DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

M.Sc (Mathematics)

Vision of the Department:

The department of Applied Sciences is committed to inculcate expertise in the students in the field of basic sciences, technology and personality development so that they can make the world a better place.

Mission of the Department:

M1: Prepare the students' basics strongly to make a mark at global perspective.
M2: Culminate extraordinary analytical, logical and ethical skills to make them industry ready.
M3: Develop a good citizen and a good human being through all round development.

Program Educational Objectives (PEOs):

PEO1: Fundamental Knowledge: to attain skills in the fundamental concepts of basic sciences necessary for success in industry or in engineering practices as well as advanced study.
PEO2: Specialization: prepare to pursue career choices in all branches of engineering or related interdisciplinary fields that will benefit from a strong background in applied sciences and engineering.
PEO3: Design Skills: to imbibe with problem solving skills, laboratory skills, and design skills for technical careers in solving critical problems.

Program Outcomes (POs):

PO1Scientific Knowledge: To employ critical thinking and the scientific method to design not only with respect to science subjects but also in all aspects related to life.
PO2 Understanding and critical thinking: To demonstrate an understanding of major concepts in all disciplines of Science.
PO3 Problem analysis: To analyze the scientific data critically and systematically and the ability to draw the objective conclusions.
PO4 Design/development of solutions: To foster observation skills and drawing logical conclusions from the scientific experiments.
PO5 Conduct investigations of complex problems: To develop scientific temper to propose novel ideas in explaining facts and figures or providing new solution to the problems.
PO6 Scientist and Society: To cultivate rational outlook and analyze the results of experiments and get an awareness of the impact of Science on the environment, society, and other cultures outside the scientific commUnity.
PO7 Environment and sustainability: To imbibe with new ideas for the sustainable developments.

PO8 Ethics and Responsibility: To nurture ethical, social and moral values in personal and social life paving a path to highly cultured and civilized personality.
PO9 Management and projects: Enhancing To acquire the analytical skills in handling scientific instruments, planning and performing in laboratory experiments.
PO10 Individual and Team Work: To apply knowledge and experience to foster personal growth and appreciate the diverse social world in which we live.
PO11Modern tool usage: To provide technology-oriented skills, tools and ability to develop creative solutions and engage in continuing professional development.
PO12 Life-long learning: To attain the knowledge of subjects in other faculties such as humanities, performing arts, social sciences etc. can have greatly and effectively influence which inspires in evolving new scientific theories and inventions.

Program Specific Outcomes (PSO):

PSO1: To carry out experiments in basic as well as certain advanced areas of Mathematics such as Real Analysis, Algebra, Statistics, Linear Programming and Calculus.
PSO2: To build a scientific temper and to learn the necessary skills to succeed in research or industrial field.
PSO3: To be able to define and resolve new problems in Mathematicsand participate in future development of Mathematics.
PSO4: To develop strong student competencies in Mathematicsand its applications in a technology--rich, interactive environment
PSO5: Have necessary skills and expertise in field of research and development.

(U/S 2(f) and 12B of the UGC Act1956, NAAC Accredited)

DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

M.Sc (Mathematics)

1. **Duration of Course:**

1.1 The duration of Degree course shall be two academic years consisting of four (4) semesters i.e. two semesters in each year. The duration of each semester will be 18-20 weeks with ninety (90) teaching days.

1.2 The duration of Post-Graduate Diploma course shall be one academic years consisting of two (2) semesters i.e. two semesters in each year. The duration of each semester will be 18-20 weeks with ninety (90) teaching days

2. **Maximum period for passing M.Sc. Mathematics.**

2.1 The candidate must pass all the subjects of all the semesters of Degree course in M.Sc. Mathematics in two (2) years. If the candidate fails to pass all the subjects of the course within stipulated period, his/her registration will be cancelled.

2.2 The candidate must pass all the subjects of all the semesters of Post-Graduate Diploma course in M.Sc. Mathematics in one (1) years. If the candidate fails to pass all the subjects of the course within stipulated period, his/her registration will be cancelled.

3. **Eligibility for admission**

3.1 A candidate must be admitted to a two year Master's course with second year devoted entirely to research for those who have completed the three years Bachelor's course.

3.2 A candidate must be completed a four-years Bachelor's course withHonours/ Researchmay be admitted to a one year Master's course.

3.3 There may be an integrated five-year Bachleor's/Masters's Course.

3.4 The Entry Requirment for Masters's Course:

(i) A Bachelor's Degree (Honours/Research) for the one-year/two semester Master's degree course.

(ii) A Bachelor's Degree for the two-year/four semester Master's degree course.

(iii) A Bachelor's Degreefor the one-year/two semester Post-Graduate Diploma course.

4. **Medium of Instructions**

The medium of instruction during the course and examinations shall be Punjabi/Hindi/English.

5. **Examination Schedule, examination fee and examination forms:**

5.1 The examination of Odd Semesters shall ordinarily be held in the month of December and that of Even Semesters in the month of May, or on such other dates as may be fixed by the competent authority.

5.2 The candidates will be required to pay examination fees as prescribed by the University from time to time.

5.3 The Examination Form must reach in the office of the Controller of Examinations as per the schedule notified, from time to time.

5.4 The Examination Forms must be countersigned by the Director/Head of the Department along with the following certificate :--

(i) that he/she has been on the rolls of the University Teaching Department during the academic term preceding the end semester examination;

(ii) that he/she has attended not less than 75% lectures delivered to that class in each paper; and

(iii) That he/she has a good moral character.

5.5 The shortage in the attendance of lectures of the candidate may be condoned by the Vice-Chancellor, on the recommendations of Head of the Department, as per rules.

6. Re-admission

In case name of a student is struck off from the rolls due to non-payment of fee or continued absence from classes in any subject for one month and he/she will be re-admitted after payment of re-admission fee as prescribed by the University from time to time. However, the student will be allowed to appear in the end semester examination of that paper (s) only after attending the required lectures/practical delivered to that paper(s). However, if a student falls short of attendance in all courses offered in a semester, he/she shall be required to repeat the semester, along with the next batch of students.

7. Scheme of Examinations

The examination in each semester shall be conducted according to the syllabus prescribed for the semester. The end semester examination for each paper shall be of three hours duration.

8. Minimum pass marks

The minimum number of marks required to pass in each semester shall be 40% marks in each in Theory and Practical/Laboratory/Seminar/Viva-Voce paper and in Internal Assessment, separately.

9. Grading of performances

9.1 Letter grades and grade points allocations:

Based on the performances, each student shall be awarded a final letter grade at the end of the semester for each course. The letter grades and their corresponding grade points are given here under: -

Percentage of marksobtained	LetterGrade	Grade Points	Performance
90.00 – 100	O	10	Outstanding
80.00 – 89.99	A+	9	Excellent
70.00 – 79.99	A	8	Very Good
60.00 – 69.99	B+	7	Good
50.00 – 59.99	B	6	Average

40.00 – 49.99	C	5	Pass
Less than 40.00	F	0	Fail
Absent	AB	0	Fail

9.2 Grades from 'O' to 'C' are pass grades.

9.3 A student who fails in any end semester shall be assigned a letter grade 'F' and a corresponding grade point of zero. He/she should reappear for the said evaluation/examination in due course.

9.4 A student who remains absent for any end semester examination shall be assigned a letter grade of 'AB' and a corresponding grade point of zero.

Semester Grade Point Average (SGPA) = $(\sum C_i G_i) / (\sum C_i)$

Where C i = No. of credits assigned to ith semester
G i = No. of Grade equivalent point assigned to ith semester.

$$\text{Cumulative Grade Point Average (CGPA)} = \frac{\sum (SGPA_j \times C_j)}{\sum C_j}$$

Where $SGPA_j$ = SGPA score of jth semester
C_j = Total no. of credits in the jth Semester

9.5 Percentage can be calculated as CGPA *10

10. Declaration of class and Division

The class shall be awarded on the basis of CGPA as follows:

CGPA: ≥7.5 provided that the candidate must have passed all the Semester Examinations in the first available attempt.	First Division with Distinction
CGPA: 6.0 to 7.49	First Division
CGPA: 5.0 to 5.99	Second Division
CGPA: 4.0 to 4.99	Third Division

11. Internal Assessment of failed candidate

The internal assessment award of a candidate who fails in the external examination shall be carried forward to the next Examination, if passed in Internal Assessment.

12. Grace Marks

12.1 The grace marks of 1% of total marks of the semester shall be given to a candidate to his best advantage so as to enable him to pass in one or more written papers, to make up aggregate to pass the examination/paper or for changing the result from FAIL to COMPARTMENT/PASS. If a fraction works out to be half or more, it shall be counted as one mark and fraction less than half shall be ignored

12.2 If a candidate appears in an examination to clear re-appear/compartment paper, the grace marks of 1% will be given only on the total marks of that particular paper.

13. **Re-evaluation**

A candidate who is not satisfied with his result may apply to the Examination Branch for re-evaluation in a subject/paper within 15 days of declaration of result along with a fee as prescribed by the university from time to time.

14. **Re-checking**

A candidate who is not satisfied with his result may apply to the Examination Branch for re-evaluation in a subject/paper within 15 days of declaration of result along with a fee as prescribed by the university from time to time.

15. **Special examination**

A Special Examination will be conducted for those students who are passing out but having re-appear(s) in the last semester and/or in the lower semesters. The special examination will be conducted within one month of the declaration of final semester result. The student shall have to pay prescribed fee for Special Examination.

16. **Re-appear/Supplementary examination**

In case of re-appear examination, the University will adopt even/odd semester examination or open semester system. The student will be eligible to appear in the re-appear papers of odd semester along with the odd semester regular examinations of subsequent batches and re-appear of even semester's paper of the even semester regular examinations in the case of even/odd semester examination. The student will be eligible to appear in the re-appear papers of all semesters (even/odd) along with regular examinations of open semester examinations. Controller of Examination will implement any of the above examination system with the approval of the Vice-Chancellor.

17. **Mercy Chance**

The candidate will be given maximum two chances to appear in the supplementary examinations. After that, mercy chance may be given by the Vice-Chancellor on the recommendations of the Director of the concerned school on payment of a special fee.

18. **Syllabus for re-appear candidates**

A student who obtains re-appear(s) in a subject will be examined from the same syllabus which he/she studied as a regular student.

19. **Promotion Criteria**

19.1 A candidate who joins First Semester of M.Sc. Mathematics may on completing attendance requirements appear in 1st semester examination. He/she shall be allowed to continue his/her studies in the 2nd Semester evenif he/she does not clear any paper of the 1st semester and on completing attendance requirements may appear in the 2nd Semester examination.

19.2 A candidate shall not be eligible to join 3rd Semester of M.Sc. Mathematics if he/she has yet to clear more than 50% papers of First and Second Semesters taken together.

A candidate who has cleared 50% or more papers of M.Sc. Mathematics 1st and 2nd Semesters taken together may join 3rd Semester and on completing attendance requirements may take 3rd Semester Examination. He/she shall be allowed to continue his/her studies in the 4th Semester even if he/she does not clear any paper of the 3rd Semester and on completing attendance requirements may appear in 4th Semester examination.

20. **Division Improvement**

A candidate who has passed M.Sc. Mathematics examination from this University may re-appear for improvement of division in one or more subjects in the succeeding semesters with regular candidates in order to increase the percentage for obtaining higher division. However, final year candidates who have passed an examination of the University may re-appear for improvement of performance under special examination as per rules of the university.

21. **Migration to this University**

21.1 Migration to this Universitywill be allowed only after completion of the 1st year and is applicable only to those students who are eligible to register for 3rd semester.

21.2 Migration shall be allowed after completion of the second semester but before start of the 3rd semester.

21.3 The candidates shall not be allowed to change his/ her discipline of study in the process of migration.

21.4 Migration to an affiliated College /Institute of the University from other recognized universities will be allowed 15 days prior to of the start of the 3rd semester. The following conditions shall be applying: -

i) The candidate should have passed all the courses of the first year of the University from where he/she wants to migrate.

ii) The courses studied by the candidate in first year must be equivalent to the courses offered in this University. Deficiency, if any, should not be of more than two subjects. The candidate would be required to furnish an undertaking that he/she will attend classes and pass these courses (found deficient). The institute and the University where the student is studying and the Institute, to which migration is sought, have no objection to the migration.

iii) There is a vacant seat available in the discipline in the college in which migration is sought.

22. **Power of Relaxation:**

Notwithstanding the existing Migration Rules, the Vice-Chancellor, after obtaining an undertaking/affidavit from the candidate, to his satisfaction, to be recorded in writing, shall be authorized to consider the migration for the cases that are not otherwise covered under the above Migration Rules, with the approval of the Chancellor.

23. **Migration to any other University**

23.1 Migration to any other University will be allowed 15 days prior to of the start of the 3rd semester.

23.2 The candidate seeking migration from this University shall be apply for the approval of his migration to the University within 15 working days after passing the 2nd

Semester/First Year Examination.

23.3 The Director/Head of the department concerned of the University will issue "No Objection Certificate" after the candidate has paid all the fees due for the remaining period of the full session as well as the annual dues as per rules. In addition to the above, Migration fee as prescribed by the University shall be charged from such candidates.

23.4 If a candidate, on completion of any course, applies for Migration Certificate, the same shall be issued on receipt of fee prescribed for Migration Certificate and on completion of other formalities etc.

24. Award of Detail Marks Card

Each candidate of First Year M.Sc. Mathematics (i.e. Semester-I & Semester-II) and Second Year (i.e. Semester-III & Semester-IV) on successfully completion of course and passing all the papers of each semester, shall be supplied Detail of Marks Cards indicating CGPA score and Division obtained by him/her in the examination.

25. Award of Degree

25.1 The Post-Graduate Diploma of Master of Science in Mathematics in the concerned stream stating the CGPA score and Division will be awarded to the candidate who has successfully completed the course and passed all the papers of all the semesters. The degree will be awarded at the University Convocation. However, a degree in absentia can be issued before the convocation, on completion of required formalities and payment of prescribed fee.

25.2 The degree of Master of Science in Mathematics in the concerned stream stating the CGPA score and Division will be awarded to the candidate who has successfully completed the course and passed all the papers of all the semesters. The degree will be awarded at the University Convocation. However, a degree in absentia can be issued before the convocation, on completion of required formalities and payment of prescribed fee.

(U/S 2(f) and 12B of the UGC Act1956, NAAC Accredited)

DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Program: M. Sc (Mathematics)

Semester I

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1.	MSCM-101	Real Analysis-I	CC	40	60	100	2	2	0	3
2.	MSCM-102	Algebra -I	CC	40	60	100	2	2	0	3
3.	MSCM-103	Differential Geometry	CC	40	60	100	2	2	0	3
4.	MSCM-104	Differential Equations	CC	40	60	100	2	2	0	3
Department Elective Courses (Select Any One)										
5.	MSCM-105	Discrete Mathematics	DE	40	60	100	2	2	0	3
6.	MSCM-106	Numerical Analysis	DE	40	60	100	2	2	0	3
Life Skill Courses										
7.	DBEF-101	Foundations of Employability Skills	LSC	40	60	100	1	0	4	3
Total				240	360	600	11	10	4	18

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course

Course Code: MSCM-101
Title of the Course: Real Analysis–I

L	T	P	Credits
2	2	0	3

Course Outcomes:
After completion of this course, students will be able to
CO1: Describe fundamental properties of the real numbers that lead to the formal development of real analysis.
CO2: Comprehend the concept of R-S integration and fundamental theorems.
CO3: Demonstrate an understanding of limits and how that is used in sequences, series along with the concept of Uniform convergence and continuity.
CO4: Understand how abstract ideas and regions methods in mathematical analysis can be applied to important practical problems.
CO5: Understand the differentiation and other properties of Functions of several variables.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
(CO's)	Program Outcomes(PO's)											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	S	M	S	M	M	S	M	W	W	S	S	M
CO2	S	S	S	M	S	W	M	W	M	M	M	W
CO3	S	S	M	M	M	W	M	M	W	S	W	M
CO4	S	M	S	S	S	M	W	W	M	S	M	S
CO5	S	S	M	M	M	S	M	S	W	M	S	M

Unit	Course Outline	Hour(s)
I	**Metric Spaces:** Definition and examples, The Euclidean space R^K as a metric space, Neighborhoods, Open and Closed sets, Interiors, Closures and Relative open sets.Compactness, Compactness of k- cells in R^K, Weierstrass Theorem, Perfect sets, Cantor set, Connected sets in R^1.	**9**
II	**Riemann- Stieljes Integration**: Definition and Existence of Riemann-Stieljes Integral, Properties of Integral, Integration and Differentiation, The Fundamental Theorem of Calculus, Change of Variables, Integration of vector valued functions, Rectifiable Curves, Uniform convergence and continuity, Uniform convergence and Riemann-Stieljes Integration, Uniform convergence and Differentiation, Stone-Weierstrass Theorem.	**9**
III	Rearrangement of terms of a series, Riemann's Theorem. Power series, uniqueness theorem for power series, Abel's theorem and Tauber's theorem. Exponential and Logarithmic functions. Trigonometric functions. Fourier series.	**9**

IV	Functions of several variables, Linear transformations, Derivatives in an open subset of R^n, Chain Rule, Partial derivatives, Interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem, Inverse function theorem, Implicit function theorem.	**9**

Total: 36

Textbooks:

1. W. Rudin, Principles of Mathematical Analysis, Mc-Graw Hill, 1976.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, 2010.

References Books:

1. H. L. Royden, Real Analysis, Macmillan Publishing Company, 1998.
2. T. Tao, Analysis I, Hindustan Book Agency, 2006.
3. T. Tao, Analysis II, Hindustan Book Agency, Springer, 2015.
4. T. M. Apostol, Mathematical Analysis, Addison-Wesley, 1974.
5. G. F. Simmons, Topology and Modern Analysis, Kreiger, 2003.
6. C. C. Pugh, Real Mathematical Analysis, Springer, 2002.
7. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, Wiley, 2000.

E-book Links:

1. https://fac.ksu.edu.sa/sites/default/files/royden.pdf [1]
2. https://lms.umb.sk/pluginfile.php/111477/mod_page/content/5/TerenceTao_Analysis.I.Third.Edition.pdf [2]

References Links:

1. https://swayam.gov.in/nd1_noc20_ma03/preview
2. https://nptel.ac.in/courses/111/106/111106053/

Course Code: MSCM-102
Title of the Course: Algebra–I

L	T	P	Credits
2	2	0	3

Course Outcomes:
On satisfying the requirements of this course, students will have the knowledge to:
CO1: Understand different properties of permutation groups and concept of solvable group.
CO2: Demonstrate accurate and efficient use of algebraic properties and theorems.
CO3: Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts of Ideals.
CO4: Apply problem-solving using algebraic techniques applied to diverse situations in other mathematical areas.
CO5: Apply different properties and theorems of algebraic structures and homomorphism.

CO/PO mapping
(S/M/W indicates strength of correlation)S- Strong , M-Medium , W- Weak

CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	S	M	S	M	W	M	M	M	M	M
CO2	S	M	M	S	M	W	W	M	M	S	M	S
CO3	S	S	M	M	S	M	M	W	S	M	S	S
CO4	S	S	S	S	S	M	M	M	S	S	S	M
CO5	S	M	S	S	M	W	M	M	M	M	W	M

Unit	Course Outline	Hour(s)
I	**Group Theory:** Normal and subnormal Series, Jordan Holder theorem for finite groups, Fundamental theorem of arithmetic, solvable groups, Nilpotent groups, Zassenhaus Lemma, Scherer's refinement theorem and Jorden Holder theorem for groups (not necessarily finite).	**9**
II	**Group Theory:** Review of permutation groups, Alternating group An, simplicity of An, Structure theory of groups, Direct products, Fundamental theorem of finite abelian groups. Invariants of finite abelian groups, Sylow theorems, Groups of order P2, pq	**9**
III	**Ring Theory:** Ideals, Ring homomorphism, algebra of ideals: sum and direct sum of ideals, maximal and prime ideals, Nilpotent and nil ideals, Statement of Zorn's Lemma, Field of Quotients of integral domain.	**9**

IV	**Vector Space:** Review of vector spaces, Equal spaces, dual Bases, second dual space, Reflexivity, Annihilators, inner product spaces, Schwarz inequality, Gram-Schmidt orthogonalisation process.	**9**

Total:36

Text Books:

1. S. Singh and Q. Zameruddin, Modern Algebra, Vikash Publishing House, 2006
2. K. Hoffman and R. Kunz, Linear Algebra, Prentice Hall, 1965

Reference Books:

1. Seymour Lipschutz, Schaum's Outline ofLinear Algebra, The McGraw-Hill Companies, Inc., 2013
2. I. N.Herstein, Topics in Algebra, John Wiley& Sons, 1975.
3. C. Musili, Introduction to Rings and Modules, Narosa Publishing House, 1994
4. D. S. Malik, J.M. Mordeson and M. K. Sen, Fundamentals of Abstract Algebra, McGrawHill Company, 1997
5. K. B. Datta, Matrix and linear algebra, PHI Pvt. Limited, 2004

E-book Links:

1. http://www.astronomia.edu.uy/progs/algebra/Linear_Algebra,_4th_Edition__(2009)Lipschutz-Lipson.pdf [1]

References Links:

1. https://nptel.ac.in/courses/111/101/111101115/
2. https://nptel.ac.in/courses/111/106/111106051/

Course Code: MSCM-103
Title of the Course: Differential Geometry

L	T	P	Credits
2	2	0	3

Course Outcomes:
On satisfying the requirements of this course, students will be able to:
CO1: Explain the representation of curves, properties of curves and contact between curves and surfaces.
CO2: Understand the concept of involute and evolute, spherical indicatrix along with tangent vectors, their length and angle between them.
CO3: Apply Gauss and Weingarten formulae for problem-solving and understand the concept of geodesic curvature.
CO4: Understand different types of curvature and surfaces along with their properties.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong , M-Medium , W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	W	M	W	M	M	M	M
CO2	S	M	M	S	M	M	M	W	S	M	S	M
CO3	S	S	S	S	S	W	W	S	M	S	M	W
CO4	S	M	S	M	M	M	W	M	M	S	M	M

Unit	Course Outline	Hour(s)
I	A simple are, Curves and their parametric representation, are length and natural parameter, contact of curves, Tangent to a curve, osculating plane, Frenettrihedron, Curvature and Torsion, SerretFrenet formulae, fundamental theorem for spaces curves, helices, contact between curves and surfaces.	**9**
II	Evolute and involute, Bertrand Curves, spherical indicatrix, implicit equation of the surface, Tangent plane, the first fundamental form of a surface, length of tangent vector and angle between two tangent vectors, area of a surface.	**9**
III	The second fundamental form, Gaussian map and Gaussian curvature, Gauss and Weingarten formulae, the Christoffel symbols, Codazzi equation and Gauss theorem, curvature of a curve on a surface, geodesic curvature.	**9**
IV	Geodesic, normal curvature, principal curvature, Mean Curvature, principal directions, lines curvature, Rodrigue formula, asymtotic Lines, conjugate directions, envelopes, developable surfaces associated with spaces curves, minimal surfaces, ruled surfaces.	**9**
		Total: 36

Text books:

1. Kuhnel, Wolfgang. Differential Geometry: Curves – Surfaces – Manifolds. Student mathematical library, vol. 16. Providence, RI: American Mathematical Society, 2002.
2. Pressley, Andrew. Elementary Differential Geometry. Springer undergraduate mathematics series. London, UK: Springer, 2002.

References Books:

1. Weatherburn, C.E., Differential Geometry of Three Dimensions, Cambridge University Press, 2016.
2. Willmore, T.J., Introduction to Differential Geometry, Dover Publications Inc., United States, 2012.

E-book Links:

1. https://ia800705.us.archive.org/28/items/differentialgeom003681mbp/differentialgeom003681mbp.pdf [1]

References Links:

1. https://ocw.mit.edu/courses/mathematics/18-950-differential-geometry-fall-2008/index.html

Course Code: MSCM-104
Title of the Course: Differential Equations

L	T	P	Credits
2	2	0	3

Course Outcomes:
After completion of this course, students will be able to:
CO1: Apply concept of existence and uniqueness theorems for calculating solutions of differential equations.
CO2: Solve nth order differential equations along with recognization of dependency of solutions on initial conditions and parameters.
CO3: Solve homogenous, non homogenous linear differential equations and understand the concept ofadjoint and self adjoint system of differential equations with their properties.
CO4: Calculate characteristic values and functions from Sturm Liouville boundary value problem.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong , M-Medium , W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	W	W	M	M	S	M	M
CO2	S	S	S	S	S	M	W	W	M	S	M	M
CO3	S	M	S	M	S	M	M	M	S	M	S	S
CO4	S	S	M	M	M	W	W	M	M	S	M	W

Unit	Course Outline	Hour(s)
I	Existence of solution of ODE of first order, initial value problem, Ascoli's Lemma, Gronwall's inequality, Cauchy Peano Existence Theorem, Uniqueness of Solutions. Method of successive approximations, Existence and Uniqueness Theorem.	**9**
II	System of differential equations, nth order differential equation, Existence and Uniqueness of solutions, dependence of solutions on initial conditions and parameters.	**9**
III	Linear system of equations (homogeneous & non homogeneous). Superposition principle, Fundamental set of solutions, Fundamental Matrix, Wronskian, Abel Liouville formula, Reduction of order, Adjoint systems and self adjoint systems of second order, Floquet Theory.	**9**

IV	Linear 2^{nd} order equations, preliminaries, Sturm's separation theorem, Sturm's fundamental comparison theorem, Sturm Liouville boundary value problem, Characteristic values & Characteristic functions, Orthogonality of Characteristic functions, Expansion of a function in a series of orthonormal functions.	**9**

Total:36

Textbooks:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, McGraw-Hill, 1955.
2. G.F. Simmons, Differential Equations with Applications and Historical Notes, 2ndEd,McGraw- Hill, 1991.
3. R.P. Agarwal and D. O'Regan, An Introduction to Ordinary Differential Equations, Springer- Verlag, 2008.

References Books:

1. G. Birkhoff and G.-C. Rota, Ordinary Differential Equations, John Willey and Sons, 4th Ed., 1989.
2. R.P. Agarwal and R.C.Gupta, Essentials of Ordinary Differential Equations, McGraw-Hill, 1993.
3. E.A. Coddington an, An Introduction to Ordinary Differential Equations, PHI Learning 1999.
4. M. Braun, Differential Equations and Their Applications, 3rdEd., Springer-Verlag, 1983.
5. S. G. Deo, V. Raghavendra, R. Kar and V. Lakshmikantham, Textbook of Ordinary Differential Equations, McGraw Hill Education, 3rd Ed., 2015.
6. G.F. Simmons and S.G. Kantz, Differential Equations: Theory, Technique and Practice, Tata McGraw-Hill, 2007.

E-Book Links:

1. http://www.burhantiryakioglu.com/wpcontent/uploads/2015/06/Ravi_P._Agarwal_Donal_ORegan_An_Introduction_tBookZZ.org_.pdf [2]

References Links:

1. https://nptel.ac.in/courses/111/106/111106100/

Course Code: MSCM-105
Title of the Course: Discrete Mathematics

L	T	P	Credits
2	2	0	3

Course Outcomes:
Upon successful completion of this course, the student will be able to:
CO1: Understand the concept of set theory, lattice and their properties.
CO2: Demonstrate different traversal methods for trees and graphs.
CO3: Write an argument using logical notation and determine if the argument is valid or not.
CO4: Understand the concept of Boolean algebra and its applications.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong , M-Medium , W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	W	W	M	M	S	M	M
CO2	S	S	S	S	S	M	W	W	M	S	M	M
CO3	S	M	S	M	S	M	M	M	S	M	S	S
CO4	S	S	M	M	M	W	W	M	M	S	M	W

Unit	Course Outline	Hour(s)
I	**Lattices:** Lattices as Partially Ordered Sets. Their Properties, Lattices as algebraic Systems, Sublattices, Direct Product and homomorphisms. Some Special Lattices e.g. Complete, Complemented and Distributive Lattices, Isomorphic Lattices. Join Irreducible elements. Atoms.	9
II	**Boolean Algebra:** As Lattices, Various Boolean identifies, The switching Algebra Example, Sub Algebras, Direct Production and Homomorphisms. Boolean Forms and their Equivalence, Minterm Boolean forms, Sum of Products Canonical Forms, Minimization of Boolean Functions, Application to Switching Theory, The Karnaugh Map Method.	9
III	**Graph Theory:** Definition of (undirected, Multigraphs, Subgraphs, Paths, Circuits, cycles, Induced Subgraphs, degree of vertex, Connectivity, Planar graphs, Euler's theorem, Directed Graphs, Warshall's Algorithm of shortest paths, Regular and Bipartite Graphs, Kuratowski's Theorem.	9
IV	Trees, Spanning Trees, Cut Sets, Fundamental Cut sets and Cycles, Minimal Spanning Trees and Kruskal's Algorithm, Matrix representation of graphs, Euler's Theorem on the existence of Eulerian paths and circuits. Directed Graphs, indegree and Outdegree of vertex. Directed trees, Search trees, Tree Traversals.	9
		Total:36

Textbooks:

1. C. L. Liu, Elements of Discrete Mathematics, Second Edition, McGraw Hill 1985.
2. J. L. Mott, A. Kandel and T. P. Baker,Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall India, 2nd Ed., 1986.

References Books:

1. F. Harary, Graph Theory, Narosa, 1969.
2. H. C. Thomas, C. E. Leiserson, R. L. Rivest and C.Stein,An Introduction to Algorithms, MIT Press and McGrawHill, 2nd Ed.,2001.

E-Book Links:

1. https://edutechlearners.com/download/Introduction_to_algorithms-3rd%20Edition.pdf [2]
2. https://cs.bme.hu/fcs/graphtheory.pdf [1]

References Links:

1. https://nptel.ac.in/courses/111/106/111106086/
2. https://nptel.ac.in/courses/111/107/111107058/

Course Code: MSCM-106
Title of the Course: Numerical Analysis

L	T	P	Credits
2	2	0	3

Course Outcomes:
After completion of this course, Students will be able to:
CO1: Describe errors involved in computations and to estimate the errors.
CO2: Solve algebraic and transcendental equations & Simultaneous Algebraic Equations using different directs and iteration methods.
CO3: Solve differential equation using numerical methods. (Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4th order, Predictor-Corrector methods)

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	M	S	M	S	W	S	M	S	S
CO2	S	S	M	S	M	M	M	M	S	S	M	M
CO3	S	M	S	S	M	S	S	S	M	M	S	M

Unit	Course Outline	Hour(s)
I	**Approximation and Errors:** Significant digits, Types of errors, absolute and relative error. Errors in numerical calculations, Absolute, relative and percentage errors, Round off and truncation errors, Error propagation, Loss of significant digits, Errors in series approximation.	9
II	**Solution of Algebraic and Transcendental Equations:** Solution of Algebraic and Transcendental Equations: Graphical Method, Bisection Method, False Position (Regula-Falsi) Method, Secant Method, Iteration Method, Newton-Raphson Method.	9
III	**Solution of Simultaneous Algebraic Equations:** Solution of Simultaneous Algebraic Equations through different Direct & Iteration Methods Direct Methods: Gauss Elimination Method, Gauss Jordan Method, Triangularisation Method (Method of Factorisation), Iteration Methods: Gauss-Jacobi Method, Gauss-Seidal Method, Relaxation Method.	9
IV	**Numerical Methods for Differential Equations:** Solution of first order differential equations using Euler's method, modified Euler's method and Runge-Kutta 4th order	9

	method, Predictor- Corrector methods (Adam's and Milne's method), Simultaneous differential equations of first order, Finite difference method.	

Total: 36

References Books:

1. Introductory Methods of Numerical Analysis: S.S. Sastry, Prentice Hall India.
2. Engineering Mathematics: N.P. Bali and Dr. N.Ch.S. NarayanaIyengar
3. Numerical Methods for Mathematics, Science and Engineering: Mathews, Prentice Hall.
4. An Introduction to Numerical Analysis: Atkinson, John Wiley.
5. Introductory Methods of Numerical Analysis: S.S. Sastry, Prentice Hall India.
6. Engineering Mathematics: N.P. Bali and Dr. N.Ch.S. NarayanaIyengar
7. Numerical Methods for Mathematics, Science and Engineering: Mathews, Prentice Hall.
8. An Introduction to Numerical Analysis: Atkinson, John Wiley.

Course Code: DBEF-101
Title of the Course: Foundations of Employability Skills

L	T	P	Credits
1	0	4	3

The course is designed to achieve superior outcomes of placement, retention and progression of students through 21' century employability skills' training and assessment.

Skills development network shall provide Vocational curricula and e-content for high quality employability and work skills training through an online learning platform

(U/S 2(f) and 12B of the UGC Act1956, NAAC Accredited)

DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Program: M.Sc (Mathematics)

Semester II

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1.	MSCM-201	Real Analysis-II	CC	40	60	100	2	2	0	3
2.	MSCM-202	Algebra-II	CC	40	60	100	2	2	0	3
3.	MSCM-203	Complex Analysis	CC	40	60	100	2	2	0	3
4.	MSCM-204	Linear Algebra	CC	40	60	100	2	2	0	3
Department Elective Courses (Select Any One)										
5.	MSCM-205	Number Theory	DE	40	60	100	2	2	0	3
6.	MSCM-206	Fourier Analysis & Applications	DE	40	60	100	2	2	0	3
Life Skill Courses										
7.	DBES-101	EVS	LSC	40	60	100	3	0	2	4
Total				240	360	600	13	10	2	19

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course

Course Code: MSCM-201
Title of the Course: Real Analysis–II

L	T	P	Credits
2	2	0	3

Course Outcomes:
After completion of this course, students will be able to:
CO1: Understand the concept of measurability and properties of measurable sets.
CO2: Recognize different measurable functions and their applications.
CO3: Apply various convergence theorem proofs in field of Lebesgue integral.
CO4: Understand the concept of function of bounded variation along with dini derivatives.
CO5: Apply approximation in L^Pspaces.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	M	M	W	W	M	M	M	M	M
CO2	S	M	S	M	M	W	W	M	M	S	M	S
CO3	S	S	M	S	S	M	M	W	S	M	S	S
CO4	S	S	S	S	S	M	M	M	S	S	S	M
CO5	S	M	M	S	S	W	S	S	M	S	W	M

Unit	Course Outline	Hour(s)
I	**Lebesgue measure:** Introduction, outer measure, Lebesgue measure, Measurable sets, properties of measurable sets, Borel sets and their measurability, Non measurability sets.	9
II	**Measurable functions:** Definitions and properties of measurable function, step function, characteristics function, Simple function. **Lebesgue integral:** Lebesgue integral of bounded function, Properties of Lebesgue integral, Integration of non-negative measurable functions, Fatou's lemma, Monotone convergence theorem, Lebesgue convergence theorem, General Lebesgue integral, Integration of series, Comparison of Riemann and Lebesgue integrals.	9
III	**Differentiation and integration:** Differentiation and integration; Dini derivatives. Functions of bounded variation, Vitalis Cover, Vitalis Lemma, Lebesgue differentiation theorem, Differentiation of an Integral, Absolute Continuity.	9
IV	**L^P spaces:** L^P spaces, Convex Functions and Jensens inequality, Holder and Minkowski's inequalities, Riesz Fisher Theorem, Approximation in L^P, Bounded Linear Functionals on the	9

	L^Pspaces; The Riesz Representation Theorem.	

Total: 36

Text Books:

1. S.C. Malik and SavitaArora, Mathematical Analysis, New Age International Private Limited, 2017
2. H.L. Royden, Real Analysis, Prentice Hall of India, 2011
3. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, Anshan Ltd., 2012

Reference Books:

1. R.R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing, 2012.
2. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill Education, 1976

E-Book Links:

1. https://merounak.files.wordpress.com/2016/02/methods-of-real-analysisrichard-r-goldberg.pdf [1]

Reference Links:

https://nptel.ac.in/courses/111/105/111105098

Course Code: MSCM-202
Title of the Course: Algebra-II

L	T	P	Credits
2	2	0	3

Course Outcomes:
On satisfying the requirements of this course, students will be able to:
CO1: Explain the fundamental concepts of algebraic structures Group & Field and their role in different areas of mathematics
CO2: Understand the concept of Modules and its properties.
CO3: Apply different theorems and results of Vector algebra in the field of modules and its properties.
CO4: Understand the concepts of different types of Modules and its various properties.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	S	M	S	M	W	M	M	M	M	M
CO2	S	S	M	S	M	W	W	M	M	S	M	M
CO3	S	S	S	M	S	M	M	W	S	M	S	S
CO4	S	M	S	M	S	W	M	M	S	M	W	M

Unit	Course Outline	Hour(s)
I	**Group Theory:** Review of group theory, subgroup, Homomorphism, normal subgroup, Normal Quotient group, Composition series, Jordan Holder theorem, Solvable group, Nilpotent group, Conjugate element, class equation for a finite group, Sylow p-subgroup, Sylows theorem and applications.	9
II	**Field Theory:** Algebraic and transcendental extensions, Separable and inseparable extensions, Normal extensions, Perfect fields, Finite field, Primitive elements, Algebraically closed fields, Automorphism of extensions, Gralosis extensions, Fundamental theorem of Gralosis theory.	9
III	**Modules:** Review of vector space, modules, submodules, quotient modules, free modules, difference modules and vector, Homomorphism of modules, simple module, Modules of PID.	9
IV	**Modules with chain conditions:** Artinian Modules, Noetherian Modules, composition series of a module, Length of a module, Hilbert Basis Theorem.	9
		Total: 36

Textbooks:

1. J.A. Gallian, Contemporary Abstract Algebra, Narosa, 4th Ed., 1999.

2. I. N. Herstein,Topics in Algebra, John-Wiley, 1995.

References Books:

1. M.Artin, Algebra, Prentice Hall Inc., 1994.
2. T. A. Hungerford, Algebra, Graduate Texts in Mathematics, Vol. 73, Springer-Verlag, 1980.
3. D. S. Dummit and R. M. Foote, Abstract Algebra, John-Wiley, 2nd Ed., 1999.
4. S. Lang, Algebra, Addison-Wesley, 3rd Ed., 1999. 5. J. B.Fraleigh,A First Course in Abstract Algebra, Pearson, 7thEd., 2003.

E-Book Links:

1. https://solisinvicti.com/books/TheOlympiad/Books/AlgebraArtin.pdf [1]

Course Code: MSCM-203
Title of the Course: Complex Analysis

L	T	P	Credits
2	2	0	3

Course Outcomes:
Upon successful completion of this course, the student will be able to:
CO1: Know the condition(s) for a complex variable function to be analytic and/or harmonic
CO2: State and prove the Cauchy Riemann Equation and use it to show that a function is analytic.
CO3: Define singularities of a function, know the different types of singularities, and be able to determine the points of singularities of a function
CO4: Explain the concept of transformation in a complex space (linear and non-linear) and sketch associated diagrams.
CO5: Understand the concept of sequences and series with respect to the complex numbers system and establish whether a given series/ sequences is convergent/ divergent at a specified point or interval.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	M	S	W	W	M	M	S	M	M
CO2	M	S	S	S	S	M	W	W	M	S	W	M
CO3	S	S	M	M	M	M	M	M	S	M	S	S
CO4	S	S	S	M	S	W	W	M	S	M	S	S
CO5	S	M	M	S	M	M	M	S	S	S	M	M

Unit	Course Outline	Hour(s)
I	**Analytic function:** Function of complex variables, limit, continuity, derivatives, Cauchy - Riemann equations, Analytic function, Power series, Exponential functions, Trigonometric functions, Logarithmic functions, hyperbolic and inverse hyperbolic functions, Branches of multivalued functions with reference to arg z, log z and z^c.	**9**
II	Complex Integration, Cauchy Goursat theorem, Cauchy integral formula, Cauchy integral formula for higher order derivatives, Liouville's theorem, Moreara's theorem, Power series, Taylors Theorem, Taylor series, Laurent series, Singularities, Types of singularities, Residue theorem, Zero, Poles.	**9**
III	Maximum Modules Principle, Schwarz Lemma, Argument principle, Rouche's theorem, Fundamental theorem of algebra. Cauchy's residue theorem, Definite integral using residue theorem.	**9**

IV	**Conformal Mappings:** Elementary conformal mapping, Bilinear transformation, Schwartz-christoffel transformation, analytic continuation, Method of analytic continuation by Power series.	**9**

Total:36

Text Books:

1. M.R. Spiegel, Complex Variables. Schaum's Outlines series, McGraw Hill Education, 2017
2. E. G. Philips, Functions of a complex variables with applications, Oliver and Boyd, 1957

Reference Books:

1. Walter Rudin, Real and Complex Analysis, McGraw Hill Education, 2017
2. L. V. Ahlfors, Complex Analysis, McGraw Hill., 2000
3. H. A. Priestly, Introduction to Complex Analysis, Clarendon Press Oxford, 1990
4. Mark J. Ablowitz and A.S. Fokas, Complex Variables, Introduction and Application, CUP, 1998.
5. John B Conway, Functions of Complex Variable, Springer, 1872.M. J. Ablowitz and A. S. Fokas, Complex Variables: Introduction and Applications, Cambridge University Press, NY, 2003.

E-Book Links:

1. https://59clc.files.wordpress.com/2011/01/real-and-complex-analysis.pdf [1]

Reference Links:

https://nptel.ac.in/courses/111/107/111107056/
https://nptel.ac.in/courses/111/103/111103070/

Course Code: MSCM-204
Title of the Course: Linear Algebra

L	T	P	Credits
2	2	0	3

Course Outcomes:
On satisfying the requirements of this course, students will be able to:
CO1: Explain the fundamental concepts of algebraic structures Group & Field and their role in different areas of mathematics
CO2: Understand the concept of Modules and its properties.
CO3: Apply different theorems and results of Vector algebra in the field of modules and its properties.
CO4: Understand the concepts of different types of Modules and its various properties.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	S	M	S	M	W	M	M	M	M	M
CO2	S	S	M	S	M	W	W	M	M	S	M	M
CO3	S	S	S	M	S	M	M	W	S	M	S	S
CO4	S	M	S	M	S	W	M	M	S	M	W	M

Unit	Course Outline	Hour(s)
I	Linear systems and vector spaces Systems of linear equations, matrices and elementary row operations, row-reduced Echelon matrices, finite dimensional vector spaces, subspaces, linear dependence, basis, dimension.	**9**
II	Linear transformations Linear transformations and their matrix representations, change of basis,isomorphism, rank and determinant of matrices,Rank-Nullity theorem, linear functional and dual space, annihilator, double dual, transpose of a linear transformation.	**9**
III	Matrices and its properties Eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, invariant subspaces, diagonal forms, triangular forms, Hermitian, skew-Hermitian and Unitary matrices, direct-sum decompositions, invariant direct sums, primary decomposition theorem.	**9**
IV	Canonical forms Cyclic subspaces and annihilators, cyclic decomposition and rational forms, Jordan-canonical form. Inner product spaces Finite dimensional inner product spaces, linear operators on inner product spaces, orthonormal basis, Gram-Schmidt orthonormalization process, self-adjoint operators, and quadratic forms.	**9**

Total: 36

Reference Books:

1. G.Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, 1993.
2. K. Hoffman and R. Kunze,Linear Algebra, 2ndEd., Prentice Hall of India, 2005.
3. S. Kumaresan,Linear Algebra: A Geometric Approach, Prentice-Hall of India, 2004.
4. S. Axler,Linear Algebra Done Right, 2nd Ed., Springer UTM, 1997.
5. S. Lang,Linear Algebra, Springer Undergraduate Texts in Mathematics, 1989.

Course Code: MSCM-205
Title of the Course: Number Theory

L	T	P	Credits
2	2	0	3

Course Outcomes:

CO1: Understand about the concept of arithmetic function along with properties and its application

CO2: Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime and prime-factorization.

CO3: Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residue.

CO4: Apply various methods to solve numerical problems in short period of time.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	W	W	M	M	S	M	M
CO2	S	S	M	M	S	M	M	W	S	M	S	S
CO3	S	S	S	S	S	M	M	M	S	S	S	M
CO4	S	M	S	S	M	W	M	M	M	S	M	S

Unit	Course Outline	Hour(s)
I	**Arithmetical Functions:** Mobius function, Euler's totient function, Mangoldtfunction,Liouville's function, the divisor function, Relation connecting ϕ and μ Product formula for ϕ(n), Dirichlet product of arithmetical functions, Dirichlet inverse and Mobius invertion formula, Multiplicative function, Dirichlet multiplication, the inverse of a completely multiplicative function, Generalized convolutions.	**9**
II	**Averages of Arithmetical Function**: The Big oh notation, Asymptotic equality of functions,Euler's summation formula, Elementary asymptotic formulas, Average order of d(n), ϕ(n), a(n), μ(n), Λ(n), The partial sums of a Dirichlet product, application to μ(n) and Λ(n), Legendre's identity.	**9**
III	Some elementary theorems on the Distribution of prime numbers Chebyshev's functions (X) &( ), Relation Connecting ( ) (X), Abel's identity, equivalent forms of prime number theorem, Inequalities for (n) and Pn Shapiro's Tauberian theorem, Application of Shapiro's theorem.	**9**
IV	Elementary properties of groups, characters of finite abelian groups, the character group, Orthogonality relation for characters, Dirichletcharacter, Dirichlet theorem for prime of the form 4n-1 and	**9**

	4n+1, Dirichlet theorem in primes on Arithmetical progression, Distribution of primes in arithmetical progression.	

Total:36

Recommended Books:

1. T.M. Apostol, 'Introduction to Analytic Number Theory', Springer.
2. Paul T. Bateman, 'Analytic Number Theory', World scientific.
3. Murty M. Ram, 'Problems in Analytic Number Theory', Springer.
4. H. Rosen Kenneth, 'Elementary Number Theory', 6^{th}Edn.
5. G.H. Hardy, 'An Introduction to the Theory of Numbers', 6^{th}Edn.

Course Code: MSCM-206
Title of the Course: Fourier Analysis &Applications

L	T	P	Credits
2	2	0	3

Course Outcomes:
After completion of this course, Students will be able to:
CO1: Calculate the Fourier series representation of a function of one variable.
CO2: Find the solution of the wave, diffusion and Laplace equations using the Fourier series.
CO3: Solve an initial value problem for an nth order ordinary differential equation using Laplace transform.
CO4: Solve a Cauchy problem for the wave or diffusion equations using the Fourier transform.
CO5: Find the mean and the variance of a random variable.

CO/PO mapping (S/M/W indicates strength of correlation)S- Strong , M-Medium , W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	M	S	W	W	M	M	M	M	M
CO2	S	M	M	S	M	W	W	M	M	S	M	S
CO3	S	S	S	M	S	M	M	W	S	M	S	S
CO4	S	S	S	S	S	M	M	M	S	S	S	M
CO5	S	S	M	S	M	W	M	M	M	M	W	M

Unit	Course Outline	Hour(s)
I	**Fourier Series**: Fourier series, Theorems, Dirichlet's conditions, Fourier series for even andodd functions, Half range Fourier series, Other forms of Fourier series.	**9**
II	Convergence and Uniform convergence of Fourier series, Cesaro and Abel SummabilityofFourier series, The DirichletKernal, The Fejer kernel, ^{2}-theory: Orthogonality, Completeness.	**9**
III	**Fourier Transforms**: Dirichlet's conditions, Fourier integral formula (without proof),Fourier transform, Inverse Theorem for Fourier transform, Fourier sine and cosine transforms and their inversion formulae. Properties of Fourier transform, Convolution theorem of Fourier transforms, Parseval's identity, Finite Fourier sine and cosine transform, Inversion formula for sine transform, **Application of Fourier Transforms**: Simultaneous ordinary differential equations, secondorder Partial differential equations (Heat, Wave and Laplace).	**9**
IV	**The Discrete Fourier Transform (DFT)**: Definition, Theorems, Properties: Periodicand Linear Convolution by	**9**

	DFT, The Fast Fourier Transform, FFT convolutions, Two dimensional FFT Analysis.	

Total:36

Text books:

1. B.S. Grewal, 'Higher Engineering Mathematics', Khanna Publisher, 2014.
2. DuraisamySundararajan, 'The Discrete Fourier Transform: Theory, Algorithms andApplications', World Scientific Publishing Co. Pte Ltd., 2001.

References Books:

1. Javier Duoandikoetxe, 'Fourier Analysis', University Press, 2012.
2. Gerald B. Folland, 'Fourier Analysis and its Applications', American Mathematical Society, 2010.
3. N.K. Bary, 'A Treatise on Trigonometric Series' Vol. 1, Pergamon, 2014.
4. DuraisamySundararajan, 'The Discrete Fourier Transform: Theory, Algorithms andApplications', World Scientific Publishing Co. Pte Ltd.,2001.

E-Book Links:

1. https://www-elec.inaoep.mx/~rogerio/Tres/FourierAnalysisUno.pdf

References Links:

1. https://nptel.ac.in/courses/111/106/111106046/

Course Code: DBES-101
Title of the Course: EVS

L	T	P	Credits
3	0	2	4

Course Outcomes:
After undergoing this course student will be able to:
CO1: Articulate the interdisciplinary context of environmental issues.
CO2: Identify and justify key stakeholders in humanities and social sciences that need to be a part of sustainable solutions.
CO3: Formulate an action plan for sustainable alternatives that integrate science, humanist, and social perspectives.
CO4: Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	W	S	S	W	W	S	M	S	M
CO2	S	S	M	M	S	M	M	W	W	S	M	S
CO3	S	M	S	M	S	W	S	M	S	W	S	S
CO4	S	S	M	W	S	S	W	W	S	M	S	M

Unit	Course Outline	Hour(s)
I	**The Multidisciplinary Nature of Environmental Studies** Definition, scope and importance Need for public awareness. **Natural Resources** Renewable and Non-renewable Resources: • Natural resources and associated problems. (a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. (b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. (c) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. (d) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.	**10**
II	**Ecosystems**	**10**

	• Concept of an ecosystem. • Structure and function of an ecosystem. • Producers, consumers and decomposers. • Energy flow in the ecosystem. • Ecological succession. • Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the ecosystem **Biodiversity and Its Conservation** • Introduction, definition: genetic, species and ecosystem diversity. • Biodiversity at global, National and local levels.	
III	**Environmental Pollution** • Definition • Causes, effects and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards • Solid waste management: Causes, effects and control measures of urban and industrial wastes. • Role of an individual in prevention of pollution. **Social Issues and the Environment** • From unsustainable to sustainable development. • Water conservation, rain water harvesting, watershed management. • Environmental ethics: Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. • Consumerism and waste products. • Environment Protection Act. • Air (Prevention and Control of Pollution) Act. • Water (Prevention and Control of Pollution) Act. • Wildlife Protection Act. • Forest Conservation Act.	**10**
IV	**Human Population and the Environment** • Population growth, variation among nations. • Population explosion—Family Welfare Programme. • Environment and human health. • Human rights. • Value education. • HIV/AIDS. • Women and Child Welfare. • Role of Information Technology in environment and human health. • Case Studies. **Field Work** • Visit to a local area to document environmental assets—river/forest/grassland/hill/mountain.	**15**

	• Visit to a local polluted site—Urban/Rural/Industrial/Agricultural. • Study of common plants, insects, birds. • Study of simple ecosystems—pond, river, hill slopes, etc. • (Field work equal to 5 lecture hours	

Total- 45

Reference Books –

1. "Environmental Science" by Miller T G.
2. "Introduction to Environmental Engineering and Science" by Gilbert M Masters.
3. "The Biodiversity of India" by BharuchaErach.
4. "Essentials of Ecology" by Townsend C and Michael Begon.
5. https://nptel.ac.in/courses/122102006/
6. https://swayam.gov.in/nd2_cec19_bt03/preview
7. https://www.pdfdrive.com/environmental-science-e12033451.html

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DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Program: M.Sc (Mathematics)

Semester III

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1.	MSCM-301	Operations Research	CC	40	60	100	2	2	0	3
2.	MSCM-302	Seminar	CC	40	60	100	0	0	4	2
Department Elective Courses (Select Any One)										
3.	MSCM-303	Advanced Complex Analysis	CC	40	60	100	2	2	0	3
4.	MSCM-304	Theory of Partitions	CC	40	60	100	2	2	0	3
Life Skill Courses										
5.	DBEI-301 (SDN)	Employability Skills Intermediate	LSC	40	60	100	1	0	4	3
Total				160	240	400	5	4	8	11

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course

Course Code: MSCM-301
Title of the Course: Operations Research

L	T	P	Credits
2	2	0	3

Course Outcomes:
CO1: Give an appreciation of strategic importance of operations and supply chain management in a global business environment.
CO2: Understand how an operation relates to other business function.
CO3: Develop a working knowledge of concepts and methods related to designing and managing operations and supply chains.
CO4: Develop a skill set for quality and process improvement.
CO5: Develops how to manage and control the resource allocation.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	M	S	M	W	M	M	M	M	M
CO2	S	M	M	S	M	W	W	M	M	S	M	S
CO3	S	S	S	S	S	M	M	W	S	S	S	S
CO4	S	S	M	M	S	M	M	M	S	M	S	M
CO5	S	S	S	S	M	W	W	M	M	M	W	M

Unit	Course Outline	Hour(s)
I	Introduction, Definition of operation research, Models in operation research. Formulation of linear programming problem (LPP): Graphical method, Basic Feasible Solution, optimal solution of LPP using Simplex, Big-M and Two-phase methods, Exceptional cases in LPP i.e. Infeasible, unbounded, alternate and degenerate solutions, Extreme Points, Convex set Convex linear combination.	**9**
II	**Duality in Linear Programming**: General Primal-Dual pair, formulating a dual problem, duality theorems, Complementary slackness theorem, Duality & simplex method, Dual simplex method, Sensitivity analysis: change in right hand side of constraints, change in the objective function and coefficient matrix addition and deletion of constraint and variables.	**9**
III	**Transportation Problem**: Initial basic Feasible solution, Balanced and unbalancedtransportation problems, Optimal solutions of transportation problem using U-V/MODI methods, Assignment problems: Mathematical formulation of assignment problem, typical assignment problem, the traveling salesman problem, Test for optimality, degeneracy, Project management with critical path	**9**

	method.	
IV	Concept of convexity and concavity, Maxima and minima of convex functions, Single and multivariate unconstrained problems, constrained programming problems, Kuhn-Tucker conditions for constrained programming problems, Quadratic programming, Wolfe's method.	**9**

Total:36

Textbooks:

1. H. A. Taha, Operations Research: An Introduction, MacMillan Pub Co., NY, 9th Ed., 2013.
2. KantiSwarup, P.K. Gupta and Man Mohan, Opeartions Research, S. Chand and Co., 2010
3. Richard Bronson, GovindasamiNaadimuthu,Operations Research, Schaum Outlines Series, McGraw Hill Education, 2017.

Reference Books:

1. F. S. Hillier and G. J. Lieberman, B. Nag and P. Basu, Introduction to Operations Research, McGraw Hill Education; Tenth edition (5 July 2017)
2. P. K. Gupta and D. S. Hira,Introduction to Operations Research, S. Chand Publishing, 2012

E-Book Links:

1. https://notendur.hi.is/kth93/3.20.pdf [1]

Reference Links:

https://swayam.gov.in/nd2_cec20_ma10/preview

Course Code: MSCM -302
Title of the Course: Seminar

L	T	P	Credits
0	0	4	2

Course Outcomes:
At the end of the course, the student will be able to
CO1: Collect useful information from the literature on the particular topic chosen by student

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	W	M	W	S	M	S	M	S

Course Code: MSCM-303
Title of the Course: Advanced Complex Analysis

L	T	P	Credits
2	2	0	3

Course Outcomes:
After completion of this course, Students will be able to:
CO1: To calculate normal limits of analytic functions and univalent functions.
CO2: To evaluate analytic continuation along paths via power series.
CO3: To understand the importance of various theorems and their applications.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M	S	M	W	W	M	M	S	M	S
CO2	S	S	M	M	S	M	M	W	S	M	S	M
CO3	S	S	S	M	S	M	M	M	S	S	S	M

Unit	Course Outline	Hour(s)
I	Fundamental theorems connected with zeros of analytic functions, the argument (counting) principle, Rouche's theorem, Fundamental theorem of algebra, Morera's theorem, Normal limits of analytic functions, Hurwitz's theorem, Normal limits of univalent functions, Open mapping theorem, Inverse function theorem.	**9**
II	Implicit function theorem, Analyticity of the explicit function, Riemann surfaces for multivalued functions, Direct and indirect analytic continuation, Lipschitz nature of the radius of convergence, Analytic continuation along paths via power series.	**9**
III	Monodromy theorem (first version and second version), The Mean value property, Harmonic functions, Maximum principle (with proof), Schwarz's lemma (with proof), Differential or infinitesimal schwarz's lemma.	**9**
IV	Pick's lemma, Hyperbolic geometry on the Unit disc, Arzela-ascoli theorem (with proof), Montel's theorem (with proof), Riemann mapping theorem (with proof).	**9**
		Total: 36

Recommended Books:

1. L.V. Ahlfors, 'Complex Analysis', 2nd Edn.,McGraw Hill International Student Edn.,1990.
2. E.T. Capson, 'An Introduction to the Theory of Functions of a Complex Variable', OxfordUniversity Press,1995.
3. Theodore Gamelin, 'Complex Analysis (UTM)', Springer, 2003.
4. S. Ponnusamy& Herb Silverman, 'Complex Variables with Applications', Birkhaeuser,

Course Code: MSCM-304
Title of the Course: Theory of Partitions

L	T	P	Credits
2	2	0	3

Course Outcomes:
CO1: Understand about the concept of Partition
CO2: Understand the different applications of Patition
CO3: Apply various identities on partition functions.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong, M-Medium, W- Weak												
CO's	Program Outcomes(PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	W	W	M	M	S	M	M
CO2	S	S	M	M	S	M	M	W	S	M	S	S
CO3	S	S	S	S	S	M	M	M	S	S	S	M

Unit	Course Outline	Hour(s)
I	Partitions - partitions of numbers, the generating function of p(n), other generating functions, two theorems of Euler, Jacobi's triple product identity and its applications.	**9**
II	$1\psi1$ - summation formula and its applications, combinatorial proofs of Euler's identity, Euler's pentagonal number theorem, Franklin's combinatorial proof.	**9**
III	Congruence properties of partition function, the Rogers - Ramanujan Identities.	**9**
IV	Elementary series - product identities, Euler's, Gauss', Heine's, Jacobi's identities. Restricted Partitions – Gaussian, Frobinius partitions.	**9**

Total: 36

Reference Books:
1. G. H. Hardy and E. M. Wright – An Introduction to Theory of Numbers, Oxford University Press, 1979, 5th Ed.,
2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, New York, John Wiley and Sons, Inc., 2004, 5th Ed.,
3. Bruce C. Berndt – Ramanujan's Note Books Volumes-1 to 5.
4. G. E. Andrews – The Theory of Partitions, Addison Wesley, 1976.
5. A. K. Agarwal, Padmavathamma, M. V. Subbarao – Partition Theory, Atma Ram & Sons, Chandigarh, 2005.

Course Code: DBEI-301 (SDN)
Title of the Course: Employability Skills Intermediate

L	T	P	Credits
1	0	4	3

The course is designed to achieve superior outcomes of placement, retention and progression of students through 21' century employability skills' training and assessment.

Skills development network shall provide Vocational curricula and e-content for high quality employability and work skills training through an online learning platform

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DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Program: M. Sc (Mathematics)

Semester IV

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1.	MSCM-401	Research Methodology	CC	40	60	100	2	0	0	2
2.	MSCM-402	Major Project	CC	100	200	300	0	0	48	24
Life Skill Courses										
3.	HVP-201C*	Human Value and Professional Ethics	LSC	40	60	100	2	0	0	2
		Total		180	320	500	4	0	48	28

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course

Course Code: MSCM-401
Title of the Course: Research Methodology

L	T	P	Credits
2	0	0	2

Course Outcomes:
At the end of the course, the student will be able to
CO1: Organize and conduct research (advanced project) in a more appropriate manner.
CO2: Write a research report and thesis.
CO3: Write a research proposal (grants).
CO4: Prepare a project proposal (to undertake a project).

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	M	S	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	M	W	W

Unit	Course Outline	Hour(s)
I	Foundations of Research: Meaning, Objectives. Concept of theory, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable.ResearchProcess Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic&Importance	**9**
II	Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent &Dependentvariables. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.	**9**
III	Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of thesample Practical considerations in sampling andsamplesize.	**9**

	Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	
IV	Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, PlagiarismandSelf-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	**9**

Total- 36

Books Recommended:-

1. BusinessResearchMethods–DonaldCooper&PamelaSchindler,TMGH,9thedition
2. Business Research Methods – Alan Bryman& Emma Bell, Oxford UniversityPress.
3. Research Methodology –C.R.Kothari
4. Select references from theInternet

Links:

1. https://swayam.gov.in/nd2_cec20_hs17/preview#:~:text=The%20present%20course%20intends%20to,sociology%2C%20social%20work%2C%20etc.
2. https://swayam.gov.in/nd1_noc19_ge21/preview

Course Code: MSCM-402
Title of the Course: Major Project

L	T	P	Credits
0	0	48	24

Course Outcomes:
On completion of this course, the students will be able to:
CO1: Understand project characteristics and various stages of a project.
CO2: Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M

Course Code: HVP-201C*
Title of the Course: Human Value and Professional Ethics

L	T	P	Credits
2	0	0	2

Course Outcomes:
On completion of this course, the students will be able to:
CO1: Become sensitive towards human values.
CO2: Understand commitment and responsibility.
CO3: Gain the ability to bring harmony to the society they live
CO4: Progress from discrimination to commitment
CO5: Develop the ability to face difficult situations in life boldly and resolve them confidently

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	M	S	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	M	W	W
CO5	M	S	S	W	M	M	S	W	M	S	W	M

Unit	Course Outline	Hour(s)
I	**Introduction - Need, Basic Guidelines and Content:**Understanding the need, basic guidelines, content and process for Value Education. Self Exploration–what is it? - Its content and process; „Natural Acceptance" and Experiential Validation- as the mechanism for selfexploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations	**10**
II	**Process for Value Education**: Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living inHarmony at various levels **Understanding Harmony in the Human Being** - Understanding human being as a co-existence of the sentient „I" and the material „Body" Understanding the needs of Self („I") and „Body" - Sukh and Suvidha Understanding the Body as an instrument of „I" (I being the doer, seer and	**10**

	enjoyer)	
III	**Harmony in Myself! :** Understanding the characteristics and activities of „I‟ and harmony in „I‟ . Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya- practice exercises and case studies will be taken up in practice sessions. **Understanding Harmony in the Family and Society**- Harmony in Human-Human Relationship Understanding harmony in the Family- the basic unit of human interaction. Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship	**10**

Total- 30

Recommended Books

1. Engineering Ethics (Includes Human Values)" by Govindarajan M.
2. "Professional Ethics and Human Values" by Govindarajan M.
3. "Human Values" by A N Tripathi.
4. "Human Values and Professional Ethics" by Jayshree Suresh and B S Raghavan.