8th-Rule - Boole' s and Weddle' s Rule - Newton' s Cotes Integration Formulae.

Unit- IV

Numerical Solutions of Ordinary Differential Equations: Taylor' s Series Method - Picard' s Method - Euler' s Methods - Runge Kutta Methods.

Text:

- S.S.Sastry, *Introductory Methods of Numerical Analysis*, PHI

References:

- Richard L. Burden and J. Douglas Faires, *Numerical Analysis* (9e)
- M K Jain, S R K Iyengar and R K Jain, *Numerical Methods for Scientific and Engineering computation*
- B.Bradie , *A Friendly introduction to Numerical Analysis*

1.7 Integral Transforms

(w.e.f. academic year 2021-22)

DSE - 1F/B

BS:601/B

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: Students will be exposed to Integral Transforms. The students also learning the Applications of Laplace Transforms to Differential Equations which arises in Physics and Engineering Problems.

Outcome: Students apply their knowledge to solve some problems on special functions and Differential Equations by using the Integral Transforms.

Unit- I

Laplace Transforms-Definition-Existence theorem-Laplace transforms of derivatives and integrals
- Periodic functions and some special functions.

Unit- II

Inverse Transformations - Convolution theorem - Heaviside' s expansion formula.

Unit- III

Applications to ordinary differential equations - solutions of simultaneous ordinary differential equations - Applications to Partial differential equations.

Unit- IV

Fourier Transforms- Sine and cosine transforms-Inverse Fourier Transforms.

Text:

- Vasishtha and Gupta, *Integral Transforms*, Krishna Prakashan Media(P), Ltd, Meerut (2e)

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1.8 Analytical Solid Geometry

(w.e.f. academic year 2021-22)

DSE - 1F/C

BS:601/C

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: Students learn to describe some of the surfaces by using analytical geometry.

Outcome: Students understand the beautiful interplay between algebra and geometry.

Unit- I

Sphere: Definition-The Sphere Through Four Given Points-Equations of a Circle- Intersection of a Sphere and a Line-Equation of a Tangent Plane-Angle of Intersection of Two Spheres-Radical Plane.

Unit- II

Cones and Cylinders: Definition-Condition that the General Equation of second degree Represents a Cone-Cone and a Plane through its Vertex -Intersection of a Line with a Cone.

Unit- III

The Right Circular Cone-The Cylinder- The Right Circular Cylinder.

Unit- IV

The Conicoid: The General Equation of the Second Degree-Intersection of Line with a Conicoid-Plane of contact-Enveloping Cone and Cylinder.

Text:

- Shanti Narayan and P K Mittal, *Analytical Solid Geometry* (17e)

References:

- Khaleel Ahmed, *Analytical Solid Geometry*
- S L Loney, *Solid Geometry*
- Smith and Minton, *Calculus*

Course 1: Communication Skills

Context and Justification :

Communication plays an important role in shaping an individual's life, personal as well as professional. Also it is the backbone of any organisation/institution. Success in life to a considerable extent depends on effective communication skills. In today's world of computers and digital media, a strong communication skill base is essential for learners and for smooth functioning of an organisation.

Objectives :

This course has been developed with the following objectives:

1. Identify common communication problems that may be holding learners back
2. Identify what their non-verbal messages are communicating to others
3. Understand role of communication in teaching-learning process
4. Learning to communicate through the digital media
5. Understand the importance of empathetic listening
6. Explore communication beyond language.

Expected Outcome :

By the end of this program participants should have a clear understanding of what good communication skills are and what they can do to improve their abilities.

Credit: 02

Duration: 30 Hours

Number & Titles of Modules:

Total of 7 Modules

Module 1	Listening	4 Hours
Module 2	Speaking	6 Hours
Module 3	Reading	3 Hours
Module 4	Writing and different modes of writing	4 Hours
Module 5	Digital Literacy	4 Hours
Module 6	Effective use of Social Media	4 Hours
Module 7	Non-verbal communication	5 Hours

Module Outline :

Module 1: Listening

4 Hours

- Techniques of effective listening
- Listening and comprehension
- Probing questions
- Barriers to listening

Module 2: Speaking

6 Hours

- Pronunciation
- Enunciation
- Vocabulary
- Fluency
- Common Errors

Module 3: Reading

3 Hours

- Techniques of effective reading
- Gathering ideas and information from a given text
 - i. Identify the main claim of the text
 - ii. Identify the purpose of the text
 - iii. Identify the context of the text
 - iv. Identify the concepts mentioned
- Evaluating these ideas and information
 - i. Identify the arguments employed in the text
 - ii. Identify the theories employed or assumed in the text
- Interpret the text
 - i. To understand what a text says
 - ii. To understand what a text does
 - iii. To understand what a text means

Module 4: Writing and different modes of writing

4 Hours

- Clearly state the claims
- Avoid ambiguity, vagueness, unwanted generalisations and oversimplification of issues
- Provide background information
- Effectively argue the claim
- Provide evidence for the claims
- Use examples to explain concepts
- Follow convention
- Be properly sequenced
- Use proper signposting techniques
- Be well structured
 - i. Well-knit logical sequence
 - ii. Narrative sequence
 - iii. Category groupings

- Different modes of Writing
 - i. E-mails
 - ii. Proposal writing for Higher Studies
 - iii. Recording the proceedings of meetings
 - iv. Any other mode of writing relevant for learners

Module 5: Digital Literacy**4 Hours**

- Role of Digital literacy in professional life
- Trends and opportunities in using digital technology in workplace
- Internet Basics
- Introduction to MS Office tools
 - i. Paint
 - ii. Office
 - iii. Excel
 - iv. Powerpoint

Module 6: Effective use of Social Media**4 Hours**

- Introduction to social media websites
- Advantages of social media
- Ethics and etiquettes of social media
- How to use Google search better
- Effective ways of using Social Media
- Introduction to Digital Marketing

Module 7: Non-verbal communication**5 Hours**

- Meaning of non-verbal communication
- Introduction to modes of non-verbal communication
- Breaking the misbeliefs
- Open and Closed Body language
- Eye Contact and Facial Expression
- Hand Gestures
- Do's and Don'ts
- Learning from experts
- Activities-Based Learning

Pedagogy : Instructor-Led Training, Supplemented by Online Platform (SWAYAM)

Materials : Teaching & Learning

Assessment : Paper-Based or Online Assessment

Bibliography & Suggested Reading including audio video material :

Books

- Sen Madhucchanda (2010), *An Introduction to Critical Thinking*, Pearson, Delhi
- Silvia P. J. (2007), *How to Read a Lot*, American Psychological Association, Washington DC

Course 2: Professional Skills

Context with Justification :

One of the significant outcomes of Higher Education is to prepare an individual for entering the job/employment market. Besides knowledge and skills required for a particular job/occupation, professional skills are also required for an individual to be gainfully employed for a successful and satisfied life. Professional skills are part of life skills. An individual should be able to demonstrate professional skills involving the use of intuitive, logical and critical thinking, communication and interpersonal skills, not limited to cognitive/creative skills. These skills, behaviour and quality of output enhance employability.

The career skills empower an individual with ability in preparing an appropriate resume, addressing the necessary gaps for facing interviews and actively and effectively participating in group discussion thereof, etc. It is also of significant importance that students /individuals possess the know-how to explore career opportunities for themselves, considering their innate strengths and weaknesses.

It is important that the students/individuals are well prepared to take on new challenges and opportunities. With the increasing use of technology in the way we live, learn and work, it is critical for students/individuals to be able to utilise basic computing concepts and also have and espouse excellent Team Skills. Collaborating and working together can assist in resolving complex problems, which allow/offer individuals an opportunity to articulate new ideas and perspectives. It further allows learner / individuals design, develop, problem solve and to adapt to situations based on their experience and skills.

Credit: 02

Duration:30 hours

The Course Professional Skills is divided into two parts:

- a) Career Skills
- b) Team Skills

A. Career Skills

Objectives :

The Objectives of the course are to help students/candidates:

1. Acquire career skills and fully pursue to partake in a successful career path
2. Prepare good resume, prepare for interviews and group discussions
3. Explore desired career opportunities in the employment market in consideration of an individual SWOT.

Expected Outcomes :

At the end of this course the students will be able to:

1. Prepare their resume in an appropriate template without grammatical and other errors and using proper syntax
2. Participate in a simulated interview
3. Actively participate in group discussions towards gainful employment
4. Capture a self - interview simulation video regarding the job role concerned
5. Enlist the common errors generally made by candidates in an interview
6. Perform appropriately and effectively in group discussions
7. Explore sources (online/offline) of career opportunities
8. Identify career opportunities in consideration of their own potential and aspirations
9. Use the necessary components required to prepare for a career in an identified occupation (as a case study).

Duration: 15 Hours

Number & Titles of Modules:

Module 1	Resume Skills	3 Hours
Module 2	Interview Skills	5 Hours
Module 3	Group Discussion Skills	4 Hours
Module 4	Exploring Career Opportunities	3 Hours

Module Outline :

Module 1: Resume Skills **3 Hours**

i. Resume Skills : Preparation and Presentation

- Introduction of resume and its importance
- Difference between a CV, Resume and Bio data
- Essential components of a good resume

ii. Resume skills : common errors

- Common errors people generally make in preparing their resume
- Prepare a good resume of her/his considering all essential components

Module 2: Interview Skills **5 Hours**

i. Interview Skills : Preparation and Presentation

- Meaning and types of interview (F2F, telephonic, video, etc.)
- Dress Code, Background Research, Do's and Don'ts
- Situation, Task, Approach and Response (STAR Approach) for facing an interview
- Interview procedure (opening, listening skills, closure, etc.)
- Important questions generally asked in a job interview (open and closed ended questions)

ii. Interview Skills : Simulation

- Observation of exemplary interviews
- Comment critically on simulated interviews

iii. Interview Skills : Common Errors

- Discuss the common errors generally candidates make in interview
- Demonstrate an ideal interview

Module 3: Group Discussion Skills

4 Hours

- Meaning and methods of Group Discussion
- Procedure of Group Discussion
- Group Discussion- Simulation
- Group Discussion - Common Errors

Module 4: Exploring Career Opportunities

3 Hours

- Knowing yourself – personal characteristics
- Knowledge about the world of work, requirements of jobs including self-employment.
- Sources of career information
- Preparing for a career based on their potentials and availability of opportunities

Pedagogy : Besides Face to Face lectures (theory would be limited only to 20% of the component and remaining 80% would be practical oriented), the focus would be primarily on blended /hybrid learning. This could include a flipped classroom approach that leverages project-based learning, demonstration, group discussion, simulations etc.

Materials : Audio video materials, Online Platform (SWAYAM), FutureSkills Platform, Used Cases & Case Studies etc.

Assessment: Online evaluation, demonstration, assignments : Some components could be aligned to NOS (SSC/N9005) IT-ITeS Sector . The questions posed to the students would be a mix of MCQs, scenario-based, logical reasoning, comprehension, simulations, etc. Do check the assessment model and sample assessment at (<http://nac.nasscom.in/>)

Bibliography & Suggested Reading including audio video material :

Please check IT-ITeS Sector Skills Council readiness programs namely

- Foundation Skills In IT (FSIT) - Refer the websites like <https://www.sscnasscom.com/ssc-projects/capacity-building-and-development/training/fsit/> and
- Global Business Foundation Skills (GBFS) – Refer websites like <https://www.sscnasscom.com/ssc-projects/capacity-building-and-development/training/gbfs/>

B. Team Skills

Objectives :

The objectives of the course is to make learners:

1. Understand the significance of Team Skills and help them in acquiring them
2. To help them design, develop and adapt to situations as an individual and as a team.

Expected Outcomes :

By the end of this course the learners/candidates will be able to:

1. Use common technology messaging tools that are used in enterprises for flow of information and transition from command and control to informal communication during an online/offline team session
2. Actively use and operate online team communication tools: Webinar, Skype, Zoom, Google hangout etc
3. Appreciate and demonstrate Team Skills
4. Participate in a digital lifestyle conversant with computers, applications, Internet and nuances of cyber security
5. Explore (online) and identify career opportunities in consideration of their own potential and aspirations.
6. Discuss and articulate the key requirements of an entrepreneurial exercise
7. Empathise and trust colleagues for improving interpersonal relations
8. Engage in effective communication by respecting diversity and embracing good listening skills
9. Distinguish the guiding principles for communication in a diverse, smaller internal world
10. Practice interpersonal skills for better relations with seniors, juniors, peers and stakeholders
11. Project a good personal image and social etiquette so as to have a positive impact on building of one's chosen career
12. Generate, share and maximise new ideas with the concept of brainstorming and the documentation of key critical ideas/thoughts articulated and action points to be implemented with timelines in a team discussion (as MOM) in identified applicable templates.

Duration: 15 Hours

Number & Titles of Modules:

Module 1	Presentation Skills	5 Hours
Module 2	Trust and Collaboration	2 Hour
Module 3	Listening as a Team Skill	2 hour
Module 4	Brainstorming	2 Hour
Module 5	Social and Cultural Etiquettes	2 Hour
Module 6	Internal Communication	2 Hour

Module Outline :

Module 1: Presentation Skills **5 Hours**

- Types of presentations
- Internal and external presentation
- Knowing the purpose
- Knowing the audience
- Opening and closing a presentation
- Using presentation tools
- Handling questions
- Presentation to heterogenic group
- Ways to improve presentation skills over time

Module 2: Trust and Collaboration **2 Hours**

- Explain the importance of trust in creating a collaborative team
- Agree to Disagree and Disagree to Agree – Spirit of Team work
- Understanding fear of being judged and strategies to overcome fear

Module 3: Listening as a Team Skill **2 Hours**

- Advantages of Effective Listening
- Listening as a team member and team leader. Use of active listening strategies to encourage sharing of ideas (full and undivided attention, no interruptions, no pre-think, use empathy, listen to tone and voice modulation, recapitulate points, etc.).

Module 4: Brainstorming**2 Hour**

- Use of group and individual brainstorming techniques to promote idea generation.
- Learning and showcasing the principles of documentation of team session outcomes

Module 5: Social and Cultural Etiquette**2 Hour**

- Need for etiquette (impression, image, earn respect, appreciation, etc)
- Aspects of social and cultural/corporate etiquette in promoting teamwork
- Importance of time, place, propriety and adaptability to diverse cultures

Module 6: Internal Communication**2 Hour**

- Use of various channels of transmitting information including digital and physical, to team members.

Pedagogy : Besides Face to Face Lectures (as theory would be limited only to 20% of the component and remaining 80% would be practical oriented), the focus would be primarily on blended learning/hybrid learning. This could include a flipped classroom approach that leverage project based learning, demonstration, group discussion, simulation as well as coaching, seminars and tutorials.

Materials : Audio video materials, Online Platform (SWAYAM), Future Skills platform

Assessment: Written evaluation, demonstration, assignments:

Some components aligned to NOS (SSC/N9005) IT-ITeS . The questions posed to the students would be a mix of MCQs, Scenario-based, logical reasoning, comprehension, simulations, etc. Do check the assessment at website like (<http://nac.nasscom.in/>)

Bibliography & Suggested Reading including audio video material :

Please check IT-ITeS Sector Skills Council readiness program namely Global Business Foundation Skills (GBFS) in website (<https://www.sscnasscom.com/ssc-projects/capacity-building-and-development/training/gbfs/>), and Generic and the entrepreneurial NOS at NSQF Level 4 -7.

1.9 Theory of Equations

(w.e.f. academic year 2020-21)

SEC-II

Theory: 2 credits
Theory: 2 hours /week

Objective: Students learn the relation between roots and coefficients of a polynomial equation, Descartes' rule of signs in finding the number of positive and negative roots if any of a polynomial equation besides some other concepts.

Outcome: By using the concepts learnt the students are expected to solve some of the polynomial equations.

Unit- I

Graphic representation of a polynomial-Maxima and minima values of polynomials-Theorems relating to the real roots of equations-Existence of a root in the general equation -Imaginary roots-Theorem determining the number of roots of an equation-Equal roots-Imaginary roots enter equations in pairs-Descartes' rule of signs for positive roots- Descartes' rule of signs for negative roots.

Unit- II

Relations between the roots and coefficients-Theorem-Applications of the theorem-Depression of an equation when a relation exists between two of its roots-The cube roots of unity Symmetric functions of the roots-examples.

Text:

- W.S. Burnside and A.W. Panton, *The Theory of Equations*

References:

- C. C. Mac Duffee, *Theory of Equations*
 - Hall and Knight, *Higher Algebra*
-

1.10 Logic and Sets

(w.e.f. academic year 2020-21)

SEC - II

Theory: 4 credits and Tutorials: 0 credits
Theory: 4 hours /week and
Tutorials: 1 hours/week

Objective: Students learn some concepts in set theory and logic.

Outcome: After the completion of the course students appreciate its importance in the development of computer science.

Unit- I

Basic Connectives and truth tables - Logical equivalence : Laws of Logic - Logical Implication :
Rules Inference : The Use of Quantifiers - Quantifiers, Definitions, and proofs of Theorems.

Unit- II

Sets and Subsets - Set Operations and the Laws of Set Theory - Counting and Venn Diagrams -
A First Word on Probability - The axioms of Probability - Conditional Probability: Independence
- Discrete Random variables .

Text:

- Ralph P Grimaldi, *Discrete and Combinatorial Mathematics* (5e)

References:

- P R Halmos, *Naïve Set Theory*
 - E Kamke , *Theory of Sets*
-

Course 3: Leadership and Management Skills

Context with Justification :

Leaders are foundations of the society, who face and win against adversities and odds of life. Through their words and deeds, they show path to others and transform into inspirational role models, affecting social life vividly. In the current times of cut-throat competitions, disbelief in values, techno-centric complex lifestyles, there is a dire need to emphasise the 'human' agency in community living. This can be done by cultivating and nurturing the innate leadership skills of the youth so that they may transform these challenges into opportunities and become torch bearers of the future by developing creative solutions.

Objectives :

The Module is designed to:

- Help students to develop essential skills to influence and motivate others
- Inculcate emotional and social intelligence and integrative thinking for effective leadership
- Create and maintain an effective and motivated team to work for the society
- Nurture a creative and entrepreneurial mindset
- Make students understand the personal values and apply ethical principles in professional and social contexts.

Expected Outcomes :

Upon completion of the course students will be able to:

1. Examine various leadership models and understand/assess their skills, strengths and abilities that affect their own leadership style and can create their leadership vision
2. Learn and demonstrate a set of practical skills such as time management, self management, handling conflicts, team leadership, etc.
3. Understand the basics of entrepreneurship and develop business plans
4. Apply the design thinking approach for leadership
5. Appreciate the importance of ethics and moral values for making of a balanced personality.

Credit: 02

Duration: 30 Hours

Number & Titles of Modules:

Module 1	Leadership Skills	6 Hours
Module 2	Managerial Skills	6 Hours
Module 3	Entrepreneurial Skills	6 Hours
Module 4	Innovative Leadership and Design Thinking	6 Hours
Module 5	Ethics and Integrity	6 Hours

Module Outline :

Module 1- Leadership Skills

6 Hours

a. Understanding Leadership and its Importance

- What is leadership?
- Why Leadership required?
- Whom do you consider as an ideal leader?

b. Traits and Models of Leadership

- Are leaders born or made?
- Key characteristics of an effective leader
- Leadership styles
- Perspectives of different leaders

c. Basic Leadership Skills

- Motivation
- Team work
- Negotiation
- Networking

Module 2 - Managerial Skills

6 Hours

a. Basic Managerial Skills

- Planning for effective management
- How to organise teams?
- Recruiting and retaining talent
- Delegation of tasks
- Learn to coordinate
- Conflict management

b. Self Management Skills

- Understanding self concept
- Developing self-awareness
- Self-examination
- Self-regulation

Module 3 - Entrepreneurial Skills

6 Hours

a. Basics of Entrepreneurship

- Meaning of entrepreneurship
- Classification and types of entrepreneurship
- Traits and competencies of entrepreneur

b. Creating Business Plan

- Problem identification and idea generation
- Idea validation
- Pitch making

Module 4 - Innovative Leadership and Design Thinking

6 Hours

a. Innovative Leadership

- Concept of emotional and social intelligence

- Synthesis of human and artificial intelligence
- Why does culture matter for today's global leaders

b. Design Thinking

- What is design thinking?
- Key elements of design thinking:
 - Discovery
 - Interpretation
 - Ideation
 - Experimentation
 - Evolution.
- How to transform challenges into opportunities?
- How to develop human-centric solutions for creating social good?

Module 5- Ethics and Integrity

6 Hours

a. Learning through Biographies

- What makes an individual great?
- Understanding the persona of a leader for deriving holistic inspiration
- Drawing insights for leadership
- How leaders sail through difficult situations?

b. Ethics and Conduct

- Importance of ethics
- Ethical decision making
- Personal and professional moral codes of conduct
- Creating a harmonious life

Pedagogy : Pedagogy for the modules is as follows:

1. Leadership Skills - Lectures (augmented with videos); role-plays for leadership models; team building games
2. Managerial Skills - Lectures (augmented with videos), case studies (AMUL, TESLA, Toyota, DMRC, Tata Group, Google, The Mumbai Dabbawala), SWOT analysis, Johari window
3. Entrepreneurial Skills - Lectures (augmented with videos), case studies and practicing business plans
4. Innovative Leadership and Design Thinking- Concept discussion through lecture and videos followed by role-plays and exercises for each set of intelligence, activities using 5 steps – discovery, interpretation, ideation, experimentation, and evolution (Ref.: Workbook of Design Thinking by IDEO)
5. Ethics and Integrity- Experiential learning through stories suggested list (Ahilya Bai, Holkar, Abdul Kalam, Raja Harishchandra, Mahatma Gandhi, Abraham Lincoln), audio visual augmented role plays and storytelling (leaders from varied fields like academics, corporate, social, sports, art, etc.)

Assessment : It can be combination of written evaluation and presentations, including simulations, case studies and business plan.

Bibliography and Suggested Readings :

Books

- Ashokan, M. S. (2015). *Karmayogi: A Biography of E. Sreedharan*. Penguin, UK.
- Brown, T. (2012). *Change by Design*. Harper Business
- Elkington, J., & Hartigan, P. (2008). *The Power of Unreasonable People: How Social Entrepreneurs Create Markets that Change the World*. Harvard Business Press.
- Goleman D. (1995). *Emotional Intelligence*. Bloomsbury Publishing India Private Limited
- Kalam A. A. (2003). *Ignited Minds: Unleashing the Power within India*. Penguin Books India
- Kelly T., Kelly D. (2014). *Creative Confidence: Unleashing the Creative Potential Within Us All*. William Collins
- Kurien V., & Salve G. (2012). *I Too Had a Dream*. Roli Books Private Limited
- Livermore D. A. (2010). *Leading with cultural intelligence: The New Secret to Success*. New York: American Management Association
- McCormack M. H. (1986). *What They Don't Teach You at Harvard Business School: Notes From A Street-Smart Executive*. RHUS
- O'Toole J. (2019) *The Enlightened Capitalists: Cautionary Tales of Business Pioneers Who Tried to Do Well by Doing Good*. Harpercollins
- Sinek S. (2009). *Start with Why: How Great Leaders Inspire Everyone to Take Action*. Penguin
- Sternberg R. J., Sternberg R. J., & Baltes P. B. (Eds.). (2004). *International Handbook of Intelligence*. Cambridge University Press.

E-Resources

- Fries, K. (2019). 8 Essential Qualities That Define Great Leadership. *Forbes*. Retrieved 2019-02-15 from <https://www.forbes.com/sites/kimberlyfries/2018/02/08/8-essential-qualities-that-define-great-leadership/#452ecc963b63>.
- How to Build Your Creative Confidence, Ted Talk by David Kelly - https://www.ted.com/talks/david_kelley_how_to_build_your_creative_confidence
- India's Hidden Hot Beds of Invention Ted Talk by Anil Gupta - https://www.ted.com/talks/anil_gupta_india_s_hidden_hotbeds_of_invention
- Knowledge@Wharton Interviews Former Indian President APJ Abdul Kalam - . "A Leader Should Know How to Manage Failure" <https://www.youtube.com/watch?v=laGZaS4sdeU>
- Martin, R. (2007). How Successful Leaders Think. *Harvard Business Review*, 85(6): 60.
- NPTEL Course on Leadership - <https://nptel.ac.in/courses/122105021/9>

Course 4: Universal Human Values

Context with Justification :

Human civilisation is known for the values that it cherishes and practices. Across various times and places, sages, saints and seers, drawing on their experience, developed practices that placed central importance on values, though the names used by them differed, as their languages varied but the spirit was same. Universal human values are values that human beings cherish and hold in common consciously and otherwise in most of the places and times and practice them.

Renunciation is the foundational value. Renunciation or greedlessness has two preconditions: love for all living beings and absence of selfishness. Renunciation is not self-directed but other-directed and is for life in all forms and shapes, for welfare of all. Renunciation begins when selfishness ends. Renunciation to run away from the problems of life is cowardice. Renunciation without action means parasitic life. Also, service can be practised only when renunciation with action begins. Unegoistical service is inconceivable without renunciation; and true service is possible only through love and compassion. Life and death are eternal truths, so is the truth as fact and truth as value. Truth exists between the two ends of life and death and is to be pursued.

Truth, Love, Peace, Non-Violence and Righteous Conduct are the Universal Human Values. Renunciation (sacrifice), Compassion and Service are also commonly acceptable human values, which at the operation level have been named differently as sincerity, honesty, righteousness, humility, gratitude, aspiration, prosperity, non-violence, trust, faith, forgiveness, mercy, peace and so on. These are needed for well-being of an individual, society and humanity and ultimately Peace in the world.

This course aims at making learners conscious about universal human values in an integral manner, without ignoring other aspects that are needed for learner's personality development.

Objectives :

The present course deals with meaning, purpose, and relevance of universal human values and how to inculcate and practice them consciously to be a good human being and realise one's potentials.

Learning outcomes :

By the end of the course the learners will be able to:

1. Know about universal human values and understand the importance of values in individual, social circles, career path, and national life.
2. Learn from case studies of lives of great and successful people who followed and practised human values and achieved self-actualisation.
3. Become conscious practitioners of human values.
4. Realise their potential as human beings and conduct themselves properly in the ways of the world.

Credit: 02

Duration: 30 Hours

Number & Titles of Modules:

Module 1: Love & Compassion

5 Hours

Module 2: Truth

5 Hours

Module 3: Non-Violence	5 Hours
Module 4: Righteousness	5 Hours
Module 5: Peace	4 Hours
Module 6: Service	3 Hours
Module 7: Renunciation (Sacrifice)	3 Hours

Module Outline :

Module 1: Love & Compassion **5 Hours**

- Introduction: What is love? Forms of love—for self, parents, family, friend, spouse, community, nation, humanity and other beings, both for living and non-living
- Love and compassion and inter-relatedness
- Love, compassion, empathy, sympathy and non-violence
- Individuals who are remembered in history for practicing compassion and love.
- Narratives and anecdotes from history, literature including local folklore
- Practicing love and compassion: What will learners learn gain if they practice love and compassion? What will learners lose if they don't practice love and compassion?
- Sharing learner's individual and/or group experience(s)
- Simulated Situations
- Case studies

Module 2: Truth **5 Hours**

- Introduction: What is truth? Universal truth, truth as value, truth as fact (veracity, sincerity, honesty among others)
- Individuals who are remembered in history for practicing this value
- Narratives and anecdotes from history, literature including local folklore
- Practicing Truth: What will learners learn/gain if they practice truth? What will learners lose if they don't practice it?
- Learners' individual and/or group experience(s)
- Simulated situations
- Case studies

Module 3: Non-Violence **5 Hours**

- Introduction: What is non-violence? Its need. Love, compassion, empathy sympathy for others as pre-requisites for non-violence
- Ahimsa as non-violence and non-killing
- Individuals and organisations that are known for their commitment to non-violence
- Narratives and anecdotes about non-violence from history, and literature including local folklore
- Practicing non-violence: What will learners learn/gain if they practice non-violence? What will learners lose if they don't practice it?
- Sharing learner's individual and/or group experience(s) about non-violence
- Simulated situations
- Case studies

Module 4: Righteousness**5 Hours**

- Introduction: What is righteousness?
- Righteousness and *dharma*, Righteousness and Propriety
- Individuals who are remembered in history for practicing righteousness
- Narratives and anecdotes from history, literature including local folklore
- Practicing righteousness: What will learners learn/gain if they practice righteousness? What will learners lose if they don't practice it?
- Sharing learners' individual and/or group experience(s)
- Simulated situations
- Case studies

Module 5: Peace**4 hours**

- Introduction: What is peace? Its need, relation with harmony and balance
- Individuals and organisations that are known for their commitment to peace
- Narratives and Anecdotes about peace from history, and literature including local folklore
- Practicing peace: What will learners learn/gain if they practice peace? What will learners lose if they don't practice it?
- Sharing learner's individual and/or group experience(s) about peace
- Simulated situations
- Case studies

Module 5: Service**3 Hours**

- Introduction: What is service? Forms of service, for self, parents, family, friend, spouse, community, nation, humanity and other beings—living and non-living, persons in distress or disaster.
- Individuals who are remembered in history for practicing this value.
- Narratives and anecdotes dealing with instances of service from history, literature including local folklore
- Practicing service: What will learners learn/gain if they practice service? What will learners lose if they don't practice it?
- Sharing learners' individual and/or group experience(s) regarding service
- Simulated situations
- Case studies

Module 6: Renunciation (Sacrifice)**3 Hours**

- Introduction: What is renunciation? Renunciation and sacrifice. Self-restrain and Ways of overcoming greed. Renunciation with action as true renunciation
- Individuals who are remembered in history for practicing this value.
- Narratives and anecdotes from history and literature, including local folklore about individuals who are remembered for their sacrifice and renunciation.
- Practicing renunciation and sacrifice: What will learners learn/gain if they practice Renunciation and sacrifice? What will learners lose if they don't practice it?
- Sharing learners' individual and/or group experience(s)
- Simulated situations
- Case studies

ADDITIONAL PRACTICAL MODULES or OPERATIVE ELECTIVES:

NOTE: The faculty/institution may choose any/some of the following modules keeping in mind the level and specific needs of learners.

Module Outline :

MODULE A - Integral Human Well-Being

5 Hours

Importance of well-being, inter-relatedness of different kinds of well-being and definition of well-being (state of being comfortable, healthy, happy and equanimity)

Well-being and its Kinds

- (i) Physical (physical strength and endurance)
- (ii) Emotional (ability to respond to emotions and control them)
- (iii) Aesthetic (faculty to see and appreciate beauty in all beings)
- (iv) Intellectual (rational, logical well-being)
- (v) Relational well-being (obligation to self, parents, family society, nation humanity and other beings in the universe; living with others with their acceptance)
- (vi) Moral (difference between good and evil and practicing goodness; righteousness)
- (vii) Spiritual (thinking beyond self and journey from senses to spiritual level)

Establish and recognise various states of well-being, embedded in different creatures, but consciously understood by humans

Identify the most pronounced emotions in the individual through given activities

Anecdotes/video/activity to help identify different well-beings

Discussion of related values to well-beings: Aesthetics, ethics, gratitude, forgiveness, and spiritual health i.e., thinking beyond senses and self and for the welfare of others

Importance and practice of well-being through case study/ activity

Ways to attain different kinds of well-being

Activities

MODULE B - Yoga & Pranayama

5 Hours

Importance of Yoga and Pranayama

- Yoga and pranayama for integral well-being and balance in life
- Yoga & Pranayama: Introduction
- Mind - Body – Intellect
- Difference between Yoga and Pranayama and their inter-relatedness.

1.11 Number Theory

(w.e.f. academic year 2020-21)

SEC-IV

Theory : 2credits Theory : 2 hours /week

Objective: Students will be exposed to some of the jewels like Fermat's theorem, Euler's theorem in the number theory.

Outcome: Student uses the knowledge acquired solving some divisor problems.

Unit- I

The Goldbach conjecture - Basic properties of congruences- Binary and Decimal Representation of Integers - Number Theoretic Functions; The Sum and Number of divisors- The Mobius Inversion Formula- The Greatest integer function.

Unit- II

Euler's generalization of Fermat's Theorem: Euler's Phi function- Euler's theorem Some Properties of the Euler's Phi function.

Text:

- David M Burton, *Elementary Number Theory* (7e)

References:

- Thomas Koshy, *Elementary Number Theory and its Applications*
- Kenneth H Rosen, *Elementary Number Theory*

1.12 Vector Calculus

(w.e.f. academic year 2020-21)

SEC-IV Theory:2credits
Theory:2hours/week

Objective: Concepts like gradient, divergence, curl and their physical relevance will be taught.

Outcome: Students realize the way vector calculus is used to address some of the problems of physics.

Unit- I

Line Integrals: Introductory Example - Work done against a Force-Evaluation of Line Integrals
Conservative Vector Fields.

Surface Integrals: Introductory Example : Flow Through a Pipe Evaluation of Surface Integrals.

Unit- II

Volume Integrals: Evaluation of Volume integrals

Gradient, Divergence and Curl: Partial differentiation and Taylor series-Partial differentiation
Taylor series in more than one variable-Gradient of a scalar field-Gradients, conservative fields and
potentials-Physical applications of the gradient.

Text:

- P.C. Matthews, *Vector Calculus*

References:

- G.B. Thomas and R.L. Finney, *Calculus*
 - H. Anton, I. Bivens and S. Davis ; *Calculus*
 - Smith and Minton, *Calculus*
-

1.13 Basic Mathematics

Generic Elective - V(A)

BS:502(A)

Theory: 4 credits and Tutorials: 0 credits
Theory: 4 hours /week and Tutorials: 1 hours /week

Objective: Students learn the techniques which have been applied successfully to an increasingly wide variety of complex problems in business. Also learn the scientific approach to managerial decision making.

Outcome: Student realizes how the quantitative analysis will be an aid to decision-making process. Also the quantitative analysis how it will be linked with other information in making decisions.

Unit- I

Coordinate Geometry: Fundamentals - Cartesian Coordinates system - Polar Coordinates - Distance Formula - Section Formula -Centroid of a Triangle - Area of a Triangle.(Chapter 11)

Unit- II

Straight Line: Introduction - Definitions of the Terms - Different Forms of the Equations of a Straight Line - Distance of a point from a Straight Line - Angle between two Lines and Condition of Parallelism and Perpendicularity of Lines - Point of intersection of Two Lines - Condition of Concurrency of Three Given Straight Lines - Position of a Point with respect to a given Line.(Chapter 13)

Unit- III

Matrices: Introduction - Definitions and Notations - Operations on Matrices - Determinant of a Square Matrix - Non Singular matrix and Singular Matrix - Sarrus Diagram for Expansion of Determinant of a matrix 3×3 - Properties of Determinants.(15.1,15.2,15.3,15.5.1,15.5.2,15.5.3 of Chapter 15)

Unit- IV

Linear System of Equations: Conversion of a business problem into a Linear System of Equations - Rank of a Matrix - Application of Rank concept - Minor and Cofactor - Adjoint of a Square matrix -Inverse of a Square Matrix - Matrix Equation - Methods to Solve Linear System of Equations - Solution to the linear system of Equations - Types of Solutions - Cramer” s rule - Matrix Inversion method. (15.4,15.5.4,15.5.5,15.5.6,15.5.7,15.5.8,15.6,15.7.1,15.7.2,15.7.3,15.7.4,15.7.4 of Chapter 15).

Text:

- P. Mariappan , *Business Mathematics*, Pearson Publication 2015, New Delhi.

1.14 Mathematics for Economics and Finance

Generic Elective - V(B)

BS:502(B)

Theory: 4 credits and Tutorials: 0 credits
Theory: 4 hours /week and Tutorials: 1 hours /week

Objective: Many models and problems in modern economics and finance can be expressed using the language of mathematics and analysed using mathematical techniques. The aim is to show how a range of important mathematical techniques work and how they can be used to explore and understand the structure of economic models.

Outcome: Student were chiefly interested in learning the mathematics that had applications to economics and finance. Students gain a familiarity with economics and finance principles and are confident in applying them.

Unit- I

Linear Equations: Introduction - Solution of Linear Equations - Solutions of Simultaneous Linear Equations - Graphs of Linear Equations - Budget Lines - Supply and Demand Analysis .
Quadratic Equations: Introduction - Graphs of Quadratic Functions - Quadratic Equations - Applications to Economics.

Unit- II

Functions of a Single Variable: Introduction - Limits - Polynomial Functions - Reciprocal Functions - Inverse Functions. **The Exponential and Logarithmic Functions:** Introduction - Exponential Functions - Logarithmic Functions - Returns to Scale of Production Functions - Compounding of Interest.

Unit- III

Matrices and Determinants: Introduction - Matrix Operations - Solutions of Linear Systems of Equations - Cramer's Rule - More Determinants - Special Cases.

Unit-IV

Linear Difference Equations: Introduction - Difference Equations - First Order Linear Difference Equations.

Text:

- Vassilis. C. Mavron and Timothy N. Phillips, *Elements of Mathematics for Economics and Finance*; Springer Publishers.

1.15 Mathematical Modeling

Project/ Optional - VI

BS:602

Theory: 4 credits and Tutorials: 0 credits
Theory: 4 hours /week and Tutorials: 1 hours /week

Objective: This topic aims to provide the student with some basic modelling skills that will have application to a wide variety of problems.

Outcome: The focus is on those mathematical techniques that are applicable to models involving differential equations, and which describe rates of change. Student realizes some beautiful problems can be modeled by using differential equations. The students also learn how to use the mathematical technique in solving differential equations.

Unit- I

Introduction to Mathematical Modelling: Mathematical Models-Modelling for decision making.

Compartmental Models: -Exponential decay and radioactivity - Case Study: Detecting art forgeries - Lake Pollution Models - First order Linear Differential Equations - Equilibrium points and stability.

Unit- II

Models of Single Populations: Exponential growth - Density-dependent growth - Limited growth with harvesting. **Interacting Population Models:** Model for an influenza outbreak -

Case Study: Cholera - Predators and prey - Competing Species.

Unit- III

Formulating Heat and Mass Transport Models: Some basic physical laws -Model for a hot water heater- Heat conduction and Fourier's Law - Heat conduction through a wall - Radiative heat conduction - Diffusion.

Unit- IV

Boundary Value Problems - Heat loss through a wall - Insulating a water pipe - **Introduction to**

Partial Differential Equations: The heat conduction equation - Oscillating soil temperatures

- **Case study:** Detecting Land Mines - Lake Pollution.

Text:

- 1. B.Barnes and G.R.Fulford, *Mathematical Modelling with Case Studies* 3rd Edition, 2009, CRC press.

References:

- 1. Shepley L. Ross, *"Differential Equations"*.
- 2. I. Sneddon, *Elements of Partial Differential Equations*
- 3. Zafar Ahsan, *"Differential Equations and their Applications"*

Few Websites

- NPTEL: nptel.ac.in
- COURSERA: www.coursera.org
- MITOCW: ocw.mit.edu
- ACADEMIC EARTH: www.academicearth.org
- EdX : www.edx.org
- KHAN ACADEMY :www.khanacademy.org
- ALISON: www.alison.com
- STANFORD ONLINE: www.online.stanford.edu
- VIDEO LECTURES: videlectures.net
- INTERACTIVE REAL ANALYSIS: mathcs.org
- VISUAL CALCULUS: archives.math.utk.edu/visual.calculus
- MOOCS CALCULUS: mooculus.osu.edu

Few Math Softwares

- Useful for Classroom teaching: *Geogebra (Freeware)*
- Type setting software: *LaTeX*
- High end commercial softwares: *Mathematica , Maple , Matlab*
- Answering search engine: www.wolframalpha.com
- Group theory software: *group explorer 2.2 (Freeware)*
- Visualization software: *Mathematics Visualization Toolkit (freeware)*

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