Curriculum of Mathematics

BS (4 year)/M.Sc. (2 year)

Government College Women University, Sialkot

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Objectives of BS Program:

The objectives of the Bachelor of Mathematics program are to produce graduates who are able:

- To formulate and solve abstract mathematical problems.
- To recognize real-world problems that are amenable to mathematical analysis, and formulate mathematical models of such problems.
- To perform standard mathematical computations with accuracy.
- To understand the basic rules of logic, including the role of axioms or assumptions.
- To distinguish a coherent argument from a fallacious one, both in mathematical reasoning and in everyday life.
- To appreciate the role of mathematical proof as a means of conveying mathematical knowledge.
- To become aware of the applications of mathematics across science and technology, and to learn how to use mathematical ideas and techniques to solve reallife problems.
- To produce proficient mathematicians having conceptual clarity and ability to express their thoughts and ideas in logical and coherent manner.

Learning Outcomes of BS Program:

The Outcomes of the Bachelor of Mathematics program are to produce graduates who will be able:

- To read, analyze and write logical arguments to prove mathematical concepts.
- Students will be able to communicate and transmit mathematical ideas with clarity and coherence, both written and verbally.
- To investigate and apply mathematical problems and solutions in a variety of contexts related to science, technology, business and industry and illustrate these solutions using symbolic, numeric, or graphical methods.
- To develop and understand the value of proof, the single factor that distinguishes mathematics from all other disciplines and will demonstrate proficiency in writing and understanding proofs.
- To apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate programs in mathematics and other fields such as the field of quantitative/mathematical finance, mathematical computing, statistics and actuarial science.
- Students will be able to propose new mathematical and questions and suggest possible software packages and/or computer programming to find solutions to these questions.

SCHEME OF STUDIES FOR 4 YEARS BS MATHEMATICS

Code	Course Title	Credit
Semester-I		
Math-108	Calculus-I	4
Math-165	Vectors and Mechanics-I	4
Eng-122	English-I	3
Isl-100	Islamic Studies	3
Phys-146	Physics-I	3
Phys-146L	Physics-I Lab	1
	Total Credit Hours	**18(17+1)**

Semester-II		
Math-109	Calculus-II	4
Math-166	Vectors and Mechanics-II	4
Eng-123	English-II	3
Pks-100	Pakistan Studies	3
Phys-147	Physics-II	3
Phys-147L	Physics-II Lab	1
	Total Credit Hours	**18(17+1)**

Semester-III		
Math-228	Linear Algebra-I	3
Math-210	Calculus-III	4
Eng-224	English-III	3
Arab-101	Arabic Studies	2
Phys-248	Physics-III	3
Phys-248L	Physics-III Lab	1
	Total Credit Hours	**16(15+1)**

Semester-IV		
Math-263	Ordinary Differential Equations-I	3
Math-141	Number Theory	2
Math-117	Discrete Mathematics	2
Math-279	Metric Spaces	2
Math-283	Introduction to Computer and Programming Languages	4
Phys-249	Physics-IV	3
Phys-249L	Physics-IV Lab	1
	Total Credit Hours	**17(16+1)**

Semester-V		
Math-351	Real Analysis-I	3
Math-325	Group Theory	3
Math-312	Complex Analysis-I	3
Math-359	Vector and Tensor Analysis	3
Math-358	Topology	3
Math-315	Differential Geometry	3
	Total Credit Hours	**18(18+0)**

Semester-VI		
Math-352	Real Analysis-II	3
Math-329	Linear Algebra-II	3
Math-368	Complex Analysis-II	3
Math-305	Analytical Mechanics	3
Math-423	Functional Analysis	3
Math-347	Ordinary Differential Equations-II	3
	Total Credit Hours	**18(18+0)**

Semester-VII		
Math-464	Set Theory	3
Math-448	Partial Differential Equations	3
Math-442	Numerical Analysis-I	3
Any Two of the following:		
Math-331	Mathematical Statistics-I	3
Math-471	Programming in Matlab	3
Math-403	Advanced Group Theory-I	3
Math-454	Rings and Modules	3
Math-469	Advance Number Theory-I	3
Math-449	Quantum Mechanics-I	3
Math-404	Analytical Dynamics	3
Math-419	Electromagnetic Theory-I	3
Math-444	Operations Research-I	3
Math-470	Theory of Approximation and Splines-I	3
Math-422	Fluid Mechanics-I	3
	Total Credit Hours	**15(15+0)**

Semester-VIII		
Math-437	Measure Theory and Lebesgue Integration	3
Math-438	Methods of Mathematical Physics	3
Math-443	Numerical Analysis-II	3
Any Two of the following:		
Math-432	Mathematical Statistics-II	3
Math-472	Computer Applications	3
Math-473	Advanced Group Theory-II	3
Math-457	Theory of Modules	3
Math-474	Advance Number Theory-II	3
Math-450	Quantum Mechanics-II	3
Math-455	Special Theory of Relativity	3
Math-475	Electromagnetic Theory-II	3

Math-445	Operations Research-II	3
Math-476	Theory of Approximation and Splines-II	3
Math-478	Fluid Mechanics-II	3
Math-426	Integral Equations	3
	Total Credit Hours	**15(15+0)**
Total Credit Hours of BS Program: 135		

Semester-I

Course Title: Calculus-I

Course Code: Math-108

Credit Hours: 4(4+0)

Course Objectives:

The main objectives of this course are to:

- Develop the concept of limit through multiple representations (numerical, graphical, and symbolic).
- Develop the concept of derivative and standard algorithms for taking derivatives.
- Explore applications of derivatives in contextual problems.
- Apply the derivative concept to the exploration of function behaviour.
- Introduce the concept of antiderivative and integral.

Course Outcomes:

Students will be able to:

- Demonstrate knowledge of limit.
- Discuss the concept of derivative and take derivatives using standard rules.
- Solve realistic application problems.
- Use Maple to reconcile a function's behavior with characteristics in first and second derivatives.
- Take integrals using standard rules.

Course Outline:

Preliminaries: Real numbers and the real line, Functions and their graphs, Shifting and scaling graphs, Solution of equations involving absolute values, Inequalities, Complex numbers system. Polar form of complex numbers, De Moivr's theorem, Circular function, hyperbolic functions, logarithmic.

Limitand Continuity: Limit of a function, left hand and right hand limits, Theorems of limit, Continuity, Continuous functions

Derivatives and its Applications: Differentiable functions, Differentiation of polynomial, rational and transcendental functions, Mean value theorems and applications, Higher derivatives, Leibniz's theorem, L'Hospitals Rule, Intermediate value theorem, Rolle's theorem, Taylor's and Maclaurin's theorem with their remainders.

Integration and Definite Integrals: Techniques of evaluating indefinite integrals, Integration by substitutions, Integration by parts, Change of variable in indefinite integrals, Definite integrals,

Fundamental theorem of calculus, Reduction formulas for algebraic and trigonometric integrands, Improper integrals, Gamma functions.

Recommended Books:

1. Thomas, Calculus, 11th Edition.(Addison Wesley Publishing Company, 2005)
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th Edition,(John Wiley & Sons, Inc. 2005)
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition (John Wiley & Sons, Inc. 2002.)
4. Frank A. Jr, Elliott Mendelson, Calculus, (Schaum's outlines series, 4th Edition, 1999)
5. C.H. Edward and E.D Penney, Calculus and Analytics Geometry,(Prentice Hall, In1988)
6. E. W. Swokowski, Calculus and Analytic Geometry, PWS Publishers, (Boston, Massachosetts, 1983).

Course Title: Vector and Mechanics-I

Course Code: Math-165

Credit Hours: 4(4+0)

Course Objectives:

The main objective of this course is:

- To provide an understanding of the concepts of vector algebra, vector calculus, forces, frictions and virtual work.

Course Outcomes:

Students will able to:

- Understand the concepts of vector algebra, vector calculus, forces, frictions and virtual work.

Course Outline:

Vector Algebra: Introduction to vector algebra, Scalar and vector product**,** Scalar triple product and vector triple product, Applications to geometry**.**

Vector Calculus: Limit, continuity and differentiability of vector point functions**,** Partial derivatives of vector point functions**,** Scalar and vector fields**,** The gradient, divergence and curl**,** Expansion formulas.

Forces: Fundamental concepts and principles**,** Inertial-non-inertial frames, Newton's laws**,** Resultant of several concurrent forces**,** The parallelogram law of forces**,** Resolution of a forces, triangle of forces**,** Lamy's theorem, polygon of forces**,** Conditions of equilibrium for a particle**,**External and internal forces, principle of transmissibility**,** Resultant of like and unlike parallel forces**,** Moment of forces about a point, Varigon's theorem**,** Moment of a couple, equivalent couples, composition of couples**,** Reduction of coplanar forces to a force or a couple.

Friction: Dry friction and fluid friction**,** Laws of dry friction, coefficients of friction, angle of friction**,** Equilibrium of a particle on a rough inclined plane**,** Particle on a rough inclined plane acted on by an external force**,** Conditions for sliding or titling.

Virtual Work: Principle of virtual work, Problems involving tensions and thrust.

Recommended Books:

1. Fowles, G.R, Cassiday, G.L. Analytical Mechanics, 7th Edition, (Thomson Brook Cole, 2005)
2. Jafferson, B. Beasdsworth, T. Further Mechanics, (Oxford University Press, 2001)
3. Joseph F, Shelley. Vector Mechanics, (Mc-Graw Hill Company, 1990).
4. Murray R. Spiegel, Theoretical Mechanics, Schaum's Outline Series,(Mc Graw Hill Book Company)
5. Hwei P. HSU, Applied Vector Analysis, (San Diego, New York, 1984).
6. Murray R. Spiegel, Vector Analysis, Schaum's Outline Series, (McGraw Hill Book Company, 1959)
7. D.K. Anand and P.F. Cunnif, Statics and Dynamics, (Allyn and Becon, Inc. 1984).

Course Title: English-I

Course Code: Eng-119

Credit Hours: 3(3+0)

Course Objective:

The main objectives of this course are to:

- Enhance language skills through grammar, phrases and sentence making.
- Develop skills for English writing and translation.
- Enhance creative writing skills.

Course Outcomes:

Students will able to:

- Write for various audiences and purposes and to adapt the essay form to various writing situations.
- Understand the structure and style of effective sentences, paragraphs, and essays.

Course Outline:

Introduction and usage of parts of speech, Tenses, Use of models, Comprehension skills in detail, Skimming and scanning, Identification of main idea through comprehension, Vocabulary building skills, Introduction to synonyms and antonyms, Use of dictionary, Active and passive voice, Paragraph writing, Punctuation.

Recommended Books

1. Eastwood, j. 2004. English practice
2. e Grammar (new edition with tests and answer).
3. Murphy, R (2003). Grammar in use

Course Title: Islamic Studies

Course Code: Isl-100

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic information about Islamic studies.
- Enhance understanding of the students regarding Islamic civilization.
- Improve student's skill to perform prayers and other worships.
- Enhance the skill of the students for understanding of issues related to faith and religious life.

Course Outcomes:

Students will be able to:

- Know basic information about Islamic studies.
- Understand Islamic civilization.
- Understand issues related to faith and religious life.

Course Outline:

۱۔القرآن الکریم

الف۔ تعارف قرآن (لغوی،اصطلاحی مفہوم)

ب۔ منتخب قرآنی آیات کا لغوی و بامحاورہ ترجمہ و تشریح (ضمیمہ "الف")

ج۔ عربی گرائمر فعل ماضی، مضارع،امر۔ نہی،جملہ اسمیہ،جملہ فعلیہ،مرکب اضافی و توقیفی،ضمائر،حروف جارہ،ناصبہ و جازمہ واستفہام

۲۔الحدیث النبوی ﷺ:

الف۔ تعارف حدیث (لغوی واصطلاحی مفہوم)

ب۔ منتخب احادیث نبویہ کا لغوی و بامحاورہ ترجمہ و تشریح (ضمیمہ "ب")

نوٹ: اساتذہ کرام آیات واحادیث کی تعلیم وتدریس کے دوران لغوی اور بامحاورہ ترجمہ کے ضمن میں مندرجہ بالا قواعد عربیہ کی تطبیق کا اہتمام کریں۔

۳۔سیرت النبی ﷺ

ا۔الف۔ سیرۃ النبی ﷺ کا لغوی واصطلاحی مفہوم۔

ب۔ سنت وحدیث میں فرق

۲ ۔ مطالعہ سیرت کی ضرررت واہمیت

۳ ۔ **نبی کریم** ﷺ کی حکمت انقلاب

[ہجرت، مواخات، میثاق مدینہ، صلح حدیبیہ، خطبہ حجۃ الوداع]

۴ ۔ تزکیہ نفس اور تعمیر سیرت وشخصیت کا نبوی منہاج اور عملی نمونے

(عشرہ مبشرہ، امہات المومنین، اولاد النبی ﷺ)

۵۔ تشکیل اجتماعیت ومعاشرت اور اسوہ حسنہ

مجوزہ کتب (Recommended Books)

ا۔القرآن	اللہ جل جلالہ
2۔معارف القرآن	مفتی محمد شفیع
3۔ تفہیم االقرآن	سید ابوالاعلیٰ مودودی
4۔تدبر القرآن	امین احسن اصلاحی
5۔ضیاالقرآن	پیر کرم شاہ الازہری
6معارف الحدیث	محمد منظور نعمانی
7۔ترجمان السنۃ	بدر عالم میرٹھی
8۔اللسان العربی	محمد نعمان طشقندی
9۔ قواعد القرآن	عبدالرحمٰن طاہر مدنی

[مختصر قرآنی عربی گرائمر]

10۔ تعلیم اللغۃ العربیۃ: مختصر القواعد	ڈاکٹر مظہر معین
11۔عربی کا معلم	مولانا عبدالستار خان

12۔عربک گرائمر اینڈ ٹرانسلیشن ایم ڈی چوہدری

13۔مصباح اللغات [عربی، اردو ڈکشنری] عبدالحفیظ بلیاوی

14۔سیرۃ النبی ﷺ شبلی نعمانی، سید سلیمان ندوی

15۔الرحیق المختوم صفی الرحمٰن مبارکپوری

16۔رحمت اللعالمین محمد سلیمان منصور پوری

17۔انسان کامل ﷺ ڈاکٹر خالد علوی

18۔سیرت عائشہ سید سلیمان ندوی

19۔سیرّ الصحابہ شاہ معین الدین ندوی

20۔تاریخ اسلام شاہ معین الدین ندوی

21۔سیرّ الصحابیات محمد سعید دانصاری

22۔(الثقافۃ الاسلامیہ) تاریخ افکار علوم اسلامی راغب الطباخ [ترجمہ: افتخار احمد بلخی]

23۔اسلامی تہذیب اور اس کے اصول و مبادی سید ابوالاعلیٰ مودودی

24۔عشرہ مبشرہ محمود احمد ظفر

25۔تنقیحات سید ابوالاعلیٰ مودودی

26۔اسلام اور مغرب کے تہذیبی مسائل سید قطب شہید ترجمہ ساجد الرحمن صدیق

27۔اسلامی نظریہ حیات پروفیسر خورشید احمد

28۔اسلام کا معاشرتی نظام ڈاکٹر خالد علوی

29اسلام اور جدید ذہن کے شبہات [شبھات حول الاسلام] محمد قطب

(Islam the Misunderstood Religion)

30۔معرکہ اسلام و جاہلیت صدالدین اصلاحی

32. The Holy Quran (Textt, Translation &commentary): Abdullah Yousaf Ali

33. The Glorious Quran :Muhammad Marma Duke pickthall.

34. The Massage of Quran : Muhammad Asad(Leopold weiss)

35. Sahih-Al- Bukhari (English Translation) Muhaammad Mohsin Khan

36. Takalam Al Arbiyyah (تکلم العربیۃ) Arabic – English : Mahmud Ismaeel al-Seeni.

37. Al. Mawrid (المورد) English -Arabic Dictionary : Munir Al-Balabakki.

38. The Road to Maakkah : Muhammad Asad (leopoled weiss)

39.Quran , Bible & Science (القرآن والانجیل والعلم) Maurice de Bouccai.

40. T0wards Understanding Islam (مبادی الاسلام) :Abul Ala Maudoodi.

41. Introduction of Islam (المدخل الاسلام) : Dr .Mahammad Hamidullah.

42. Spirit of Islam(روح اسلام) Syed Ameer Ali.

43. Purdah and Status of Women in Islam(الحجاب) Abul Ala maudoodi.

44. Ettiquates of lLife in Islam (آسان فقہ) Muhammad Yousaf Islahi

ااسلام میں عدل اجتمائی [العدالۃ الاجتماعیۃ فی الاسلام]

45. Social justice in Islam Sayyid Qutb.

46 . Islam in Theory and Practice Maryam jameela (Margrat Marcus)

اسلام ایک نظریہ ایک تحریک [الاسالم فی النظریۃ والتطبیق]

47. Umar The Grate [الفاروق] Shible Nomani .(Translated by Zafar Ali Khan)

Note: The Books available in two or three language (Arabic ,English , urdu have been mentioned Accordingly)

Course Title: Physics-I

Course Code: Phys-146

Credit Hours: 4(3+1)

Course Objectives:

The main objectives of this course are:

- To provide an understanding of the concepts of mechanics vector operations, particle dynamic, work, energy and power.
- To provide an understanding of the concepts of conservation of energy, rotational dynamics and bulk properties of matters.

Course Outcomes:

Students will able to:

- Understand the concepts of mechanics vector operations, particle dynamic, work, energy and power.
- Understand the concepts of conservation of energy, rotational dynamics and bulk properties of matters.

Course Outline:

Mechanics Vector Operations: Vector in 3 dimensions; Vector derivatives and operation; Gradient, Divergence and Curl of a vector; Divergence Theorem; Stokes Theorem.

Particle Dynamic: Advanced application of Newton's laws Dynamics of Uniform motion; Equations of motion; Time dependent forces; Effect of drag forces on motion; Non inertial frames and pseudo forces; Non inertial frames and Pseudo forces; Limitations of Newton's Laws.

Work, Energy and Power: Work done by a constant force, work done by a variable force (1-dimensions); Work done by a variable (2-dimension) Work energy theorem, General proof of work energy theorem. Power: Reference Frames.

Conservation of Energy: Conservative, and non-conservative forces; one dimensional conservative system; 2 3 dimensional system; Conservation of en*ergy* in a system of particles system two practical conservative system. Center of mass of solid object; Momentum changes in system of variable mass.

Collisions: Inelastic collision conservation of momentum during collision in center of Mass reference frame.

Rotational Dynamics: Angular momentum; angular velocity; Overview of rotational Dynamics; Parallel axis theorem; Determination of momentum of interstice of various shapes; Rotational dynamics

of spinning Top rigid bodies; combined rotational and transitional motion. Stability of spinning objects, the spinning Top.

Gravitation: Review of basic concepts of gravitation. Gravitational effect of a spherical mass distribution; Gravitational Potential Energy; Gravitational field & potential; Universal Gravitational Law.

Bulk Properties of Matters: Elastic Properties of Matter; Fluid Statistics; Fluid Dynamics; Bernoulli Equation; Viscosity.

Optic Topic: Nature of light; Light as an electromagnetic wave; Interference; Adding of Electromagnetic wave using phasors; Interference from thin films; Michelson Interferometer; Fresnel Biprism and its use; Diffraction; Diffraction from multiple slits; Diffraction grating; Holography; Polarization; Description of polarization states; Rotation of plane of polarization.

Course Title: Physics-I Lab

Course Code: Phys-146L

Course Outline:

1. Surface tension by capillary rise.
2. Study of compound pendulum and estimate of value of 'g'.
3. Elastic constants by spiral spring.
4. Modulus of rigidity by dynamic method and static method of Maxwell's Needle.
5. Spring Constant by static and dynamic method.
6. Modulus of rigidity by dynamic method.

Recommended Books:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison-Wesley, Reading (MA), USA.
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Semester-II

Course Title: Calculus-II

Course Code: Math-109

Credit Hours: 4(4+0)

Course Objectives:

The main objectives of this course are to provide concepts of:

- Conic section and quadratic equations.
- Conic sections in polar coordinates.
- Rectangular coordinates system in a space.
- Analytic geometry of three dimensions.

Course Outcomes:

Students will be able to:

- Cite basic definitions.
- Classifying conic section by eccentricity, translation and rotation of axis.
- Solve application problems.
- Determine equation of straight lines and planes in three dimensions.
- Determine equation of sphere, cylinder, cone, ellipsoids, paraboloids and hyperboloids.

Course Outline:

Plane Analytics Geometry: Conic section and quadratic equations**,** Classifying conic section by eccentricity, Translation and rotation of axis**,** Properties of circle, parabola, ellipse, hyperbolaPolar coordinates, conic sections in polar coordinates, Graphing in polar coordinates**,** Tangents and normal, pedal equations, parametric representations of curves.

Applications of Integration: Asymptotes, Relative extrema, points of inflection and concavity, Singular, points, tangents at the origin, Graphing of Cartesian and polar curves, Area under the curve, area between two curves, Arc length and intrinsic equations**,** Curvature, radius and centre of curvature**,** Involute and evolute, envelope

Analytic Geometry of Three Dimensions: Rectangular coordinates system in a space**,** Cylindrical and spherical coordinate system**,** Direction ratios and direction cosines of a line**,** Equation of straight lines and planes in three dimensions, Shortest distance between skew lines**,** Equation of sphere, cylinder, cone, ellipsoids, paraboloids, hyperboloids, Quadric and ruled surfaces**,** Spherical trigonometry. Direction of Qibla.

Recommended Books:

1. Thomas, Calculus, 11th Edition.(Addison Wesley publishing company, 2005)
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th Edition,(John Wiley & Sons, Inc. 2005)
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition (John Wiley & Sons, Inc. 2002).
4. Frank A. Jr, Elliott Mendelson, Calculus, (Schaum's outlines series, 4th edition, 1999)
5. C.H. Edward and E.D Penney, Calculus and Analytics Geometry (Prentice Hall, Inc. 1988)

6. E. W. Swokowski, Calculus and Analytic Grometry PWS Publishers (Boston, Massachosetts, 1983).
7. Dennis G. Zill & Patric D. Shanahan, Complex Analysis,(Jones & Barlett Publishers, 2003)

Course Title: Vector and Mechanics-II

Course Code: Math-166

Credit Hours: 4(4+0)

Course Objectives:

The main objectives of this course are to provide an understanding of the basic concepts of:

- Kinematics and kinetics.
- Simple harmonic motion, central forces and planetary motion and centre of mass and gravity.

Course Outcomes:

Students will able to understand the concepts of:

- Kinematics and kinetics.
- Simple harmonic motion, central forces and planetary motion and centre of mass and gravity.

Course Outline:

Kinematics: Rectilinear motion of particles**,** Uniform rectilinear motion, uniformly accelerated rectilinear motion**,** Curvilinear motion of particle, rectangular components of velocity and acceleration, Tangential and normal components**,** Radial and transverse components, Projectile motion

Kinetics: Work, power, kinetic energy, conservative force fields, Conservation of energy, impulse, torque, Conservation of linear ad angular momentum, Non-conservative forces**,**

Simple Harmonic Motion: The simple harmonic oscillator, amplitude, period, frequency, Resonance and energy**,** The damped harmonic oscillator, over damped, critically damped and under damped, Motion, forces vibrations

Central Forces and Planetary Motion: Central force fields, equations of motion, potential energy, orbits, Kepler's laws of planetary motion**,** Apsides and apsidal angles for nearly circular orbits, Motion in an inverse square field

Centre of Mass and Gravity: Discrete and continuous systems, density of rigid and elastic bodiesCentroid: Discrete and continuous systems, solid region, region bounded byplanes, Semi-circular regions, sphere, hemisphere, cylinder and cone.

Recommended Books:

1. Fowles, G.R, Cassiday, G.L. Analytical Mechanics, 7th Edition, (Thomson Brook Cole, 2005)
2. Jafferson, B. Beasdsworth, T. Further Mechanics,(Oxford University Press 2001)

3. Murray R. Spiegel, Theoretical Mechanics,(Schaum's Outline Series, (Mc Graw Hill Book Company)
4. D.K. Anand and P.F. Cunnif, Statics and Dynamics, (Allyn and Becon, Inc. 1984)
5. Ferdinand P.B and E.R. Johnston, Statics and Dynamics, (Mc-Graw Hill Book Company, Inc. 1977).

Course Title: English-II

Course Code: Eng-120

Credit Hours: 3(3+0)

Course Objectives:

The main objective of this course is:

- To enable the students to meet their real life communication needs.

Course Outcomes:

Students will able to:

- Develop their communication skills.

Course Outline:

Comprehension practice, Précis writing practice, Translation into English, Documentation, The notice, The agenda, The supplementary material ,Models of agenda and notice, Cv writing (practices, hybrid, functional, chronological),Covering letter, Business letter, Presentation skills.

Recommended Books:

1. Eastwood, j. 2004. English practice Grammar (new edition with tests and answer).
2. Murphy, R (2003). Grammar in use
3. Hacker, D. 1992. A writer's reference. 2nd edition.

Course Title: Pakistan Studies

Course Code: Pks-100

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Impart an understanding of the fundamental principles and teaching of Pakistan studies.

- Take an analytical view in the history and development of Muslim society and culture in the subcontinent, emergence of Pakistan and its constitutional development.
- Have a view on International Relations of Pakistan.

Course Outcomes:

Students will able to:

- Understand historical perspective.
- Know about the history and development of Muslim society and culture in the subcontinent, emergence of Pakistan and its constitutional development.

Course Outline:

Historical Perspective, Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah. Factors leading to Muslim separatism , People and Land, Indus Civilization, Muslim advent, Location and Geo-Physical features, Government and Politics in Pakistan, Political and constitutional phases: 1947-58, 1958-71, 1971-77, 1977-88, 1988-99, 1999 onward, Contemporary Pakistan, Economic institutions and issues, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan.

Recommended Books:

1. Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. Pakistan Political Roots & Development.Lahore, 1994.
5. Wilcox, Wayne.The Emergence of Banglades., Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-eIslamia, Club Road, nd.
7. Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. Enigma of Political Development. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. The Political System of Pakistan. Boston: Houghton Mifflin, 1967.

Course Title: Physics-II

Course Code: Phys-147

Credit Hours: 4(3+1)

Course Objectives:

The main objectives of this course are:

- To provide an understanding of the basic concepts of Harmonic oscillations, wave topic and sound topic.
- To provide an understanding of the basic concepts of thermodynamics and kinetic theory of gases, statistical mechanics and entropy and second law of thermodynamics.

Course Outcomes:

Students will able to:

- Understand the basic concepts of Harmonic oscillations, wave topic and sound topic.
- Understand the basic concepts of thermodynamics and kinetic theory of gases, statistical mechanics and entropy and second law of thermodynamics.

Course Outline:

Harmonic Oscillations: Simple harmonic oscillation (SHM); Application of S H M; S H M and uniform circular motion, combinations of Harmonic motion Damped Harmonic Motion.

Wave Topic: Mechanical waves Traveling waves; Waves speed; Waves equation; Power and intensity in wave motion; Principle of superposition. (Basic ideas);

Sound Topic: Beats Phenomenon; Doppler Effect.

Thermodynamics and Kinetic Theory of Gases: Kinetic theory of the ideal gas, wok done on an ideal gas internal energy of an ideal gas

Intermolecular forces.

Statistical Mechanics: Statistical, Distribution and Mean values; Distribution of molecular speeds; Brownian motion.

Heat: Review of previous concepts; First law of Thermodynamics; Transfer of heat;

Entropy and Second law of Thermodynamics: Reversible and irreversible Process, Second Law; Cycle; Carnot engines Thermodynamic temperature scale; Entropy; Joule – Thomson effect.

Course Title: Physics-II Lab

Course Code: Phys-147L

Course Outline:

1. Thermo-Couple, Thermal e.m.f. and temperature diagram.
2. Determination of 'J' Electrical Method (Calendar and Barnes Method) with compensation for heat loss.

3. Velocity of Sound by Kundt's tube.
4. Frequency & A.C. mains by Sonometer.
5. Frequency & A.C. mains by Melde's Approvals
6. Use of sextant and measurement of altitude with it
7. Wavelengths of sodium D lines by Newton's Rings.
8. Wavelengths of light by Fresnel's biprism
9. Wavelength of light by diffraction grating
10. Measurement of the Rotation of the Plane of Polarization
11. Resolving Power of diffraction grating
12. Determination of the radius of Lycopodium Particles

Recommended Books:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison Wesley, Reading (MA), USA.
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Semester-III

Course Title: Linear Algebra-I

Course Code: Math-228

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Set up and solve systems of linear equations.
- Perform matrix operations as appropriate.
- Evaluate determinants and use their properties.
- Evaluate and apply eigenvectors and eigenvalues.
- Explore real vector spaces.

Course Outcomes:

Students will be able to:

- Use matrix algebra to analyze and solve equations arising in many applications that require a background in linear algebra.

- Utilize vector space terminology.

Course Outline:

Matrices, Determinants and System of Linear Equations: Definition of matrix, Various types of matrices, Algebra of matrices, Determinant of square matrix, cofactors and minors, Laplace expansion of determinants, Elementary matrices, adjoint and inverses of matrices, Rank of a matrix, Introduction to systems of linear equations, Cramer's rule, Guassian elimination and Gauss Jordan method, Solution of homogenous and non-homogenous linear equations, Net work flow problems

Groups: Definition and example of group, Properties of group, Subgroup, Cyclic group, Permutations, Definition of ring and field.

Vector Spaces: Vector spaces, subspaces, Linear combination and spanning set, Linear independence and linear dependence, basis and dimension, row space, Colum space and Null space, Homomorphism of vector spaces, Quotient spaces**.**

Recommended Books:

1. Howard Anton and Chris Rorres, Elementary Linear Algebra Applications Version,(John Wiley and Sons Inc. 9th Edition, 2005)
2. W. Keith Nicholoson, Elementary Linear Algebra, (PWS-Kent Publishing Company, Boston, 2004)
3. Bernard Kolman, David R. Hill, Introduction Linear Algebra with Applications, (Prentice Hall International, Inc. 7th Edition, 2001)
4. Stephen H. Friedberg Et al, Linear Algebra, (Prentice Hall, Inc. 3rd Edition, 2000)
5. Seymour Lipschutz, Theory and Problems of Beginning Linear Algebra, (Schaum's Outline Series, Mc-Graw Hill Company, New York, 1997).

Course Title: Calculus-III

Course Code: Math-210

Credit Hours: 4(4+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding about sequences, infinite series, and convergence.
- Explore methods of determining convergence and evaluating limits of sequences and series.
- Provide basic understanding about vector-valued functions.
- Provide basic understanding about derivatives, gradients, and integrals of multivariate functions.
- Explore problems in multiple integration using rectangular, cylindrical, and spherical coordinate systems.

Course Outcomes:

Students will able to:

- Determine convergence of sequences and series.
- Determine the limit of a sequence or series for standard special types (such as geometric series).
- Understand the concepts of derivatives, gradients, and integrals of multivariate functions.
- Solve problems in multiple integration using rectangular, cylindrical, and spherical coordinate systems.

Course Outline:

Sequence and Series: Sequences, Infinite series, Convergence of sequence and series , The integral test, Comparison tests, Ratio test, Root test , Alternative series, Absolute and conditional convergence , Power series, Interval and radius of convergence.

Functions of Several Variables: Functions of two variables, Graphs of functions of two variables ,Contour diagrams, Linear functions, Functions of three variables , Limit and continuity of a function of two variables , The partial derivative, Computing partial derivatives algebraically , The second-order partial derivative, Local linearity and the differential, Tangent planes and normal lines ,Optimization, Maxima and minima of a function of two variables, Lagrange multipliers, Various methods for finding area and volume surface of revolution.

Multiple Integrals: Double integral in rectangular and polar form, Triple integral in rectangular, Cylindrical and spherical coordinates, Substitutions in multiple integrals, Moments and centre of mass.

Recommended Books:

1. Thomas, Calculus, 11th Edition. (Addison Wesley Publishing Company,2005)
2. H.Anton, I. Bevens, S. Davis, Calculus, 8th Edition, (John Wiley & Sons,In. 2005)
3. Hughes-Hallet, Gleason, McCalum, et al, Calculus Single and Multivarible, 3rd Edition (John Wiley & Sons, Inc 2002)
4. Frank A. Jr, Elliott Mendelson, Calculus,(Schaum's Outline Series, 4th Edition 1999)
5. C.H. Edward and E.D Penney, (Calculus and Analytical Geometry Prentice Hall, Inc. 1985)

Course Title: English-III

Course Code: Eng-221

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Enhance language skills.
- Develop critical thinking and communication skills.

Course Outcomes:

Students will able to:

- Learn language skills.
- Develop critical thinking and communication skills.

Course Outline:

Essay Writing (introduction), Descriptive essays (5 topics), Narrative essays (5 topic), Discursive essays (5 topic), Argumentative essays (5 topic), Proposal writing for research paper, How to write a research paper : Style , Content, Language, Form, Clarity, Consistency, How to write technical reports, How to write progress report, Models of technical report, Models of progress report, Communication skills, Memo writing, Dictionary skills.

Recommended Books:

1. Eastwood, j. 2004. English practice grammar (new edition with tests and answer).
2. Murphy, R (2003). Grammar in use
3. Hacker, D. 1992. A writer's reference. 2nd edition

Course Title: Arabic Studies

Course Code: Arab-101

Credit Hours: 2(2+0)

Course Objectives:

The main objective of this course is to:

- Provide basic information about the Arabic language.

Course Outcomes:

Students will able to:

- Know about basic information of Arabic language.

Course Outline:

1-حروف الهجاء العربية و نطقها

2-حروف الشمسية والقمرية

3- الضمائر

4- الاسماء الاشارة

5- الاسماء الموصولة

11- باورچی خانے کی چیزیں

12 - الفعل المضعف

13 - الفعل الُصحيح

14- الاءسما الخمسة

15- اسم الفاعل

6- المفرد و الجمع
7- المذكر والموءنث
8- المركب الاضافى
9-المركب التوصيف
10-الفعل الماضى المضارع
16 -العددوالمعدود
17 --حروف الاستفهام
18- حروف جر
19- الجملة الا سمية
20 -الجملة الفعلية

النصوص:(Text)

1-الآيات القرآنية
(سورة الفاتحہ و الاخلاص)
2- الاءحاديث النبوِية
3-الاءنا شيد المختار
4- القصة
5- لقاء فى المطار
6- اعضاء الجسم
7- الاءلوان

الكتاب المقرد: (Prescribed Books)

اللسان العربى :_ 15)مشق(محمد نعمان طاشكندى

جامعة العلامة اقبال المفتو حة ، اسلام آباد-

الكتاب المقترحة (Proposed Book)

1- تكلم العربية : د ـ محمود الصينى وزملاوه
2 ـ دروس اللغة العربية : د ـ فا عبد الرحيم
3 ـ قصص النبين (١-٥) : ابوالحسن على الندوى
4 ـ عربى كا معلم(ا-٤) : مولوى عبد الستار
5 ـ النحو الواضح (ا-٦) : مصطفىٰ امين وعلى جارم
6 ـ البلاغة الواضحة : مصطفىٰ امين وعلى جارم
7- مختصر القواعد العربية : مظهر معين
8- اللغة العربية : اكرام الله خان

Course Title: Physics-III

Course Code: Phys-248

Credit Hours: 4(3+1)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding about electrostatics, electric field, electric potential and electric current.
- Provide basic understanding about DC circuits, magnetism magnetic field effects, laws and magnetic properties of matter.

Course Outcomes:

Students will be able to:

- Understand the concepts of electrostatics, electric field, electric potential and electric current.
- Understand the concepts of DC circuits, magnetism magnetic field effects, laws and magnetic properties of matter.

Course Outline:

Electrostatics: Electric Charge; Conductors and Insulators; Vector form of coulomb's law.

Electric Field: Electric field of continuous charged stribution; Point charge in an electric field; Dipole in an electric field. Gauss's Law; Application of Gauss's Law (Integral Form).

Electric Potential: Calculating the field from the potential; Capacitors and dielectrics; Capacitor with dielectric.

Electric Current: Electric Current; Ohm's Law; Energy transfer in the electric circuit; Semiconductors; Superconductor.

DC Circuits: Calculating the current in a single loop, multiple loops; voltages at various elements of a loop; RC circuits.

Magnetism Magnetic Field Effects: Magnetic field, B. Magnetic force on a charged particle magnetic force on a charged particle magnetic force on a current; Torque on a current loop; Magnetic dipole.

Laws: Biot-Savart Law; Ampere's Law. Faraday's Law; Lenz's Law; Motional E.M.F. Induced electric fields.

Magnetic Properties of Matter: Gauss Law for Magnetism; Origin of Atomic and Nuclear magnetization; Magnetic Materials.

Inductance: Inductance; LR Circuits; Energy stored in magnetic field; Electromagnetic; Oscillation.

Alternating Current Circuits: Alternating Current; Single loop RLC circuit; Power in a.c. circuits; Transformer.

Maxwell's Equations: Summarizing ht electromagnetic equation; Induced magnetic fields & displacement current; Maxwell's equations.

Electromagnetic Waves: Generating an electromagnetic wave; Traveling waves and Maxwell's equation; Energy transport and the Poynting Vector.

Electronics: Semiconductor materials; Junction diode; Transistor; Transistor, biasing; Transistor as an amplifier; Amplification with feedback; Oscillators; Logic Gates.

Course Title: Physics-III Lab

Course Code: Phys-248L

Course Outline:

1. Measurement of resistance using a neon flash bulb and condenser
2. I-H Curve by Magnetometer
3. Conversion of a Pointer Galvanometer into a voltmeter
4. Conversion of a Pointer Galvanometer into an ammeter
5. Calibration of a meter and voltmeter by potentiometer
6. Low resistance by Carey Foster bridge.
7. Charge sensitivity of a ballistic galvanometer taking into account Logarithmic decrement
8. Comparison of capacities by ballistic galvanometer
9. Determination of temperature coefficient of a resistance
10. Measurement of magnetic field by flux meter or by search coil method.
11. Measurement of H by earth inductor.

Recommended Books:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison Wesley, Reading (MA), USA.
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Semester-IV

Course Title: Ordinary Differential Equations-I

Course Code: Math-263

Credit Hours: 3(3+0)

Course Objectives:

The main objevtives of this course are to:

- Identify essential characteristics of ordinary differential equations.
- Develop essential methods for obtaining solutions of first order differential equations.
- Develop essential methods for obtaining solutions of second order differential equations.
- Provide basic understanding about higher order differential equations.
- Explore the use of series methods to solve problems.

Course Outcomes:

Students will be able to:

- Classify ordinary differential equations according to order and linearity, as well as distinguish between initial value problems and boundary value problems.
- Solve standard constant coefficient nonhomogeneous ordinary differential equations by the methods of undetermined coefficients.
- Find series solutions about ordinary and regular-singular points.

Course Outline:

Introduction to Differential Equations: Historical background and motivation, Basic mathematical models: Directional fields, Classification of differential equations.

First Order Differential Equations, Separable equations, Modeling with first order equation, Differences between linear and nonlinear equations, Exact equations and integrating factors

Second Order Differential Equations: Homogenous equations**,** Homogenous equations with constant coefficients**,** Fundamental solutions of linear homogenous equations, Linear independence and the wronskian**,** Method of undetermined coefficients, Variation of parameters.

Higher Order LinearEquations: General theory of nth order linear equations**,** Homogenous equations with constant coefficients,The methods of undermined coefficients, The method of variation of parameters

Series Solution of Second Order Linear Equations and Special Functions: Series solution near an ordinary point,

Recommended Books:

1. W.E. Boyce and Diprima, Elementary Differential Equations, 8th Edition, (John Wiley & Sons, 2005)
2. Erwin, Kreyszig, Advanced Engineering Mathematics, (John Wiley and Sons, 2004)
3. Ross, S.L, Differential Equations, (John Wiley & Sons, 2004)
4. Dennis G. Zill & Michael R. Cullen, Differential Equation With Boundary Value Problems, (PWS Publishing Company, 2000)

5. Richard Bronson, Differential Equations, 2nd Edition,(Schaum's Outline Series, Mc-Graw Hill Company, New York, 1994)

Course Title: Number Theory

Course Code: Math-141

Credit Hours: 2(2+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic ideas of natural numbers, integers and their basic operations.
- Explore the concepts of modular arithmetic.
- Explore concretely about solutions of congruence polynomials and its uses.
- Provide basic ideas about Diophantine equations and arithmetic functions.

Course Outcomes:

Students will able to:

- Get firm grip on basic ideas of natural numbers, integers and their basic operations.
- Apply and use the concepts of modular arithmetic.
- Understand concretely about solutions of congruence polynomials and its uses.
- Apply ideas of Diophantine equations and arithmetic functions in real world problems.

Course Outline:

Prime Numbers: The sieve of Eratosthenes,Perfect numbers, Mersenne primes, Fermat numbers, Theorems related to prime numbers

Divisibility: Divisibility of primes, Divisibility of primes**,** The Euclidean algorithm, Diophantine equation**,** Divisibility tests**,** linear congruences, Techniques for solving linear Congruence, The Chinese remainder theorem**,** finding the day of the week.

Recommended Books:

1. Adler, Andrew, Coury, John E. The Theory of Numbers,(Jones and Barttlet Publishers, Boston, 1995)
2. Kenneth, H. Rosen, Elementary Number Theory and Its Applications (Pearson Addison Wesley Publishers, Boston, 2005)
3. Tom M, Apostol, Introduction to Analytic Number, (Springer, New York, 1980).
4. Burton, D.M. Elementary Number Theory (McGraw Hill, 2000)

Course Title: Discrete Mathematics

Course Code: Math-117

Credit Hours: 2(2+0)

Course Objectives:

The main objectives of this course are to:

- Explore the basic concepts of set theory, arithmetic, logic, proof techniques, binary relations.
- Explore convincing arguments, conceive and/or analyze basic mathematical proofs and discriminate between valid and unreliable arguments.
- Investigate and solve a variety of discrete mathematical problems.

Course Outcomes:

Students will able to:

- Identify and apply basic concepts of set theory, arithmetic, logic, proof techniques, binary relations
- Produce convincing arguments, conceive and/or analyze basic mathematical proofs and discriminate between valid and unreliable arguments
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Course Outline:

Function and Sequences: Introduction to sets, Functions and its Inverses, Sequences, Big-Oh notation

Elementary logic: introduction to elementary logic, propositional caculus, methods of proofs

Induction and Recursion: Loop invariance, Mathematical induction, Recursive definition and Recurrence relations

Relations: Introduction of relation**,** Equivalence relations and partitions of sets, partially ordered sets**,** Special orderings, Properties of general relations

Principles of Counting: Pigeon rule the sum rule, Inclusion exclusion principle, product rule and binomial methods.

Recommended Books:

1. K.A Ross & C.R.B. Wright, Discrete Mathematics, (Prentice Hall, New Jersey, 2003).
2. Kenneth H. Rosen, Discrete Mathematics and its Application, (Mc-Graw Hill Company, 2003)
3. J.P. Trembley & R.Manoher, Discrete Mathematical Structure with Application to Computer Science,(McGraw Hill, 1975).
4. Noman L-Brigs, Discrete Mathematics,(Oxford University Press, 2003).

Course Title: Metric Spaces

Course Code: Math-279

Credit Hours: 2(2+0)

The main objectives of this course are to:

- Explore the basic concepts of metric space and set theory.
- Get the idea of different inequalities.

Course Outcomes:

Students will able to:

- Identify and apply basic concepts of metric space and set theory.
- Apply the knowledge of inequalities to solve mathematical problems.

Course Outline:

Definition and various examples of metric spaces, Holder's inequality, Cauchy-schwarz and minkowski's inequality, Diameter of a set, Distance between sets, Open and closed balls, Neighborhoods, Open and closed sets, Interior, Exterior and boundary points, Limit points, Closure of a set, Convergence in metric spaces, Cauchy sequences, Continuous functions in metric space, Compelte metric space.

Recommended Books

1. Micheal, O. Searcoid, Metric Spaces (Springer, 2007)
2. E. Kreyszig, Introduction to Functional Analysis with Applications (John Wiley and Sons, 1978)
3. W.A. Sutherland, Introduction to Metric and Topological Spaces (Clarendon Press Oxford, 1975)
4. E.T. Copson, Metric Spaces (Cambridge University, Press, 1968)
5. G.F. Simmons, Introduction to Topology and Modern Analysis(McGraw Hill Company, 1963)

Course Title: Introduction to Computer and Programming Languages

Course Code: Math-283

Credit Hours: 4(4+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding of Introduction to Computer, Word processing (MicrosoftWord), Spread Sheets (Microsoft Excel) and other related soft Internet access and different data bases available on the internet.
- Provide basic understanding about the concepts of C language pragramming.

Course Outcomes:

Students will able to:

- Understand the concepts of Introduction to Computer, Word processing (MicrosoftWord), Spread Sheets (Microsoft Excel) and other related soft Internet access and different data bases available on the internet.
- Understand the concepts of C language pragramming.

Course Outline:

Introduction: Introduction to Computers and Information Technology in daily life, Types of Computers, Classification of Computers, Components of Computers, Hardware Components, Output Devices,

Microsoft Office : Definition its types, Application Software, System Software, Storage Devices, System Unit, Communication Channels, The Internet and World Wide Web, Microsoft Office, Microsoft Word, Microsoft Excel,

Overview of Programming Languages: Algorithms And Problem Solving, Introduction to C Programming, Getting Started with C, C Program Structure, Concept of Data Types, Variables declarations and initialization, Standard Input-Output functions in C, Basic C operators, Fundamental Programming Constructs, Basics of Programming Constructs , Sequences - Selection (If/If-else /Nested if-else/, Switch), Repetition -Fixed/Variable Count (For/While/Do-While Loops).

Recommended Books:

1. C++ How to program by DEITEL AND DEITEL
2. HanlyKoffman – Problem Solving & Program Design in C – Addison Wesley 3rd addition.

Course Title: Physics-IV

Course Code: Phys-249

Credit Hours: 4(3+1)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding about the concepts of quantum physics, wave nature of matter, states and energy levels and atomic and nuclear physics atomic structure of hydrogen.
- Provide basic understanding about the concepts of nuclear physics and special theory of relativity.

Course Outcomes:

Students will able to:

- Understand the concepts of quantum physics, wave nature of matter, states and energy levels and atomic and nuclear physics atomic structure of hydrogen.
- Understand the concepts of nuclear physics and special theory of relativity.

Course Outline:

Quantum Physics: Thermal Radiations (Black body radiation);The quantization of Energy; The Photoelectric effect; Einstein's photon theory; The Compton effect; Line Spectra.

Wave Nature of Matter: Wave behavior of particles; Testing De Broglie's hypothesis; Waves, Wave packets and particles; Heisenberg's uncertainty principle (HUP); Wave Function; Schrödinger Equation.

States and Energy Levels: Trapped Particles and Probability; Densities; The correspondence principles; Dual nature of matter (waves & particles) **Atomic and Nuclear Physics Atomic Structure of Hydrogen:** Bohr's Theory; Angular Momentum of Electrons; Electron Spin; X-ray Spectrum; X-Ray & Atomic number; Development of periodic table; Laser.

Nuclear Physics: Discovering the nucleus; Some nuclear properties; Radioactive decay; Alpha decay; Beta decay; Measuring ionizing radiation (Units); Natural Radioactive; Nuclear Reactions; Energy from the nucleus; Nuclear fission; Nuclear Reactors; Thermonuclear Fusion (T.N.F.); Controlled Thermonuclear Fusion.

Practical Paper: Mechanics, Thermodynamics, Sound, Optics and Electricity or Magnetism:

Special theory of Relativity: Trouble with classical Mechanics; Postulates of Relativity; The Lorentz Transformation inverse transformation Consequences of Lorentz transformation; Relativistic momentum; Relativistic energy.

Course Title: Physics-IV Lab

Course Code: Phys-249L

Course Outline:

1. Variation of photo-electric current with the intensity of light
2. Measurement of Planck's constant using spectrometer
3. Determination of e.m. of electron by deflection method
4. Determination of ionization potential of mercury
5. Acceptor circuit
6. Rejecter circuit
7. Characteristic curves of G.M. Counter
8. Setting up half and full wave rectifiers and the study of the waveshape on oscilloscope effect of smoothing circuit on ripple voltage.
9. To set up a transistor as an oscillator and to measure its frequency by an oscilloscope

10. Triode valve as a single stage voltage amplifier and measurement of its gain by an oscilloscope
11. To draw the characteristics of a semi-conductor diode.
12. Setting up a single stage transistor amplifier and measurement of voltage gain
13. Determination of range of Alpha Particles
14. Stopping power for alpha particles in air equivalent of Mica, Ag, Cu and Al.
15. Absorption coefficient of Beta-particles, using and End-on-Geiger Counter
16. To study the voltage current characteristics of an electric Discharge in gases at low pressures
17. Production of vacuum and its rought measurement with a monometer
18. Production of X-rays and the demonstration of their effect on a fluorescent screen.
19. To set up a High-Frequency Oscillator and measure its frequency, with a wave meter.

Recommended Books:

1. Physics Vol. I & II (extended) by Resnick, Halliday and Karne, 4th and Sons Inc, New York.
2. Fundamentals of Physics by Halliday Resnick and Krane, John Wiley and Sons Inc, New York.
3. University Physics 8th Edition by Sears, Zemansky and Young, Addison Wesley, Reading (MA), USA.
4. Physics by Alonso and Finn; Addison-Wesley, Reading (MA) USA.

Semester-V

Course Title: Real Analysis-I

Course Code: Math-351

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Define basic ideas of real numbers, and their basic operations.
- Enhance concepts of infinite sequences and series.
- Explore concretely about continuity, differentiability and partial differentiations.

Course Outcomes:

Students will able to:

- Get firm grip on basic ideas of real numbers, and their basic operations.
- Apply and use the concepts of infinite sequences and series.
- Learn concretely about continuity, differentiability and their uses.
- Apply ideas of partial differentiations and its uses in real world problems.

Course Outline:

Real Number System: Ordered sets, fields, the field of real numbers, Completeness property of R, The extended real number system, Euclidean spaces, Finite, countable and uncountable sets

Sequences and Series: Sequences, sub sequences, convergent sequences, Cauchy sequences, Monotone and bounded sequences, Bolzano Weierstrass theorem, Series, series of non-negative terms, Partial sums, the root and ratio tests, integral test, comparison test, Absolute and conditional convergence

Limit and Continuity: The limit of a function, Continuous functions, Types of discontinuity, Uniform continuity, Monotone functions

Differentiation: The derivative of a function, Mean value theorems, the continuity of derivatives, Taylor's theorem

Functions of Several Variables: Partial derivatives and differentiability, derivatives and differentials of composite functions, Change in the order of partial derivative, implicit functions, inverse functions, Jacobians, Maxima and minima.

Recommended Books:

1. W. Rudin, Principles of Mathematical Analysis, 3rd edition, (McGraw Hill, 1976)
2. R. G. Bartle, Introduction to Real Analysis, 3rd edition, (John Wiley and Sons, 2000)
3. T. M. Apostol, Mathematical Analysis, (Addison-Wesley Publishing Company, 1974)
4. A. J. Kosmala, Introductory Mathematical Analysis, (WCB Company, 1995)
5. W. R. Parzynski and P. W. Zipse, Introduction to Mathematical Analysis, (McGraw Hill Company, 1982)
6. H. S. Gaskill and P. P. Narayanaswami, Elements of Real Analysis, (Printice Hall, 1988)

Course Title: Group Theory

Course Code: Math-325

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Get firm grip on basic ideas of groups and their basic operations with examples.
- Apply and use the concepts of subgroups and Lagrange's theorem.
- Explore concretely about group homomorphism and its uses.
- Provide ideas of classifications and Sylow Theorems

Course Outcome:

Students will able to:

- Define basic ideas of groups and their basic operations with examples.

- Understand the concepts of subgroups and Lagrange's theorem.
- Understand concretely about group homomorphism and its uses.
- Understand ideas of classifications and Sylow Theorems

Course Outline:

Groups: Binary operations, Definition and examples of groups,order of an element, order of group, Abelian group, Subgroups lattice, Lagrange's theorem, Relation between groups, cyclic groups, Groups and symmetries, even and odd permutations, Cayley's theorem

Complexes in Groups: Complexes and co-set decomposition of groups, Centre of a group, Normalizer in a group, Centralizer in a group, Conjugacy classes and congruence relation in a group, Double co-sets

Normal Subgroups: Definition, Proper and improper normal subgroups, Factor groups, Fundamental theorem of homomorphism, Automorphism group of a group, Commutator subgroups of a group

Permutations Groups: Symmetric or permutations group, Transpositions, Cyclic permutations and orbits, The Alternating group, Generators of the symmetric and Alternating groups, Simplicity of Alternating groups

Sylow Theorems: Double Cosets, Cauchy's theorem for Abelian and non-Abelian group, Sylow theorems with proofs, Application of sylow theory

Recommended Books

1. J. Rose, A Course on Group Theory, (Cambridge University Press, 1978)
2. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company, 1964)
3. P. M. Cohn, Algebra, (John Wiley and Sons, London, 1974)
4. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, (Cambridge University Press, 1986)
5. J. B. Fraleigh, A First Course in Abstract Algebra, (Addison-Wesley Publishing Company, 2002)

Course Code: Math-312

Course Title: Complex Analysis-I

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Get firm grip on basic ideas of complex numbers and their basic operations with examples.
- Apply and use the concepts of analytic functions and limits.
- Provide basic understanding about elementary functions and their properties.
- Explore the ideas of complex integration and power series expansion.

- Use concept of infinite series.

Course Outcomes:

Students will able to:

- Define basic ideas of complex numbers and their basic operations with examples.
- Understand the concepts of analytic functions and limits.
- Learn concretely about elementary functions and their properties.
- Explore ideas of complex integration and power series expansion.
- Understand the concept of infinite series.

Course Outline:

The Concept of Analytic Functions: Complex numbers, complex planes, complex functions, Analytic functions, Entire functions**,** Harmonic functions,

Elementary functions: complex trigonometric, exponential, logarithmic and hyperbolic functions

Complex Integration: Complex integrals, Cauchy-Goursat theorem, Cauchy's integral formula and their consequences, Liouville's theorem, Morera's theorem, Derivative of an analytic function.

Infinite Series: Power series, derived series, radius of convergence, Taylor series and Laurent series

Recommended Books

1. D. G. Zill and P. D. Shanahan, Complex Analysis, (Jones and Bartlett Publishers, 2003)
2. H. S. Kasana, Complex Variables: Theory and Applications, (Prentice Hall, 2005)
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th edition, (McGraw Hill Company, 2004)
4. M. R. Spiegel, Complex Variables, (McGraw Hill Book Company, 1974)
5. Louis L. Pennisi, Elements of Complex Variables, (Holt, Linehart and Winston, 1976)

Course Code: Math-359

Course Title: Vector and Tensor Analysis

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Provide an understanding about the concepts of vector integration, Integral Theorems and curvilinear coordinates.
- Explore tensor analysis.

Course Outcomes:

Students will able to:

- Understand the concepts of vector integration, Integral Theorems and curvilinear coordinates.
- Define the coordinates on flat and curved surfaces.

Course Outline:

Vector Integration: Line integrals, Surface area and surface integrals, Volume integrals

Integral Theorems: Green's theorem, Gauss divergence theorem, Stoke's theorem

Curvilinear Coordinates: Orthogonal coordinates, Unit vectors in curvilinear systems, Arc length and volume elements, The gradient, divergence and curl, Special orthogonal coordinate system.

Tensor Analysis: Coordinate transformations, Einstein summation convention, Tensors of different ranks, Contravariant, covariant and mixed tensors, Symmetric and skew symmetric tensors, Addition, subtraction, inner and outer products of tensors, Contraction theorem, quotient law, The line element and metric tensor, Christoffel symbols.

Recommended Books:

1. F. Chorlton, Vector and Tensor Methods, (Ellis Horwood Publisher, Chichester, U.K., 1977)
2. M. R. Spiegel, Vector Analysis, (McGraw Hill Book Company, Singapore, 1981)
3. A. W. Joshi, Matrices and Tensors in Physics, (Wiley Eastern Limited, 1991)
4. Hwei P. Hsu, Applied Vector Analysis, (Harcourt Brace Jovanovich Publishers, San Diego, New York, 1984)

Course Title: Topology

Course Code: Math-358

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe topological spaces with examples.
- Differentiate some simple topological spaces through homeomorphism.
- Check connectedness and compactness of topological spaces.

Course Outcomes:

Students will able to:

- Define topological spaces with examples.
- Explore some simple topological spaces through homeomorphism.
- Understand connectedness and compactness of topological spaces.

Course Outline:

Topology: Definition and examples, Open and closed sets, Subspaces, Neighborhoods, Limit points, closure of a set, Interior, exterior and boundary of a set

Bases and Sub-bases: Base and sub bases, Neighborhood bases, First and second axioms of countablility, Separable spaces, Lindelöf spaces, Continuous functions and homeomorphism, Weak topologies, finite product space**s**

Separation Axioms: Separation axioms, Regular spaces, Completely regular spaces, Normal spaces

Compact Spaces: Compact topological spaces, Countably compact spaces, Sequentially compact spaces

Connectedness: Connected spaces, disconnected spaces, Totally disconnected spaces, Components of topological spaces.

Recommended Books:

1. J. Dugundji, Topology, (Allyn and Bacon Inc., Boston 1966)
2. G. F. Simmon, Introduction to Topology and Modern Analysis, (McGraw Hill Book Company, New York, 1963)
3. Stephen Willard, General Topology, (Addison-Wesley Publishing Co., London, 1970)
4. Seymour Lipschutz, General Topology, (Schaum's Outline Series, McGraw Hill Book Company 2004)
5. James R. Munkres, Topology, 2nd edition, (Prentice Hall Inc., 2003)

Course Title: Differential Geometry

Course Code: Math-315

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of curves, curvatures and torsions with examples.
- Explore the ideas of surfaces.
- Study Gauss and Weingarten equations and Gauss and Codazzi equations.

Course Outcomes:

Students will able to:

- Define basic ideas curves, curvatures and torsions with examples.
- Understand ideas of surfaces.
- Explore Gauss and Weingarten equations and Gauss and Codazzi equations.

Course Outline:

Theory of Space Curves: Introduction, index notation and summation convention, Space curves, arc length, tangent, normal and binormal, Osculating, normal and rectifying planes, Curvature and torsion, The Frenet-Serret theorem, Natural equation of a curve, Involutes and evolutes, helices, Fundamental existence theorem of space curves.

Theory of Surfaces, Coordinate transformation, Tangent plane and surface normal, The first fundamental form and the metric tensor, Christoffel symbols of first and second kinds

The second fundamental form: Principal, Gaussian, mean, geodesic and normal curvatures, Gauss and Weingarten equations, Gauss and Codazzi equations,

Recommended Books:

1. R. S. Millman & G.D. Parker, Elements of Differential Geometry (Prentice-Hall, New Jersey,1977)
2. A. Goetz, Introduction to Differential Geometry (Addison-Wesley, 1970).
3. E. Kreyzig, Differential Geometry (Dover, 1991).
4. M. M. Lipschutz, Schaum's Outline of Differential Geometry (McGraw Hill, 1969).
5. D. Somasundaram, Differential Geometry (Narosa Publishing House, New Delhi, 2005).

Semester-VI

Course Title: Real Analysis-II

Course Code: Math-352

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Get firm grip on basic ideas of Riemann integral.
- Apply and use the concepts of Riemann Stieljes (R-S) Integrals.
- Know concretely about function of bounded variation and properties.
- Explore the concepts of improper integrals.
- Explore the concepts of sequences and series of functions.

Course Outcomes:

Students will able to:

- Define basic ideas of Riemann integral.
- Understand the concepts of Riemann Stieljes (R-S) Integrals.
- Understand concretely about function of bounded variation and properties.
- Define sequences and series of functions.

Course Outline:

The Riemann-Stieltjes Integrals: Definition and existence of integrals, Properties of integrals, Fundamental theorem of calculus and its applications, Change of variable theorem, Integration by parts,

Functions of Bounded Variation: Definition, examples & Properties of functions of bounded variation

Improper Integrals: Types of improper integrals, Tests for convergence of improper integrals, Beta and gamma functions, Absolute and conditional convergence of improper integrals

Sequences and Series of Functions: Power series, Definition of point-wise and uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Examples of uniform convergence.

Recommended Books:

1. W. Rudin, Principles of Mathematical Analysis, 3rd edition, (McGraw Hill 1976)
2. R. G. Bartle, Intoduction to Real analysis, 3rd edition, (John Wiley and sons, 2000)
3. T. M. Apostol, Mathematical Analysis, (Addison-Wesley Publishing Co., 1974)
4. A. J. Kosmala, Introductory Mathematical Analysis, (WCB company, 1995)
5. W. R. Parzynski and P. W. Zipse, Introduction to Mathematical Analysis, (Mc Graw Hill company, 1982)
6. H. S. Gaskill and P. P. Narayanaswami, Elements of Real Analysis, (Printice Hall, 1988)

Course Title: Linear Algebra-II

Course Code: Math-329

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding about the concept of ring theory and dual spaces.
- Find eigenvalues and eigenvectors.
- Check whether a given mapping is a linear transformation or not.

Course Outcomes:

The main objectives of this course are to:

- Understand the concepts of ring theory and dual spaces.
- Determine eigenvalues and eigenvectors.
- Determine whether a given mapping is a linear transformation or not.

Course Outline:

Ring Theory: Definition and example of rings, Special classes of rings, Fields, Ideals and quotient rings, Ring homomorphisms, Prime and maximal ideals, Field of quotients

Linear Mappings of Vector Spaces: Review of vector spaces, Mappings, linear mappings, Rank and nullity, Linear mappings and system of linear equations, Algebra of linear operators, Space L(X, Y) of all linear transformations

Matrices and Linear Operators: Matrix representation of a linear operator, Change of basis, Orthogonal matrices and orthogonal transformations, Orthonormal basis and Gram Schmidt process

Linear Transformations: Introduction to linear transformation, Matrices of linear transformations, Rank and nullity, Eigen values and Eigen vectors, Diagonalization, Orthogonal diagonalization, orthogonal matrices, similar matrices. Eigen values and eigen vectors: Polynomials of matrices and linear operators, Characteristic polynomial.

Recommended Books:

1. J. Rose, A Course on Group Theory, (Cambridge University Press, 1978)
2. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company, 1964)
3. G. Birkhoff and S. Maclane, A Survey of Modern Algebra, (Macmillan, New York, 1964)
4. P. B. Battacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, (Cambridge University Press, 1986)
5. V. Sahai and V. Bist, Algebra, 2nd edition, (Narosa Publishing House, 2003)
6. W. Keith Nicholson, Elementary Linear Algebra, (PWS-Kent Publishing Company, Boston, 2004)
7. Seymour Lipschutz, Linear Algebra, 3rd edition, (McGraw Hill Book Company, 2001)

Course Title: Complex Analysis-II

Course Code: Math-368

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding about the concept of singularity, poles and expansion of functions and analytic continuation.
- Enhance conformal representation.
- Get a grip on concepts of expansion of Functions and analytic continuation
- Explore the concepts of elliptic functions.

Course Outcomes:

Students will able to:

- Define singularity and poles.
- Understand the concept of conformal representation.
- Understand the concepts of expansion of Functions and analytic continuation.
- Understand the concept of elliptic functions.

Course Outline:

Singularity and Poles: Review of Laurent series, Zeros, singularities, Poles and residues, Cauchy's residue theorem, Applications of Cauchy's residue theorem.

Conformal Representation: Transformation, conformal transformation, linear transformation, Möbius/bilinear transformations

Expansion of Functions and Analytic Continuation: Mittag-Leffler theorem, Weierstrass's factorization theorem, Analytic continuation

Elliptic Functions: Periodic functions, Elliptic functions and its properties, Weierstrass function $\varphi(z)$, Differential equation satisfied by $\varphi(z)$, Integral formula for $\varphi(z)$, Addition theorem for $\varphi(z)$, Duplication formula for $\varphi(z)$, Elliptic functions in terms of Weierstrass function with the same periods, Quasi periodic functions: The zeta and sigma functions of Weierstrass, Jacobian elliptic functions and its properties.

Recommended Books:

1. H. S. Kasana, Complex Variables: Theory and Applications, (Prentice Hall, 2005)
2. M. R. Spiegel, Complex Variables, (McGraw Hill Book Company, 1974)
3. Louis L. Pennisi, Elements of Complex Variables, (Holt, Linehart and Winston, 1976)
4. W. Kaplan, Introduction to Analytic Functions, (Addison-Wesley, 1966)
5. E. D. Rainville, Special Functions, (The Macmillan Company, New York, 1965)
6. E. T. Whittaker and G. N. Watson, A Course of Modern Analysis,Cambridge University Press, 1958.

Course Title: Analytical Mechanics

Course Code: Math-305

Credit Hours: 3(3+0)

Course Objectives:

Its objectives are given below:

- To develop fundamental concepts in analytics mechanics more rigorously as needed for other courses of the program.
- To apply advanced mathematical and computational techniques to complex problems.

Course Outcomes:

Students will able to:

- Understand the concept of non inertial reference systems and planar motion of rigid bodies
- Understand the concept of motion of rigid bodies in three dimensions.
- Understand the concept of euler equations of motion of a rigid body.

Course Outline:

Non Inertial Reference Systems: Accelerated coordinate systems and inertial forces, Rotating coordinate systems, Velocity and acceleration in moving system: coriolis, centripetal and transverse, Acceleration, Dynamics of a particle in a rotating coordinate system

Planar Motion of Rigid Bodies: Introduction to rigid and elastic bodies, degrees of freedom, translations, rotations, instantaneous axis and center of rotation, motion of the center of mass, Euler's theorem and Chasle's theorem, Rotation of a rigid body about a fixed axis: moments and products of inertia, hoop or cylindrical shell, circular cylinder, spherical shell, Parallel and perpendicular axis theorem, Radius of gyration of various bodies

Motion of Rigid Bodies in Three Dimensions: General motion of rigid bodies in space: Moments and products of inertia, inertia matrix, The momental ellipsoid and equimomental systems, Angular momentum vector and rotational kinetic energy, Principal axes and principal moments of inertia, Determination of principal axes by diagonalizing the inertia matrix

Euler Equations of Motion of a Rigid Body: Force free motion, Free rotation of a rigid body with an axis of symmetry, Free rotation of a rigid body with three different principal moments, The Eulerian angles, angular velocity and kinetic energy in terms of Euler angles, space, cone, Motion of a spinning top and gyroscopes- steady precession, sleeping top.

Recommended Books:

1. G. R. Fowles and G. L. Cassiday, Analytical Mechanics, 7th edition, (Thomson Brooks/Coley, USA, 2005)
2. M. R. Spiegel, Theoratical Mechanics, (McGraw Hill Book Company, Singapore, 1980)
3. F. P. Beer and E. Russell Johnston, Jr., Vector Mechanics for Engineers -Statics and Dynamics, (McGraw Hill Inc., 1977)
4. H. Goldstein, Classical Mechanics, (Addison-Wesley Publisihng Co., 1980)
5. C. F. Chorlton, Text Book of Dynamics, (Ellis Horwood, 1983)

Course Title: Functional Analysis

Course Code: Math-423

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of normed spaces.
- Differentiate rings through some homomorphism.
- Explore concretely about linear operators and linear functional.
- Provide basic understanding about ideas of inner product space and Hilbert space.

Course Outcomes:

Students will able to:

- Understand the basic ideas of normed spaces with examples.
- Understand the concept of rings through some homomorphism.
- Understand concretely about linear operators and linear functional.
- Define inner product space and Hilbert space.

Course Outline:

Metric Spaces: Review of Metric space, Completeness proofs, Dense sets and separable spaces, No-where dense sets, Baire category theorem

Normed Spaces, Normed linear spaces, Banach spaces, Convex sets, Quotient spaces, Equivalent norms, Linear operators, Linear functionals, Finite dimensional normed spaces, Continuous or bounded linear operators, Dual spaces.

Inner Product Spaces: Definition and examples, Orthonormal sets and bases, Annihilators, projections, Hilbert space, Linear functionals on Hilbert spaces, Reflexivity of Hilbert spaces.

Recommended Books:

1. E. Kreyszig, Introduction to Functional Analysis with Applications, (John Wiley and Sons, 2004)
2. A. L. Brown and A. Page, Elements of Functional Analysis, (Van Nostrand Reinhold London, 1970)
3. G. Bachman and L. Narici, Functional Analysis, (Academic Press, New York, 1966)
4. F. Riesz and B. Sz. Nagay, Functional Analysis, (Dover Publications, Inc., New York, Ungar, 1965)
5. A. E. Taylor, Functional Analysis, (John Wiley and Sons, Toppan, 1958)

Course Title: Ordinary Differential Equation-II

Course Code: Math-347

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the courses are to:

- Explore features of first and second order differential equations.
- Explore essential methods of obtaining series solutions of second order differential equations.
- Explore the methods of series solutions of special ordinary differential equations.
- Investigate systems of Sturm Liouville equations.

Course Outcomes:

Students will able to:

- Understand the features of first and second order differential equations.
- Use essential methods for obtaining series solutions of second order differential equations.
- Determine series solutions of special ordinary differential equations.
- Solve systems of Sturm Liouville equations.

Course Outline

First and Second Order Differential Equations: Review of ordinary differential equations, Techniques of solving second and higher differential equations

Sturm Liouville Systems: Some properties of Sturm-Liouville equations, Regular, periodic and singular Sturm-Liouville systems and its applications

Series Solutions of Second Order Linear Differential Equations: Review of power series, Series solution near an ordinary point, Series solution near regular singular points, Legendre's equation**,** Regular singular points, Series solution near a regular singular point.

Series Solution of Some Special Differential Equations: Hyper geometric function $F(a, b, c; x)$ and its evaluation, Series solution of Bessel equation, Expression for $J_n(X)$when n is half odd integer, Recurrence formulas for $J_n(X)$, Series solution of Legendre equation, Rodrigues formula for polynomial $P_n(X)$ Generating function for $P_n(X)$, Recurrence relations, orthogonal polynomials, Orthogonality of Bessel functions, Expansions of polynomials, The three term recurrence relation.

Recommended Books

1. E. D. Rainville, Special Functions (Macmillan and Company, 1971)
2. G. E. Andrews, R. Askey and R. Roy, Special Functions (Cambridge University Press, 2000)
3. D. G. Zill, Advanced Engineering Mathematics (Jones and Bartlett Publishers, 2005)
4. W. E. Boyce and R. C. Diprima, Elementary Differential Equations and Boundary Value Problems (John Wiley and Sons, 2005)
5. N. M. Temme, Special Functions, An Introduction to the Classical Functions of Mathematical Physics (John Wiley and Sons, 1996)

6. E. T. Whittaker, and G. N. Watson, A Course of Modern Analysis (Cambridge University Press, 1958)

Semester-VII

Course Title: Set Theory

Course Code: Math-464

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Understand the basic concepts of cardinality, discuss and prove Cantor's Theorem and discuss the status of the Continuum Hypothesis.
- Explain basic concepts and prove basic facts about ordinals and well-ordered sets.
- Understand the basic concepts of axiom of choice and paradoxes in set theory.

Course Outcomes:

Students will able to:

- Define cardinality, discuss and prove Cantor's Theorem and discuss the status of the Continuum Hypothesis.
- Understand the basic concepts of ordinals and well-ordered sets.
- Understand the concepts of axiom of choice and paradoxes in set theory.

Course Outline:

Cardinality: Equivalent sets, finite and infinite sets, denumerable sets, Countable and uncountable sets, Cardinal numbers, addition and multiplication of cardinals, Cartesian product as sets of functions, Different types of infinity (Cantor's contribution)

Ordinality: Partially ordered sets, Hasse diagrams, Totally ordered sets, Maximal and minimal elements, Upper and lower bound, Well-ordered sets, Transfinite induction, Ordinal numbers, Multiplication of ordinal numbers

Axiom of Choice: Well ordering theorem, Zorn's lemma

Paradoxes in Set Theory: Cantor's paradox, Russell's paradox and others.

Recommended Books:

1. A. A. Fraenkal, Abstract Set Theory, (North-Holland Publishing, Amsterdam, 1966).
2. Patrick Suppes, Axiomatic Set Theory, (Dover Publications, Inc., New York, 1972).
3. P. R. Halmos, Naive Set Theory, (Van Nostrand, New York, 1960).

4. B. Rotman and G. T. Kneebone, The Theory of Sets and Transfinite Numbers, (Oldbourne, London, 1968).
5. Douglas Smith, Maurice Eggen and Richard St. Andre: A Transition to Advanced Mathematics, (Brooks/Cole, 2001).

Course Title: Partial Differential Equation

Course Code: Math-448

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Know where and how PDEs arise in applications and understand concepts of PDE theory.
- Describe analytical methods for solving PDEs.
- Solve linear second order PDEs using canonical variables for initial-value problems.

Course Outcomes:

Students will able to:

- Understand fundamental concepts of PDE theory.
- Apply analytical methods for solving PDEs.
- Solve linear second order PDEs using canonical variables for initial-value problems and Separation of variables.

Course Outline:

Introduction: Review of ordinary differential equation in more than one variables, Linear partial differential equations (PDEs) of the first order, Cauchy's problem for quasilinear first order PDEs

PDEs of Second Order: PDEs of second order in two independent variables with variable coefficients, Linear transformation from one equation to another equation, Normal form, Cauchy's problem for second order PDEs in two independent variables

Adjoint Equation: Adjoint operator, Self adjoint equation and operator, Linear PDEs in n-independent variables, Lagrange's identity, Green's theorem for self adjoint operator

Boundary Value Problems: Laplace equation, Dirichlet problem for a circle, Poisson's integral for a circle, Solution of Laplace equation in Cartesian, cylindrical and spherical coordinates, The wave equation in one dimension and higher dimensions, The heat equation, Axially symmetric solutions.

Recommended Books:

1. I. N. Sneddon, Elements of Partial Differential Equations (Dover Publishing, Inc., 2006)

2. R. Dennemyer, Introduction to Partial Differential Equations and Boundary Value Problems (McGraw Hill Book Company, 1968)
3. M. Humi and W. B. Miller, Boundary Value Problem and Partial Differential Equations (PWS-Kent Publishing Company, Boston, 1991)
4. C. R. Chester, Techniques in Partial Differential Equations (McGraw Hill Book Company, 1971)
5. 5.R. Haberman, Elementary Applied Partial Differential Equations, 2nd edition (Prentice Hall Inc., New Jersey, 1987)
6. E. Zauderer, Partial Differential Equations of Applied Mathematics (Wiley-Interscience, Englewood Cliff, New York, 2006)

Course Title: Numerical Analysis-I

Course Code: Math-442

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are to:

- Describe basic ideas of number system and errors.
- Explore ideas for solution of non-linear equations.
- Understand ideas of interpolation and polynomial approximation.

Course Outcomes:

Students will able to:

- Understand basic ideas of number system and errors.
- Determine solution of non-linear equations.
- Understand the concept of interpolation and polynomial approximation.

Course Outline

Number Systems and Errors: Round off errors and computer arithmetic, Error estimation, Floating point arithmetic

Solution of Non-Linear Equations: Iterative methods and convergence: Bisection method, fixed point iterative method, Regula Falsi, Secant and Newton's method

Systems of Linear Equations: Direct methods: Gaussian elimination method, Gauss-Jordan method, matrix inversion method, factorization (Doolittle, Crout and Cholesky) method and its various forms, Iterative methods and convergence: Gauss-Jacobi method and Gauss-Seidel method, Ill-condition system and condition number, Eigen values and eigenvectors, Power and Rayleigh quotient method

Interpolation and Polynomial Approximation: Difference operators, Interpolation with unequal intervals: Lagrange's interpolation formula, Newton's divided, difference formula, error in polynomial interpolation, Interpolation with equal intervals: Gregory Newton forward/backward interpolation, formula, error in polynomial interpolation, Central difference interpolation formulae: Gauss's forward/backward interpolation, formula, Stirling's formula, Laplace Everett's and Bessel's formula.

Recommended Books:

1. Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 6th edition, (Addison-Wesley Pearson Education, 2003)
2. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 6th edition, (Brooks/Cole Publishing Company, 1997)
3. John H. Mathews, Numerical Methods for Mathematics, 3rd edition (Prentice Hall International, 2003)
4. V. N. Vedamurthy and N. Ch. S. N. Iyenger, Numerical Methods, (Vikas Publishing House Pvt. Ltd, 2002)
5. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, 3rd edition, (McGraw Hill International Edition, 1998)

Course Title: Mathematical Statistics-I

Course Code: Math-431

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of probability distributions with examples.
- Apply ideas of mathematical expectations.
- Know special probability distributions and special probability densities.
- Understand ideas of random variables and sampling distributions.

Course Outcomes:

Studens will able to:

- Construct probability distributions with examples.
- Use ideas of mathematical expectations.
- Understand special probability distributions and special probability densities.
- Understand the concepts of random variables and sampling distributions.

Course Outline:

Probability Distributions: The postulates of probability, Some elementary theorems, Addition and multiplication rules, Baye's rule and future Baye's theorem, Random variables and probability functions.

Discrete Probability Distributions: Uniform, Bernoulli and Binomial distribution, Hypergeometric and geometric distribution, Negative binomial and Poisson distribution

Continuous Probability Distributions: Uniform and exponential distribution, Gamma and beta distributions, Normal distribution.

Mathematical Expectations: Moments and moment generating functions, Moments of binomial, hypergeometric, Poisson, gamma, beta and normal distributions

Recommended Books:

1. J. E. Freund, Mathematical Statistics, (Prentice Hall Inc., 1992)
2. Hogg and Craig, Introduction to Mathematical Statistics, (Collier Macmillan, 1958)
3. Mood, Greyill and Boes, Introduction to the Theory of Statistics, (McGraw Hill)
4. R. E. Walpole, Introduction to Statistics, 3rd edition, (Macmillan Publishing Company London, 1982)
5. M. R. Spiegel and L. J. Stephens, Statistics, (McGraw Hill Book Company, 1984)

Course Title: Programming in MATLAB

Course Code: Math-471

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of MATLAB Environment.
- Provide basic knowledge of programming in MATLAB.

Course Outcomes:

Studens will able to:

- understand basic idea of MATLAB Environment.
- Make programs in MATLAB.

Course Outline:

The MATLAB Environment: The Advantages of MATLAB**,** MATLAB Desktop, Command Window, Command History Window, Start Button, Edit/Debug Window, Figure Windows, Docking and Undocking Windows, MATLAB Workspace, Getting Help

MATLAB Basics: Variables and Arrays, Initializing Variables in MATLAB, Multidimensional Arrays, Subarrays, Special Values, Displaying Output Data, Scalar and Array Operations, Built-in MATLAB Functions, Introduction to Plotting.

Branching Statements and Program Design: Introduction to Top-Down Design Techniques, Use of Pseudocode, The Logical Data Type: Relational Operators, A Caution About the == and ~= Operators , Logic Operators, Logical Functions. Branches: The if Construct, Examples Using if Constructs, The switch Construct, The try/catch Construct. Additional Plotting Features: Controlling x- and y-axis Plotting Limits, Plotting Multiple Plots on the Same Axes, Creating Multiple Figures, Subplots , Enhanced Control of Plotted Lines.

Loops: The while loop, The for loop: Details of Operation, The MATLAB Just-in-Time (JIT) Compiler, The break and continue Statements, Nesting Loops. Logical arrays and vectorization: Creating the Equivalent of if/else Constructs with Logical Arrays.

Recommended Books:

1. S.J. Chapman, MATLAB programming for engineers, (Nelson Education, 2015).
2. S. Attaway, Matlab: a practical introduction to programming and problem solving, (Butterworth-Heinemann, 2013).
3. F. B. Gross, Smart antennas with MATLAB, (McGraw-Hill Education, 2015).
4. S.J. Chapman, Essentials of MATLAB programming, (Cengage Learning, 2016)

Course Title: Advanced Group Theory-I

Course Code: Math-403

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Define automorphisms and products in groups with examples.
- Understand the concept of permutation groups.
- Understand the concept of series in groups.

Course Outcomes:

Students will able to:

- Understand the concept of automorphisms and products in groups with examples.
- Understand the concept of permutation groups.
- Understand the concept of series in groups.

Course Outline:

Automorphisms and Products in Groups: Characteristic and fully invariant subgroups, Normal products of groups, Holomorph of a group

Permutation Groups: Symmetric or permutation group, Permutability of permutations, Transposions, Generators of the symmetric and alternating group, Cyclic permutations and orbits, the alternating group, Generators of the symmetric and alternating groups, Simplicity of $A, n \geq 5$, The stabiliser subgroups,

Series in Groups: Series in groups, Zassenhaus lemma, Normal series and their refinements, Composition series

Recommended Books:

1. J. Rotman, The Theory of Groups, 2nd edition, (Allyn and Bacon, London, 1978)
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-Weseley Publishing Co.)
3. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company Mass, 1972)
4. J. A. Gallian, Contemporary Abstract Algebra, 4th edition, (Narosa Publishers, 1998)
5. J. S. Rose, A Course on Group Theory, (Dover Publications, New York, 1994)
6. K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Course Title: Rings and Modules

Course Code: Math-454

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of rings and modules with examples.
- Differentiate rings through some homomorphism.
- Know concretely about function of bounded variation and properties.
- Understand ideas of fields and finite fields.

Course Outcomes:

Students will able to:

- Understand basic concepts of rings and modules with examples.
- Understand basic concepts of rings through some homomorphism.
- Understand concretely about function of bounded variation and properties.
- Understand basic concepts of fields and finite fields.

Course Outline:

Ring Theory: Construction of new rings, Direct sums, polynomial rings, Matrix rings, Divisors, units and associates, Unique factorisation domains, Principal ideal domains and Euclidean domains

Field Extensions: Algebraic and transcendental elements, Degree of extension, Algebraic extensions, Reducible and irreducible polynomials, Roots of polynomials.

Recommended Books:

1. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company Mass, 1972)
2. B. Hartley & T. O. Hauvkes, Rings, Modules & Linear Algebra, (Chapmann and Hall Ltd., London)
3. R. B. Allenly, Rings, Fields and Groups:An Introduction to Abstract Algebra, (Edward Arnold, 1985)
4. J. Rose, A Course on Rings Theory, (Cambridge University Press, 1978)
5. G. Birkhoff and S. Maclane, A Survey of Modern Algebra, (Macmillan, New York, 1964)

Course Title: Advance Number Theory-I

Course Code: Math-469

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic details of congruences.
- Understand the ideas of number-theoretic functions.
- Grip ideas of primitive roots and indices.

Course Outcomes:

Students will able to:

- Understand basic details of congruences.
- Use ideas of number-theoretic functions.
- Understand the concept of primitive roots and indices.

Course Outline:

Congruences: Elementary properties of prime numbers, Residue classes and Euler's function, Linear congruences and congruences of higher degree, Congruences with prime moduli, The theorems of Fermat, Euler and Wilson

Number-Theoretic Functions: Möbius function, The function [x], the symbols O and their basic properties

Primitive roots and indices: Integers belonging to a given exponent, Composite moduli, primitive roots modulo a prime, Determination of integers having primitive roots indices

Recommended Books:

1. W. J. Leveque, Topics in Number Theory, (Vols. I and II, Addison-Wesley Publishing Co., 1956)
2. Tom M. Apostol, Introduction to Analytic Number theory, (Springer International, 1998)
3. David M. Burton, Elementary Number Theory, 6th edition, (McGraw Hill Company, 2007)
4. A. Andrew, The Theory of Numbers, (Jones and Barlett Publishers London, 1995)
5. Harry Pollard, The Theory of Algebraic Numbers, (John Wiley and Sons, Inc, 1950)

Course Title: Quantum Mechanics-I

Course Code: Math-449

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide understanding of the basic principles and techniques in quantum mechanics.
- Special emphasis is put on providing the student with skills to independently perform quantum mechanical analysis of atomic and electro-magnetic systems.

Course Outcomes:

Students will able to:

- Understand the basic principles and techniques in quantum mechanics.
- To perform quantum mechanical analysis of atomic and electro-magnetic systems.

Course Outline:

Inadequacy of Classical Mechanics: Black body radiation, Photoelectric effect, Compton effect, Bohr's theory of atomic structure, Wave -particle duality, The de Broglie postulate, Heisenberg uncertainty principle

The Postulates of Quantum Mechanics: Operators, Eigenfunctions and Eigenvalues , Observables and operators, Measurement in quantum mechanics, The state function and expectation values, Time development of the state function (Schrödinger wave equation), Solution to the initial-value problem in quantum mechanics, Parity operators

Preparatory Concepts: Function Spaces and Hermitian Operators**,** Particle in a box, Dirac notation, Hilbert space, Hermitian operators, Properties of Hermitian operators

Additional One-Dimensional Problems: Bound and Unbound States, General properties of the 1-dimensional Schrodinger equation, Unbound states, One-dimensional barrier problems, The rectangular barrier: Tunneling

Recommended Books:

1. H. D. Dehmen, The Picture Book of Quantum Mechanics (Springer, 2001).

2. H. F. Hameka, Quantum Mechanics: A Conceptual Approach (Wiley-IEEE, 2004).
3. R. L. Liboff, Introductory Quantum Mechanics (Addison-Wesley Publishing Co., 2003).
4. V. K. Thankappan, Quantum Mechanics (New Age Publishers, 1993).
5. D. R. Bès, Quantum Mechanics: A Modern and Concise Introductory Course (Springer, 2004).

Course Title: Analytical Dynamics

Course Code: Math-404

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide an understanding of the concepts of Lagrange's Theory of Holonomic systems.
- To provide an understanding of the concepts of Hamilton's Theory, Lagrange's Theory of Non-Holonomic systems, Canonical Transformations and Hamilton-Jacobi theory.

Course Outcomes:

Students will able to:

- Understand the concepts of Lagrange's Theory of Holonomic systems.
- Understand the the concepts of Hamilton's Theory, Lagrange's Theory of Non-Holonomic systems, Canonical Transformations and Hamilton-Jacobi theory.

Course Outline:

Lagrange's Theory of Holonomic Systems : Generalized coordinates, Holonomic and non-holonomic systems, D'Alembert's principle, d-delta rule, Lagrange equations, Generalization of Lagrange equations, Quasi-coordinates, Lagrange equations in quasi-coordinates, First integrals of Lagrange equations of motion, Energy integral

Hamilton's Theory: Hamilton's principle, Generalized momenta and phase space, Hamilton's equations, Ignorable coordinates, Routhian function, Derivation of Hamilton's equations from a variational principle, The principle of least action

Lagrange's Theory of Non-Holonomic Systems: Lagrange equations for non-holonomic systems with and without Lagrange multipliers, Hamilton's Principle for non-holonomic systems

Canonical Transformations: The equations of canonical transformations, Examples of canonical transformations, The Lagrange and Poisson brackets, Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation

Hamilton-Jacobi Theory: The Hamilton-Jacobi equation for Hamilton's principal function, The harmonic oscillator problem as an example of the Hamilton-Jacobi method, The Hamilton-Jacobi equation for Hamilton's characteristic function, Separation of variables in the Hamilton-Jacobi equation

Recommended Books:

1. D. T. Greenwood, Classical Dynamics (Dover, 1997).
2. F. Chorlton, Chorlton Text Book of Dynamics (Ellis Horwood, 1983).
3. H. Goldstein, C. P. Poole & J. L. Safko, Classical Mechanics, Addison-Wesley Publishing Co., 2003)
4. S. D. Lindenbaum, Analytical Dynamics: Course Notes (World Scientific, 1994).
5. E. J. Saleton and J. V. José, Classical Dynamics: A Contemporary Approach (Cambridge, 1998).
6. J. B. Marion and S. T. Thornton, Classical Dynamics of Particles and Systems (Thomson Learning, 2003)

Course Code: Math-419

Course Title: Electromagnetic Theory-I

Credit Hours: 3(3+0)

Course Objectives:

The objectives of the course are as follows:

- To deepen students understanding of Electromagnetic theories.
- To strengthen student's problem solving skills for electromagnetic problems that are considerably more abstract and difficult than the problems encountered in introductory Physics.
- To find both physical and formal mathematical similarities and connections between Electromagnetic Theory and other areas of Physics.

Course Outcomes:

Students will able to:

- Understand the concept of Electromagnetic theories.
- Solve electromagnetic problems
- Learn both physical and formal mathematical similarities and connections between Electromagnetic Theory and other areas of Physics.

Course Outline:

Electrostatic Fields: Coulomb's law, the electric field intensity and potential, Gauss's law and deductions, Poisson and Laplace equations, Conductors and condensers, Dipoles, the linear quadrupole, Potential energy of a charge distribution, Dielectrics, The polarization and the displacement vectors, General solutions of Laplace's equation, Solutions of Laplace's equation in spherical coordinates, Legendre's equation, Legendre's polynomials

Magnetostatic Fields: The Magnetostatic law of force, The magnetic induction, The Lorentz force on a point charge moving in a magnetic field, The divergence of the magnetic field, The vector potential, The conservation of charge and the equation of continuity, The Lorentz condition, The curl of the magnetic field, Ampere's law and the scalar potential

Steady and Slowly Varying Currents: Electric current, linear conductors, Conductivity, resistance, Kirchhoff's laws, Current density vector, Magnetic field of straight and circular current, Magnetic flux, vector potential, Forces on a circuit in magnetic field.

Recommended Books:

1. G. E. Owen, Introduction to Electromagnetic Theory (Dover, 2003).
2. D. Corrison and P. Lorrison, Introduction to Electromagnetic Fields and Waves (W.H. Freeman and Company, London, 1962).
3. J. R. Reitz, F. J. Milford and R. W. Christy, Foundations of Electromagnetic Theory (Addison Wesley Publishing Co.,1993).
4. J. D. Jackson, Classical Electrodynamics (Wiley, 1999).
5. D. J. Griffiths, Introduction to Electrodynamics (Prentice-Hall, 1999).

Course Title: Operations Research-I

Course Code: Math-444

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide an understanding of the concepts of linear programming and duality
- To provide the basic concept of sensitivity analysis and transportation models.

Course Outcomes:

Students will able to:

- Understand the concepts of linear programming and duality.
- Apply both sensitivity analysis and transportation models.

Course Outline:

Linear Programming: Linear programming, formulations and graphical solution, Simplex method, M-Technique and two-phase technique, Special cases

Duality and Sensitivity Analysis: The dual problem, primal-dual relationships, Dual simplex method, Sensitivity and postoptimal analysis

Transportation Models: North-West corner, Least-Cost and Vogel's approximations methods, The method of multipliers, The assignment model, The transhipment model, Network minimization

Recommended Books:

1. Hamdy A. Taha, Operations Research - An Introduction, (Macmillan Publishing Company Inc., New York, 1987)
2. B. E. Gillett, Introduction to Operations Research, (Tata McGraw Hill Publishing Company Ltd., New Delhi)
3. F. S. Hillier and G. J. Liebraman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974)
4. C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979)

Course Title: Theory of Approximation and Splines-I

Course Code: Math-470

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide an understanding about the concepts of Euclidean geometry, curve fitting and Interpolation.

Course Outcomes:

Students will able to:

- Understand the concepts of Euclidean geometry, curve fitting and Interpolation.

Course Outline:

Euclidean Geometry: Basic concepts of Euclidean geometry, Scalar and vector functions, Barycentric coordinates, Convex hull, matrices of affine maps: translation, rotation, scaling, reflection and shear

Curve Fitting: Least squares line fitting, least squares power fit, data linearization method for exponential functions, nonlinear least-squares method for exponential functions, transformations for data linearization, linear least squares, polynomial fitting.

Polynomial Approximation: Taylor series, laguerre polynomial approximation, Chebyshev Polynomials, Pade approximations, cubic spline.

Recommended Books:

1. David A. Brannan, Geometry, (Cambridge University Press, 1999).
2. Gerald Farin, Curves and Surfaces for Computer Aided Geometric Design: A Practical Guide, 5th edition, (Academic Press. Inc., 2002).
3. Richard H. Bartels, John C. Bealty, and John C. Beatty, An Introduction to Spline for use in Computer Graphics and Geometric Modeling, (Morgan Kaufmann Publisher 2006).
4. John H. Mathews, Numerical Methods for Mathematics, Science and Engineering, 2nd edition (Prentice-Hall International Editions, 1992).
5. Steven C. Chapra and Raymond P. Canale, Numerical edition, (McGraw Hill International Edition, 1998).

Course Title: Fluid Mechanics-I

Course Code: Math-422

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of conservation of matter
- The fundamental of nature of forces in the fluid field
- The importance of two-dimensional and irrotational motions

Course Outcomes:

The students would be able to:

- Learn the two-dimensional and irrotational flows
- Know the conservation of mass and equation of continuity
- Explore the viscous and inviscid fluids and laminar and turbulent flows

Course Outline:

Conservation of Matter: Fields and continuum concepts, Lagrangian and Eulerian specifications, Local, convective and total rates of change, Conservation of mass, Equation of continuity, Boundary conditions

Nature of Forces in a Fluid Field and their Effects: Surface and body forces, Stress at a point, Viscosity and Newton's viscosity law, Viscous and inviscid flows, Laminar and turbulent flows, Compressible and incompressible flows

Irrotational Fluid Motion: Velocity potential from an irrotational velocity field, Streamlines, Vortex lines and vortex sheets, Kelvin's minimum energy theorem, Conservation of linear momentum, Bernoulli's theorem and its applications, Circulations, rate of change of circulation (Kelvin's theorem), Aaxially symmetric motion, Stokes's stream function

Two-dimensional Motion: Stream function, Complex potential and complex velocity, Uniform flows, Sources, sinks and vortex flows, Flow in a sector, Flow around a sharp edge, Flow due to a doublet

Recommended Books:

1. H. Schlichting, K. Gersten, E. Krause and H. Oertel, Jr.: Boundary-Layer Theory,8th edition (Springer, 2004).
2. Yith Chia-Shun: Fluid Mechanics (McGraw Hill, 1974).
3. I. L. Distsworth: Fluid Mechanics (McGraw Hill, 1972).
4. F. M. White: Fluid Mechanics (McGraw Hill, 2003).
5. I. G. Curie: Fundamentals of Mechanics of Fluids, Third edition (CRC, 2002).
6. R. W. Fox, A. T. McDonald and P. J. Pritchard: Introduction to Fluid Mechanics (John Wiley and Sons, 2003)

Semester-VIII

Course Title: Measure Theory and Lebesgue Integration

Course Code: Math-437

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Understand Riemann and Riemann-Stieltjes integrable functions.
- Understand Lebesgue measurable sets, non-measurable sets, cantor set.
- Understand Lebesgue integral and Lebesgue spaces.

Course Outcomes:

Students are able to:

- Define Riemann and Riemann-Stieltjes integrable functions.
- Define Lebesgue measurable sets, non-measurable sets, cantor set.
- Determine Lebesgue integral and Lebesgue spaces with examples.

Course Outline:

Measurable Sets: Outer measure, Lebesgue measure, Lebesgue measurable sets, Borel sets, Non measurable sets

Measurable Functions: Lebesgue measurable functions, Simple functions, characteristic functions, Borel measurable function, Littlewood three principle

The Lebsegue Integration: Review of the Riemann integral, Lebsegue integral, Integral of a non-negative function, Integral of measurable functions, Convergence in measure.

Recommended Books:

1. D. Smith, M. Eggen and R. St. Andre, A Transition to Advanced Mathematics, (Brooks, 2001)
2. Seymour Lipshcutz, Set Theory and Related Topics, (Mc-Graw Hill Book Company, 1999)
3. H. L. Royden, Real Analysis, (Macmillam, 1968)
4. D. L. Cohan, Measure Theory, (Bir Khauser, 1980
5. P.R. Halmos, Measure Theory, (Von Nostrand, New York, 1950)

Course Title: Methods of Mathematical Physics

Course Code: Math-438

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Fourier, Laplace and Hankel transforms
- To understand the Green's functions and perturbation methods
- To explore the Euler's and Lagrange's equations

Course Outcomes:

The students would be able to:

- Learn the Fourier, Laplace and Hankel transforms
- Know the Green's functions and perturbation methods
- Explore the Euler's and Lagrange's equations

Course Outline:

Fourier Methods: The Fourier transform, Fourier analysis of generalized functions, The Laplace transform, Hankel transforms for the solution of PDE and their application to boundary value problems

Green's Functions and Transform Methods: Expansion for Green's functions, Transform method, Closed form Green'sfunction, Perturbation methods for algebraic equations, Perturbation methods for differential equations

Variational Methods: Euler-Lagrange equations, Integrand involving one, two, three and n variables, Special cases of Euler-Lagranges equations, Necessary conditions for existence of an extremum of a functional, Constrained maxima and minima.

Recommended Books:

1. D. L. Powers, Boundary Value Problems and Partial Differential Equations, 5th edition(Academic Press, 2005)
2. W. E. Boyce, Elementary Differential Equations, 8th edition, (John Wiley and Sons, 2005)
3. M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, Problems and Exercises in the Calculus of Variations, (Imported Publications, Inc., 1985)
4. J. W. Brown and R. V. Churchill, Fourier Series and Boundary Value Problems(McGraw Hill, 2006)
5. A. D. Snider, Partial Differential Equations: Sources and Solutions (Prentice Hall Inc.,1999)

Course Title: Numerical Analysis-II

Course Code: Math-443

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are to:

- Describe basic ideas of numerical differentiation and Integration.
- Explore ideas for the formulaion and solution of differential equations.

Course Outcomes:

Students will able to:

- Understand basic ideas of numerical differentiation and Integration.
- Formulate and determine solutions of differential equations.

Course Outline:

Numerical Differentiation: Derivatives using: Lagrange's interpolation formula, Newton's divided difference formula, Gregory Newton forward/backward interpolation formula, Gauss's forward/backward interpolation formula, Stirling's formula, Laplace Everett's formula, Bessel's formula

Numerical Integration: Newton-Cotes formulae, Trapezoidal rule, Simpson rule, Weddle's rule, Boole's rule, Errors in quadrature formulae, Gaussian quadrature formulae

Formulation of Difference Equations: Analogy of difference equations, Linear homogeneous difference equations with constant coefficients, Linear non-homogeneous difference equations with constant coefficients

Ordinary Differential Equations: Introduction to ODEs, Taylor's series method: Simultaneous first order and higher order differential equations, Euler's, improved Euler's, modified Euler's and Runge-Kutta methods with error analysis, Predictor-corrector methods for solving initial value problems

Recommended Books:

1. Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 6th edition,(Addison-Wesley Publishing Co. Pearson Education, 2003)
2. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 6th edition, (Brooks/Cole Publishing Company, 1997)
3. John H. Mathews, Numerical Methods for Mathematics, Science and Engineering, 3rd edition (Prentice Hall International, 2003)
4. V. N. Vedamurthy and N. Ch. S. N. Iyenger, Numerical Methods, (Vikas Publishing House Pvt. Ltd, 2002)
5. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers 3rd edition, (McGraw Hill International Edition, 1998)

Course Title: Mathematical Statistics-II

Course Code: Math-432

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of functions of random variables
- The introduction of sampling distributions
- The importance of regression and correlation

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of functions of random variables
- An understanding of sampling distributions
- Considerable knowledge about regression and correlation

Course Outline:

Functions of Random Variables: Distribution function technique,Transformation technique: One variable, several variables, Moment-generating function technique

Sampling Distributions: The distribution of the mean, The distribution of the mean: Finite populations, The Chi-Square distribution, The t distribution, The F distribution

Regression and Correlation: Linear regression, The methods of least squares,Normal regression analysis, Normal correlation analysis, Multiple linear regression and its matrix notation.

Recommended Books:

1. J. E. Freund, Mathematical Statistics, (Prentice-Hall Inc., 1992).
2. Hogg and Craig, Introduction to Mathematical Statistics, (Collier Macmillan, 1958)
3. Mood, Greyill and Boes, Introduction to the Theory of Statistics, (McGraw Hill).
4. R. E. Walpole, Introduction to Statistics, 3rd edition,(Macmillan Publishing Company London, 1982)
5. M. R. Spiegel, L. J. Stephens, Statistics, (McGraw Hill Book Company, 1984)

Course Title: Computer Application

Course Code: Math-472

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of Flow Chart and Algorithm
- The concept of Programming of the Numerical Methods
- The importance of Mathematica and their applications

Course Outcomes:

The students would be able to:

- Learn the Programming of Jacobi's iterative and Gauss-Seidel methods
- Know the Programming of Euler's, Runge-Kutta and predictor-corrector methods
- Explore the numerical and algebraic calculations in Mathematica

Course Outline:

Flow Chart, Algorithm and Programming of the following Numerical Methods: System of linear equations, Jacobi's iterative method, Gauss-Seidel method, Solutions of non-linear equations, Bisection method, Newton-Raphson method, Secant method, Regula Falsi method, Interpolation, Langrage interpolation, Newton's divided and forward difference interpolation, Numerical integration: Rectangular rule, Trapezoidal rule, Simpson's rule, Booles rule, Weddles rule, Differential equations: Euler's method, Runge- Kutta methods, predictor-corrector methods

Mathematica: Introduction of mathematica, numerical calculations, algebraic calculations, symbolic andnumerical mathematics, numbers, mathematical functions, algebraic manipulations,manipulating equations, series, limits and residues, linear algebra, graphs

Recommended Books:

1. Michel Metcalf, John Reid and Malcolm Cohen, Fortran 95/2003 Explained, (Oxford University Press, 2004)
2. Stephen Wolfram, The Mathematica, 3rd edition, (Cambridge University Press 1996)
3. V. Rajaraman, Computer Programming in Fortran 90 and 95, (Prentice Hall of India, New Delhi, 1999)
4. Roman E. Maeder, Computer Science with Mathematics, (Cambridge University Press, 2000)
5. Martha L. Abell, James P. Braselton, The Mathematica Handbook, (Academic Press Inc., 1992)

Course Title: Advanced Group Theory-II

Course Code: Math-473

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Solvable groups and their examples
- To understand the Nilpotent and Linear Groups
- To explore the upper and lower central series and Frattini subgroups

Course Outcomes:

The students would be able to:

- Learn the solvable and Super-solvable groups
- Know the characterisation of finite nilpotent groups
- Explore the types and representations of linear groups

Course Outline:

Solvable Groups: Solvablegroups, definition and examples, Theorems on solvable groups**,** Super-solvable groups.

Nilpotent Groups, Characterisation of finite nilpotent groups, Upper and lowercentral series**,** Frattini subgroups, free groups, basic theorems**,** Definition and examples of free products of groups

Linear Groups: Linear groups, types of linear groups, Representation of linear groups**,** Group algebras and representation modules

Recommended Books:

1. J. Rotman, The Theory of Groups, 2nd edition, (Allyn and Bacon, London, 1978)
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-Wesley Publishing Co., 2003)
3. H. Marshall, The Theory of Groups, (Macmillan, 1967)
4. J. A. Gallian, Contemporary Abstract Algebra, 4th edition, (Narosa 1998)
5. J. S. Rose, A Course on Group Theory, (Dover Publications, New York, 1994)
6. K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Course Title: Theory of Modules

Course Code: Math-457

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of Modules and Homomorphisms
- The fundamental of Submodules and Quotient modules
- The importance of matrices over rings and their connection with basis of a free module

Course Outcomes:

The students would be able to:

- Learn the Torsion and Free modules
- Know the Basis, rank and endomorphisms of free modules
- Explore the Direct sums of modules and their applications

Course Outline:

Modules: Definition and examples, Submodules**,** Homomorphisms**,** Quotient modules**,** Direct sums of modules, Finitely generated modules, Torsion modules**,** Free modules**,** Basis, rank and endomorphisms of free modules**,** Matrices over rings and their connection with the basis of a free module, A module as the direct sum of a free and a torsion module

Recommended Books:

1. J. Rotman, The Theory of Groups, 2nd edition, (Allyn and Bacon, London, 1978)
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-WeseleyPublishing Co., 2003)
3. J. A. Gallian, Contemporary Abstract Algebra, 4th edition, (Narosa Publishing House,1998)
4. J. S. Rose, A Course on Group Theory, (Dover Publications, New York, 1994)

5. K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Course Title: Advance Number Theory -II

Course Code: Math-474

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Algebraic Number Theory and Quadratic Residues
- To understand the Jacobi and Legendre symbols
- To explore the applications of Einstein irreducibility criterion

Course Outcomes:

The students would be able to:

- Learn the conjugates and discriminants
- Know the Lorentz and Poincare groups
- Explore the units and primes in a quadratic field

Course Outline:

Quadratic Residues: Composite module, Legendre symbol, Law of quadratic reciprocity, The Jacobi symbol**,** Diophantine Equations, Equations and Fermat's conjecture for n = 2, n = 4

Algebraic Number Theory: Polynomials over a field, Divisibility properties of polynomials, Gauss's lemma**,** The Einstein irreducibility criterion, Symmetric polynomials**,** Extensions of a field**,** Algebraic and transcendental numbers**,** Bases and finite extensions, properties of finite extensions, Conjugates and discriminants**,** Algebraic integers in a quadratic field, integral bases, Units and primes in a quadratic field**,** Ideals, arithmetic of ideals in an algebraic number field**,** The norm of an ideal, prime ideals, units of algebraic number field.

Recommended Books:

1. W. J. Leveque, Topics in Number Theory, Vols. I and II (Addison-Wesley Publishing Co. Publishing Co., 1956)
2. Tom M. Apostol, Introduction to Analytic Number Theory, (Springer International, 1998)
3. David M. Burton, Elementary Number Theory, 6th edition, (McGraw Hill Company, 2007)
4. A. Andrew, The Theory of Numbers, (Jones and Barlett Publishers London, 1995)
5. Harry Pollard, The Theory of Algebraic Numbers, (John Wiley and Sons, 1950)

Course Title: Quantum Mechanics - II

Course Code: Math-450

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of Harmonic oscillator and problems in Three-Dimensions
- The introduction of angular momentum
- The importance of Scattering and Perturbation Theories

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of Eigenvalues and Eigenfunctions of operators L2 and Lz
- An understanding of Scattering amplitude and Born approximation
- Considerable knowledge about motion in three dimensions

Course Outline:

Harmonic Oscillator and Problems in Three-Dimensions: The harmonic oscillator, Eigenfunctions of the harmonic oscillator, The harmonic oscillator in momentum space, Motion in three dimensions, Spherically symmetric potential and the hydrogen atom

Angular Momentum: Basic properties, Eigenvalues of the angular momentum operators, Eigenfunctions of the orbital angular momentum operators L_2 and L_z, Commutation relations between components of angular momentum and their representation in spherical polar coordinates

Scattering Theory: The scattering cross-section, Scattering amplitude, Scattering equation, Born approximation, Partial wave analysis

Perturbation Theory: Time independent perturbation of non-degenerate and degenerate cases, Time-dependent perturbations

Recommended Books:

1. R. L. Liboff, Introductory Quantum Mechanics (Addison-Wesley Publishing, 2003)
2. H. D. Dehmen, The Picture Book of Quantum Mechanics (Springer, 2001)
3. H. F. Hameka, Quantum Mechanics: A Conceptual Approach (Wiley-IEEE, 2004)
4. V. K.Thankappan, Quantum Mechanics (New Age Publishers, 1993).
5. D. R. Bès, Quantum Mechanics: A Modern and Concise Introductory Course (Springer, 2004)

Course Title: Special Theory of Relativity

Course Code: Math-455

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the derivation of Special Relativity
- To understand the Four-Vector formulation of Special Relativity
- To explore the applications of electromagnetism in Special Relativity

Course Outcomes:

The students would be able to:

- Learn the Maxwell's equations and electromagnetic waves
- Know the Lorentz and Poincare groups
- Explore the Einstein's formulation of special relativity

Course Outline:

Introduction: Fundamental concepts

Derivation of Special Relativity: Einstein's formulation of special relativity, The Lorentz transformation**,** Length contraction, time dilation and simultaneity, The velocity addition formulae**,** Three dimensional Lorentz transformations.

The Four-Vector Formulation of Special Relativity: The four-vector formalism**,** The Lorentz transformations in 4-vectors, The Lorentz and Poincare groups, The null cone structure**,** Proper time**.**

Electromagnetism in Special Relativity, Review of electromagnetism, The electric and magnetic field intensities, The electric current, Maxwell's equations and electromagnetic waves, The four-vector formulation of Maxwell's equations

Recommended Books:

1. M. Saleem and M. Rafique, Special Relativity (Ellis Horwood, 1992)
2. W. G. V. Rosser, Introductory Special Relativity (Taylor & Francis, 1991)
3. W. Ringler, Introduction to Special Relativity (Oxford, 1991)
4. A. Qadir, An Introduction to Special Theory of Relativity (World Scientific 1989)
5. G. Barton, Introduction to the Relativity Principle (Wiley, 1999)

Course Title: Electromagnetic Theory-II

Course Code: Math-475

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of steady and slowly varying currents
- The introduction of equations of electromagnetism
- The importance of electromagnetic waves

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of electromagnetic field of a moving charge
- An understanding of propagation plane electromagnetic waves in non-conductors
- Considerable knowledge about Maxwell's equations in free space and material media

Course Outline:

Steady and Slowly Varying Currents: The Faraday induction law, Induced elecromotance in a moving system, Inductance and induced electromotance, Energy stored in a magnetic field.

The Equations of Electromagnetism, Maxwell's equations in free space and material media, Solution of Maxwell's equations

Electromagnetic Waves: Plane electromagnetic waves in homogeneous and isotropic media, The Poynting vector in free space**,** Propagation plane electromagnetic waves in non-conductors, Propagation plane electromagnetic waves in conducting media, Reflection and refraction of plane waves**,** Guided waves; coaxial line; hollow rectangular wave guide, Radiation of electromagnetic waves**,** Electromagnetic field of a moving charge

Recommended Books:

1. J. R. Reitz, F. J. Milford and R. W. Christy, Foundations of Electromagnetic Theory (Addison-Wesley Publishing Co., 1993)
2. C.G. Someda, Electromagnetic Waves (CRC, 2006).
3. J. D. Jackson,Classical Electrodynamics (Wiley, 1999).
4. J. V. Stewart, Intermediate Electromagnetic Theory (World Scientific, 2001).
5. G. E. Owen, Introduction to Electromagnetic Theory (Dover, 2003).

Course Title: Operations Research-II

Course Code: **Math-445**

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Shortest-Route algorithms for acyclic networks
- To understand the Maximal-flow problem and decomposition algorithm
- To explore the applications of integer programming

Course Outcomes:

The students would be able to:

- Learn the zero-one implicit enumeration
- Know the parametric linear programming and Branch-and-bound method
- Explore the revised simplex method and bounded variables

Course Outline:

Shortest-Route algorithms for acyclic networks, Maximal-flow problem, Matrix definition of LP problem, Revised simplex method, bounded variables, Decomposition algorithm, Parametric linear programming, Applications of integer programming, Cutting-plane algorithms, Branch-and-bound method, Zero-one implicit enumeration, Elements of dynamic programming, Problem of dimensionality, Programmes by dynamic programming

Recommended Books:

1. Hamdy A. Taha, Operations Research-An Introduction, (Macmillan Publishing Company Inc., New York, 1987)
2. B. E. Gillett, Introduction to Operations Research, (Tata McGraw Hill Publishing Company Ltd., New Delhi)
3. F. S. Hillier and G. J. Liebraman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974)
4. C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979)

Course Title: Theory of Approximation and Splines-II

Course Code: Math-476

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of cubic algebraic, Hermite and control point forms
- The introduction of Bernstein Bezier and B-Spline cubic forms
- The importance of Convex hull, Affine invariance and Variation diminishing properties

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of clamped, natural and 2nd Derivative conditions
- An understanding of general, natural and periodic splines
- Considerable knowledge about Bernstein Bezier form spline functions

Course Outline:

Parametric Curves: Cubic algebraic form**,** Matrix forms of parametric curves, Cubic Hermite form**,** Cubic control point form**,** Bernstein Bezier cubic form, Bernstein Bezier general form, B-Spline cubic form, Rational quadratic form**,** Rational cubic form**,** Tensor product surface, Bernstein Bezier cubic patch, quadratic by cubic Bernstein Bezier patch, Bernstein Bezier quartic patch**,** Convex hull property**,** Affine invariance property**,** Variation diminishing property,

Spline Functions: Introduction to splines, Cubic Hermite splines, End conditions of cubic splines: clamped conditions, natural conditions, 2nd Derivative

conditions, periodic conditions, not a knot conditions, General Splines: natural splines, periodic splines, Truncated power function, representation of spline in terms of truncated power functions, Algorithms to compute Bernstein Bezier form Spline Functions.

Recommended Books:

1. Gerald Farin, Curves and Surfaces for Computer Aided Geometric Design: A Practical Guide, 5th Edition (Academic Press. Inc., 2002).
2. I. D. Faux, Computational Geometry for Design and Manufacture, (Ellis Horwood, 1979).
3. Richard H. Bartels, John C. Bealty, and John C. Beatty, An Introduction to Spline for use in Computer Graphics and Geometric Modeling, (Morgan Kaufmann Publisher, 2006).
4. Carl de Boor, A Practical Guide to Splines, (Springer Verlag, 2001).
5. Larry L. Schumaker, Spline Functions: Basic Theory, (John Wiley and Sons, 1993).

Course Title: Fluid Mechanics-II

Course Code: Math-478

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To introduce two and three-dimensional potential flows.
- To understand viscous flows of incompressible fluids.
- To study Simplified approach to fluid flow problems.

Course Outcomes:

Students will able to:

- Learn two and three-dimensional potential flows.
- Learn about viscous flows of incompressible fluids.
- Explore simplified approach to fluid flow problems.

Course Outline:

Two and Three-Dimensional Potential Flows: Circular cylinder without circulation, Circular cylinder with circulation, Blasius theorem, Kutta condition and the flat-plate airfoil, Joukowski airfoil, Vortex motion, Karman's vortex street, Method of images, Velocity potential, Stoke's stream function, Solution of the Potential equation, Uniform flow, Source and sink, Flow due to a doublet,

Viscous Flows of Incompressible Fluids: Constitutive equations, Navier-Stokes's equations, exact solutions of Navier-Stokes's equations, Steady unidirectional flow, Poiseuille flow, Couette flow, Flow between rotating cylinders, Stokes' first problem, Stokes' second problem

Simplified Approach to Fluid Flow Problems: Similarity from a differential equation, Dimensional analysis, One dimensional, steady compressible flow.

Recommended Books

1. H. Schlichting, K. Gersten, E. Krause and H. Oertel, Jr. Boundary-Layer Theory, 8th edition (Springer, 2004)
2. Yith Chia-Shun: Fluid Mechanics (McGraw Hill, 1974)
3. I. L. Distsworth: Fluid Mechanics (McGraw Hill, 1972)
4. F. M. White: Fluid Mechanics (McGraw Hill, 2003)
5. I. G. Curie: Fundamentals of Mechanics of Fluids, Third edition (CRC, 2002)
6. R. W. Fox, A. T. McDonald and P. J. Pritchard: Introduction to Fluid Mechanics (John Wiley and Sons, 2003)

Course Title: Integral Equations

Course Code: Math-426

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To introduce integral equations and its types.
- To learn methods for solving linear and Non-linear Integral equations.

Course Outcomes:

Students will able to:

- Identify the types of integral quations.

- Solve linear and Non-linear Integral equations.

Course Outline

Integral Euations: Introduction to IEs and types, Leibnitz rule, conversion of IVPs to VIEs and Vice versa, conversion of BVPs to FIEs and Vice versa.

Fredholm Integral Equations: Resolvent kernel and solution of IEs by resolvent kernel method, Hilbert Schmidt method solution of FIEs by Direct computation method, Decomposition method, modified decomposition method, successive approximation method, successive substitution method,

Volterra Integral Equations: Solution of VIEs by Direct computation method, Decomposition method, modified decomposition method, successive approximation method, successive substitution method, series solution method, solution of Integro-differential equations. Singular integral equations

Non-Linear Integral Equations: Methods to solve nonlinear integral equations.

Recommended Books:

7. Integral equations by Abdul Majeed Wazwaz.
8. Linear integral, R.P. Kanwal, 1st edition, 1971, Academic Press.
9. Elementary Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, R. Haberman, (3rd Edition), Prentice Hall.
10. Integral equations by Abdul Majeed Wazwaz.
11. Mathematical Methods in the Physical Sciences, Mary L. Boas, (3rd Edition), 2006, John Wiley & Sons.
12. Problems and Exercises in the Calculus of Variations, M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, 1984, Mir Publishers Moscow.

Objectives of M.Sc. Program:

The objectives of the M.Sc. Mathematics program are to produce graduates who are able:

- To write and understand mathematical proofs; think logically.
- To use mathematics from a variety of areas to formulate and analyze applied problems; present their work in a professional manner.
- To demonstrate a depth of understanding in a sub-area of Mathematics.

- To establish the base for lifelong education by creating essential ideas and preparing the students with necessary techniques needed to start careers in teaching, research and/or in any walk of life involving mathematics.
- To acquire a solid understanding of mathematics and the ability to apply it effectively.
- To encourage students to become effective independent learners.

Learning Outcomes of M.Sc. Program:

- Students will be able to apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate programs in mathematics and other fields such as the field of quantitative/mathematical finance, mathematical computing, statistics and actuarial science.
- Students will be able to communicate effectively in writing and orally about the subject.
- Students will be able to communicate effectively in writing and orally about the subject.
- Students will be able to develop problem-solving skills and apply them independently to problems in pure and Applied Mathematics.
- Students will be able to exhibit ethical and professional behavior.
- Students will be able to use mathematical and statistical techniques to solve well-defined problems and present their mathematical work, both in oral and written format, to various audiences (students, mathematicians and non-mathematicians).
- Students will be able to read, understand and construct correct mathematical and statistical proofs and use the library and electronic data-bases to locate information on mathematical problems.
- Students will be able to propose new mathematical questions and suggest possible software packages and/or computer programming to find solutions to these questions.
- Students will be able to continue to acquire mathematical knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematics.

SCHEME OF STUDIES FOR 2 YEARS M.Sc. MATHEMATICS

Semester-I		
Math-351	Real Analysis-I	3
Math-325	Group Theory	3
Math-312	Complex Analysis-I	3
Math-359	Vector and Tensor Analysis	3
Math-358	Topology	3
Math-315	Differential Geometry	3

	Total Credit Hours	**18(18+0)**

Semester-II		
Math-352	Real Analysis-II	3
Math-329	Linear Algebra-II	3
Math-369	Complex Analysis-II	3
Math-305	Analytical Mechanics	3
Math-423	Functional Analysis	3
Math-347	Ordinary Differential Equations-II	3
	Total Credit Hours	**18(18+0)**

Semester-III		
Math-464	Set Theory	3
Math-448	Partial Differential Equations	3
Math-442	Numerical Analysis-I	3
Any Two of the following:		
Math-331	Mathematical Statistics-I	3
Math-471	Programming in Matlab	3
Math-403	Advanced Group Theory-I	3
Math-454	Rings and Modules	3
Math-469	Advance Number Theory-I	3
Math-449	Quantum Mechanics-I	3
Math-404	Analytical Dynamics	3
Math-419	Electromagnetic Theory-I	3
Math-444	Operations Research-I	3
Math-470	Theory of Approximation and Splines-I	3
Math-422	Fluid Mechanics-I	3
	Total Credit Hours	**15(15+0)**

Semester-IV		
Math-437	Measure Theory and Lebesgue Integration	3
Math-438	Methods of Mathematical Physics	3
Math-443	Numerical Analysis-II	3
Any Two of the following:		
Math-432	Mathematical Statistics-II	3
Math-472	Computer Applications	3
Math-473	Advanced Group Theory-II	3

Math-457	Theory of Modules	3
Math-474	Advance Number Theory-II	3
Math-450	Quantum Mechanics-II	3
Math-455	Special Theory of Relativity	3
Math-475	Electromagnetic Theory-II	3
Math-445	Operations Research-II	3
Math-476	Theory of Approximation and Splines-II	3
Math-478	Fluid Mechanics-II	3
Math-426	Integral Equations	3
	Total Credit Hours	**15(15+0)**
Total Credit Hours of BS Program: 66		

Semester-I

Course Title: Real Analysis-I

Course Code: Math-351

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Define basic ideas of real numbers, and their basic operations.
- Enhance concepts of infinite sequences and series.
- Explore concretely about continuity, differentiability and partial differentiations.

Course Outcomes:

Students will able to:

- Get firm grip on basic ideas of real numbers, and their basic operations.
- Apply and use the concepts of infinite sequences and series.
- Learn concretely about continuity, differentiability and their uses.
- Apply ideas of partial differentiations and its uses in real world problems.

Course Outline:

Real Number System: Ordered sets, fields, the field of real numbers, Completeness property of R, The extended real number system, Euclidean spaces, Finite, countable and uncountable sets

Sequences and Series: Sequences, sub sequences, convergent sequences, Cauchy sequences, Monotone and bounded sequences, Bolzano Weierstrass theorem, Series, series of non-negative terms, Partial sums, the root and ratio tests, integral test, comparison test, Absolute and conditional convergence

Limit and Continuity: The limit of a function, Continuous functions, Types of discontinuity, Uniform continuity, Monotone functions

Differentiation: The derivative of a function, Mean value theorems, the continuity of derivatives, Taylor's theorem

Functions of Several Variables: Partial derivatives and differentiability, derivatives and differentials of composite functions, Change in the order of partial derivative, implicit functions, inverse functions, Jacobians, Maxima and minima.

Recommended Books:

1. W. Rudin, Principles of Mathematical Analysis, 3rd edition, (McGraw Hill, 1976)
2. R. G. Bartle, Introduction to Real Analysis, 3rd edition, (John Wiley and Sons, 2000)
3. T. M. Apostol, Mathematical Analysis, (Addison-Wesley Publishing Company, 1974)
4. A. J. Kosmala, Introductory Mathematical Analysis, (WCB Company, 1995)

5. W. R. Parzynski and P. W. Zipse, Introduction to Mathematical Analysis, (McGraw Hill Company, 1982)
6. H. S. Gaskill and P. P. Narayanaswami, Elements of Real Analysis, (Printice Hall, 1988)

Course Title: Group Theory

Course Code: Math-325

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Get firm grip on basic ideas of groups and their basic operations with examples.
- Apply and use the concepts of subgroups and Lagrange's theorem.
- Explore concretely about group homomorphism and its uses.
- Provide ideas of classifications and Sylow Theorems

Course Outcome:

Students will able to:

- Define basic ideas of groups and their basic operations with examples.
- Understand the concepts of subgroups and Lagrange's theorem.
- Understand concretely about group homomorphism and its uses.
- Understand ideas of classifications and Sylow Theorems

Course Outline:

Groups: Binary operations, Definition and examples of groups,order of an element, order of group, Abelian group, Subgroups lattice, Lagrange's theorem, Relation between groups, cyclic groups, Groups and symmetries, even and odd permutations, Cayley's theorem

Complexes in Groups: Complexes and co-set decomposition of groups, Centre of a group, Normalizer in a group, Centralizer in a group, Conjugacy classes and congruence relation in a group, Double co-sets

Normal Subgroups: Definition, Proper and improper normal subgroups, Factor groups, Fundamental theorem of homomorphism, Automorphism group of a group, Commutator subgroups of a group

Permutations Groups: Symmetric or permutations group, Transpositions, Cyclic permutations and orbits, The Alternating group, Generators of the symmetric and Alternating groups, Simplicity of Alternating groups

Sylow Theorems: Double Cosets, Cauchy's theorem for Abelian and non-Abelian group, Sylow theorems with proofs, Application of sylow theory

Recommended Books

6. J. Rose, A Course on Group Theory, (Cambridge University Press, 1978)
7. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company, 1964)
8. P. M. Cohn, Algebra, (John Wiley and Sons, London, 1974)
9. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, (Cambridge University Press, 1986)
10. J. B. Fraleigh, A First Course in Abstract Algebra, (Addison-Wesley Publishing Company, 2002)

Course Code: Math-312

Course Title: Complex Analysis-I

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Get firm grip on basic ideas of complex numbers and their basic operations with examples.
- Apply and use the concepts of analytic functions and limits.
- Provide basic understanding about elementary functions and their properties.
- Explore the ideas of complex integration and power series expansion.
- Use concept of infinite series.

Course Outcomes:

Students will able to:

- Define basic ideas of complex numbers and their basic operations with examples.
- Understand the concepts of analytic functions and limits.
- Learn concretely about elementary functions and their properties.
- Explore ideas of complex integration and power series expansion.
- Understand the concept of infinite series.

Course Outline:

The Concept of Analytic Functions: Complex numbers, complex planes, complex functions, Analytic functions, Entire functions**,** Harmonic functions,

Elementary functions: complex trigonometric, exponential, logarithmic and hyperbolic functions

Complex Integration: Complex integrals, Cauchy-Goursat theorem, Cauchy's integral formula and their consequences, Liouville's theorem, Morera's theorem, Derivative of an analytic function.

Infinite Series: Power series, derived series, radius of convergence, Taylor series and Laurent series

Recommended Books

6. D. G. Zill and P. D. Shanahan, Complex Analysis, (Jones and Bartlett Publishers, 2003)
7. H. S. Kasana, Complex Variables: Theory and Applications, (Prentice Hall, 2005)
8. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th edition, (McGraw Hill Company, 2004)
9. M. R. Spiegel, Complex Variables, (McGraw Hill Book Company, 1974)
10. Louis L. Pennisi, Elements of Complex Variables, (Holt, Linehart and Winston, 1976)

Course Code: Math-359

Course Title: Vector and Tensor Analysis

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Provide an understanding about the concepts of vector integration, Integral Theorems and curvilinear coordinates.
- Explore tensor analysis.

Course Outcomes:

Students will able to:

- Understand the concepts of vector integration, Integral Theorems and curvilinear coordinates.
- Define the coordinates on flat and curved surfaces.

Course Outline:

Vector Integration: Line integrals, Surface area and surface integrals, Volume integrals

Integral Theorems: Green's theorem, Gauss divergence theorem, Stoke's theorem

Curvilinear Coordinates: Orthogonal coordinates, Unit vectors in curvilinear systems, Arc length and volume elements, The gradient, divergence and curl, Special orthogonal coordinate system.

Tensor Analysis: Coordinate transformations, Einstein summation convention, Tensors of different ranks, Contravariant, covariant and mixed tensors, Symmetric and skew symmetric tensors, Addition, subtraction, inner and outer products of tensors, Contraction theorem, quotient law, The line element and metric tensor, Christoffel symbols.

Recommended Books:

5. F. Chorlton, Vector and Tensor Methods, (Ellis Horwood Publisher, Chichester, U.K., 1977)
6. M. R. Spiegel, Vector Analysis, (McGraw Hill Book Company, Singapore, 1981)
7. A. W. Joshi, Matrices and Tensors in Physics, (Wiley Eastern Limited, 1991)

8. Hwei P. Hsu, Applied Vector Analysis, (Harcourt Brace Jovanovich Publishers, San Diego, New York, 1984)

Course Title: Topology

Course Code: Math-358

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe topological spaces with examples.
- Differentiate some simple topological spaces through homeomorphism.
- Check connectedness and compactness of topological spaces.

Course Outcomes:

Students will able to:

- Define topological spaces with examples.
- Explore some simple topological spaces through homeomorphism.
- Understand connectedness and compactness of topological spaces.

Course Outline:

Topology: Definition and examples, Open and closed sets, Subspaces, Neighborhoods, Limit points, closure of a set, Interior, exterior and boundary of a set

Bases and Sub-bases: Base and sub bases, Neighborhood bases, First and second axioms of countablility, Separable spaces, Lindelöf spaces, Continuous functions and homeomorphism, Weak topologies, finite product space**s**

Separation Axioms: Separation axioms, Regular spaces, Completely regular spaces, Normal spaces

Compact Spaces: Compact topological spaces, Countably compact spaces, Sequentially compact spaces

Connectedness: Connected spaces, disconnected spaces, Totally disconnected spaces, Components of topological spaces.

Recommended Books:

6. J. Dugundji, Topology, (Allyn and Bacon Inc., Boston 1966)
7. G. F. Simmon, Introduction to Topology and Modern Analysis, (McGraw Hill Book Company, New York, 1963)
8. Stephen Willard, General Topology, (Addison-Wesley Publishing Co., London, 1970)
9. Seymour Lipschutz, General Topology, (Schaum's Outline Series, McGraw Hill Book Company 2004)

10. James R. Munkres, Topology, 2nd edition, (Prentice Hall Inc., 2003)

Course Title: Differential Geometry

Course Code: Math-315

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of curves, curvatures and torsions with examples.
- Explore the ideas of surfaces.
- Study Gauss and Weingarten equations and Gauss and Codazzi equations.

Course Outcomes:

Students will able to:

- Define basic ideas curves, curvatures and torsions with examples.
- Understand ideas of surfaces.
- Explore Gauss and Weingarten equations and Gauss and Codazzi equations.

Course Outline:

Theory of Space Curves: Introduction, index notation and summation convention, Space curves, arc length, tangent, normal and binormal, Osculating, normal and rectifying planes, Curvature and torsion, The Frenet-Serret theorem, Natural equation of a curve, Involutes and evolutes, helices, Fundamental existence theorem of space curves.

Theory of Surfaces, Coordinate transformation, Tangent plane and surface normal, The first fundamental form and the metric tensor, Christoffel symbols of first and second kinds

The second fundamental form: Principal, Gaussian, mean, geodesic and normal curvatures, Gauss and Weingarten equations, Gauss and Codazzi equations,

Recommended Books:

1. R. S. Millman & G.D. Parker, Elements of Differential Geometry (Prentice-Hall, New Jersey,1977)
2. A. Goetz, Introduction to Differential Geometry (Addison-Wesley, 1970).
3. E. Kreyzig, Differential Geometry (Dover, 1991).
4. M. M. Lipschutz, Schaum's Outline of Differential Geometry (McGraw Hill, 1969).
5. D. Somasundaram, Differential Geometry (Narosa Publishing House, New Delhi, 2005).

Semester-II

Course Title: Real Analysis-II

Course Code: Math-352

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Get firm grip on basic ideas of Riemann integral.
- Apply and use the concepts of Riemann Stieljes (R-S) Integrals.
- Know concretely about function of bounded variation and properties.
- Explore the concepts of improper integrals.
- Explore the concepts of sequences and series of functions.

Course Outcomes:

Students will able to:

- Define basic ideas of Riemann integral.
- Understand the concepts of Riemann Stieljes (R-S) Integrals.
- Understand concretely about function of bounded variation and properties.
- Define sequences and series of functions.

Course Outline:

The Riemann-Stieltjes Integrals: Definition and existence of integrals, Properties of integrals, Fundamental theorem of calculus and its applications, Change of variable theorem, Integration by parts,

Functions of Bounded Variation: Definition, examples & Properties of functions of bounded variation

Improper Integrals: Types of improper integrals, Tests for convergence of improper integrals, Beta and gamma functions, Absolute and conditional convergence of improper integrals

Sequences and Series of Functions: Power series, Definition of point-wise and uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Examples of uniform convergence.

Recommended Books:

7. W. Rudin, Principles of Mathematical Analysis, 3rd edition, (McGraw Hill 1976)
8. R. G. Bartle, Intoduction to Real analysis, 3rd edition, (John Wiley and sons, 2000)
9. T. M. Apostol, Mathematical Analysis, (Addison-Wesley Publishing Co., 1974)
10. A. J. Kosmala, Introductory Mathematical Analysis, (WCB company, 1995)
11. W. R. Parzynski and P. W. Zipse, Introduction to Mathematical Analysis, (Mc Graw Hill company, 1982)
12. H. S. Gaskill and P. P. Narayanaswami, Elements of Real Analysis, (Printice Hall, 1988)

Course Title: Linear Algebra-II

Course Code: Math-329

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding about the concept of ring theory and dual spaces.
- Find eigenvalues and eigenvectors.
- Check whether a given mapping is a linear transformation or not.

Course Outcomes:

The main objectives of this course are to:

- Understand the concepts of ring theory and dual spaces.
- Determine eigenvalues and eigenvectors.
- Determine whether a given mapping is a linear transformation or not.

Course Outline:

Ring Theory: Definition and example of rings, Special classes of rings, Fields, Ideals and quotient rings, Ring homomorphisms, Prime and maximal ideals, Field of quotients

Linear Mappings of Vector Spaces: Review of vector spaces, Mappings, linear mappings, Rank and nullity, Linear mappings and system of linear equations, Algebra of linear operators, Space L(X, Y) of all linear transformations

Matrices and Linear Operators: Matrix representation of a linear operator, Change of basis, Orthogonal matrices and orthogonal transformations, Orthonormal basis and Gram Schmidt process

Linear Transformations: Introduction to linear transformation, Matrices of linear transformations, Rank and nullity, Eigen values and Eigen vectors, Diagonalization, Orthogonal diagonalization, orthogonal matrices, similar matrices. Eigen values and eigen vectors: Polynomials of matrices and linear operators, Characteristic polynomial.

Recommended Books:

8. J. Rose, A Course on Group Theory, (Cambridge University Press, 1978)
9. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company, 1964)
10. G. Birkhoff and S. Maclane, A Survey of Modern Algebra, (Macmillan, New York, 1964)
11. P. B. Battacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, (Cambridge University Press, 1986)
12. V. Sahai and V. Bist, Algebra, 2nd edition, (Narosa Publishing House, 2003)

13. W. Keith Nicholson, Elementary Linear Algebra, (PWS-Kent Publishing Company, Boston, 2004)
14. Seymour Lipschutz, Linear Algebra, 3rd edition, (McGraw Hill Book Company, 2001)

Course Title: Complex Analysis-II

Course Code: Math-368

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Provide basic understanding about the concept of singularity, poles and expansion of functions and analytic continuation.
- Enhance conformal representation.
- Get a grip on concepts of expansion of Functions and analytic continuation
- Explore the concepts of elliptic functions.

Course Outcomes:

Students will able to:

- Define singularity and poles.
- Understand the concept of conformal representation.
- Understand the concepts of expansion of Functions and analytic continuation.
- Understand the concept of elliptic functions.

Course Outline:

Singularity and Poles: Review of Laurent series, Zeros, singularities, Poles and residues, Cauchy's residue theorem, Applications of Cauchy's residue theorem.

Conformal Representation: Transformation, conformal transformation, linear transformation, Möbius/bilinear transformations

Expansion of Functions and Analytic Continuation: Mittag-Leffler theorem, Weierstrass's factorization theorem, Analytic continuation

Elliptic Functions: Periodic functions, Elliptic functions and its properties, Weierstrass function $\varphi(z)$, Differential equation satisfied by $\varphi(z)$, Integral formula for $\varphi(z)$, Addition theorem for $\varphi(z)$, Duplication formula for $\varphi(z)$, Elliptic functions in terms of Weierstrass function with the same periods, Quasi periodic functions: The zeta and sigma functions of Weierstrass, Jacobian elliptic functions and its properties.

Recommended Books:

1. H. S. Kasana, Complex Variables: Theory and Applications, (Prentice Hall, 2005)
2. M. R. Spiegel, Complex Variables, (McGraw Hill Book Company, 1974)
3. Louis L. Pennisi, Elements of Complex Variables, (Holt, Linehart and Winston, 1976)
4. W. Kaplan, Introduction to Analytic Functions, (Addison-Wesley, 1966)
5. E. D. Rainville, Special Functions, (The Macmillan Company, New York, 1965)
6. E. T. Whittaker and G. N. Watson, A Course of Modern Analysis,Cambridge University Press, 1958.

Course Title: Analytical Mechanics

Course Code: Math-305

Credit Hours: 3(3+0)

Course Objectives:

Its objectives are given below:

- To develop fundamental concepts in analytics mechanics more rigorously as needed for other courses of the program.
- To apply advanced mathematical and computational techniques to complex problems.

Course Outcomes:

Students will able to:

- Understand the concept of non inertial reference systems and planar motion of rigid bodies
- Understand the concept of motion of rigid bodies in three dimensions.
- Understand the concept of euler equations of motion of a rigid body.

Course Outline:

Non Inertial Reference Systems: Accelerated coordinate systems and inertial forces, Rotating coordinate systems, Velocity and acceleration in moving system: coriolis, centripetal and transverse, Acceleration, Dynamics of a particle in a rotating coordinate system

Planar Motion of Rigid Bodies: Introduction to rigid and elastic bodies, degrees of freedom, translations, rotations, instantaneous axis and center of rotation, motion of the center of mass, Euler's theorem and Chasle's theorem, Rotation of a rigid body about a fixed axis: moments and products of inertia, hoop or cylindrical shell, circular cylinder, spherical shell, Parallel and perpendicular axis theorem, Radius of gyration of various bodies

Motion of Rigid Bodies in Three Dimensions: General motion of rigid bodies in space: Moments and products of inertia, inertia matrix, The momental ellipsoid and equimomental systems, Angular momentum vector and rotational kinetic energy, Principal axes and principal moments of inertia, Determination of principal axes by diagonalizing the inertia matrix

Euler Equations of Motion of a Rigid Body: Force free motion, Free rotation of a rigid body with an axis of symmetry, Free rotation of a rigid body with three different principal moments, The Eulerian angles, angular velocity and kinetic energy in terms of Euler angles, space, cone, Motion of a spinning top and gyroscopes- steady precession, sleeping top.

Recommended Books:

6. G. R. Fowles and G. L. Cassiday, Analytical Mechanics, 7th edition, (Thomson Brooks/Coley, USA, 2005)
7. M. R. Spiegel, Theoratical Mechanics, (McGraw Hill Book Company, Singapore, 1980)
8. F. P. Beer and E. Russell Johnston, Jr., Vector Mechanics for Engineers -Statics and Dynamics, (McGraw Hill Inc., 1977)
9. H. Goldstein, Classical Mechanics, (Addison-Wesley Publisihng Co., 1980)
10. C. F. Chorlton, Text Book of Dynamics, (Ellis Horwood, 1983)

Course Title: Functional Analysis

Course Code: Math-423

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of normed spaces.
- Differentiate rings through some homomorphism.
- Explore concretely about linear operators and linear functional.
- Provide basic understanding about ideas of inner product space and Hilbert space.

Course Outcomes:

Students will able to:

- Understand the basic ideas of normed spaces with examples.
- Understand the concept of rings through some homomorphism.
- Understand concretely about linear operators and linear functional.
- Define inner product space and Hilbert space.

Course Outline:

Metric Spaces: Review of Metric space, Completeness proofs, Dense sets and separable spaces, No-where dense sets, Baire category theorem

Normed Spaces, Normed linear spaces, Banach spaces, Convex sets, Quotient spaces, Equivalent norms, Linear operators, Linear functionals, Finite dimensional normed spaces, Continuous or bounded linear operators, Dual spaces.

Inner Product Spaces: Definition and examples, Orthonormal sets and bases, Annihilators, projections, Hilbert space, Linear functionals on Hilbert spaces, Reflexivity of Hilbert spaces.

Recommended Books:

1. E. Kreyszig, Introduction to Functional Analysis with Applications, (John Wiley and Sons, 2004)
2. A. L. Brown and A. Page, Elements of Functional Analysis, (Van Nostrand Reinhold London, 1970)
3. G. Bachman and L. Narici, Functional Analysis, (Academic Press, New York, 1966)
4. F. Riesz and B. Sz. Nagay, Functional Analysis, (Dover Publications, Inc., New York, Ungar, 1965)
5. A. E. Taylor, Functional Analysis, (John Wiley and Sons, Toppan, 1958)

Course Title: Ordinary Differential Equation-II

Course Code: Math-347

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the courses are to:

- Explore features of first and second order differential equations.
- Explore essential methods of obtaining series solutions of second order differential equations.
- Explore the methods of series solutions of special ordinary differential equations.
- Investigate systems of Sturm Liouville equations.

Course Outcomes:

Students will able to:

- Understand the features of first and second order differential equations.
- Use essential methods for obtaining series solutions of second order differential equations.
- Determine series solutions of special ordinary differential equations.
- Solve systems of Sturm Liouville equations.

Course Outline

First and Second Order Differential Equations: Review of ordinary differential equations, Techniques of solving second and higher differential equations

Sturm Liouville Systems: Some properties of Sturm-Liouville equations, Regular, periodic and singular Sturm-Liouville systems and its applications

Series Solutions of Second Order Linear Differential Equations: Review of power series, Series solution near an ordinary point, Series solution near regular singular points, Legendre's equation**,** Regular singular points, Series solution near a regular singular point.

Series Solution of Some Special Differential Equations: Hyper geometric function $F(a, b, c; x)$ and its evaluation, Series solution of Bessel equation, Expression for $J_n(X)$when n is half odd integer, Recurrence formulas for $J_n(X)$, Series solution of Legendre equation, Rodrigues formula for polynomial $P_n(X)$ Generating function for $P_n(X)$, Recurrence relations, orthogonal polynomials, Orthogonality of Bessel functions, Expansions of polynomials, The three term recurrence relation.

Recommended Books

7. E. D. Rainville, Special Functions (Macmillan and Company, 1971)
8. G. E. Andrews, R. Askey and R. Roy, Special Functions (Cambridge University Press, 2000)
9. D. G. Zill, Advanced Engineering Mathematics (Jones and Bartlett Publishers, 2005)
10. W. E. Boyce and R. C. Diprima, Elementary Differential Equations and Boundary Value Problems (John Wiley and Sons, 2005)
11. N. M. Temme, Special Functions, An Introduction to the Classical Functions of Mathematical Physics (John Wiley and Sons, 1996)
12. E. T. Whittaker, and G. N. Watson, A Course of Modern Analysis (Cambridge University Press, 1958)

Semester-III

Course Title: Set Theory

Course Code: Math-464

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Understand the basic concepts of cardinality, discuss and prove Cantor's Theorem and discuss the status of the Continuum Hypothesis.
- Explain basic concepts and prove basic facts about ordinals and well-ordered sets.
- Understand the basic concepts of axiom of choice and paradoxes in set theory.

Course Outcomes:

Students will able to:

- Define cardinality, discuss and prove Cantor's Theorem and discuss the status of the Continuum Hypothesis.

- Understand the basic concepts of ordinals and well-ordered sets.
- Understand the concepts of axiom of choice and paradoxes in set theory.

Course Outline:

Cardinality: Equivalent sets, finite and infinite sets, denumerable sets, Countable and uncountable sets, Cardinal numbers, addition and multiplication of cardinals, Cartesian product as sets of functions, Different types of infinity (Cantor's contribution)

Ordinality: Partially ordered sets, Hasse diagrams, Totally ordered sets, Maximal and minimal elements, Upper and lower bound, Well-ordered sets, Transfinite induction, Ordinal numbers, Multiplication of ordinal numbers

Axiom of Choice: Well ordering theorem, Zorn's lemma

Paradoxes in Set Theory: Cantor's paradox, Russell's paradox and others.

Recommended Books:

6. A. A. Fraenkal, Abstract Set Theory, (North-Holland Publishing, Amsterdam, 1966).
7. Patrick Suppes, Axiomatic Set Theory, (Dover Publications, Inc., New York, 1972).
8. P. R. Halmos, Naive Set Theory, (Van Nostrand, New York, 1960).
9. B. Rotman and G. T. Kneebone, The Theory of Sets and Transfinite Numbers, (Oldbourne, London, 1968).
10. Douglas Smith, Maurice Eggen and Richard St. Andre: A Transition to Advanced Mathematics, (Brooks/Cole, 2001).

Course Title: Partial Differential Equation

Course Code: Math-448

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Know where and how PDEs arise in applications and understand concepts of PDE theory.
- Describe analytical methods for solving PDEs.
- Solve linear second order PDEs using canonical variables for initial-value problems.

Course Outcomes:

Students will able to:

- Understand fundamental concepts of PDE theory.
- Apply analytical methods for solving PDEs.

- Solve linear second order PDEs using canonical variables for initial-value problems and Separation of variables.

Course Outline:

Introduction: Review of ordinary differential equation in more than one variables, Linear partial differential equations (PDEs) of the first order, Cauchy's problem for quasilinear first order PDEs

PDEs of Second Order: PDEs of second order in two independent variables with variable coefficients, Linear transformation from one equation to another equation, Normal form, Cauchy's problem for second order PDEs in two independent variables

Adjoint Equation: Adjoint operator, Self adjoint equation and operator, Linear PDEs in n-independent variables, Lagrange's identity, Green's theorem for self adjoint operator

Boundary Value Problems: Laplace equation, Dirichlet problem for a circle, Poisson's integral for a circle, Solution of Laplace equation in Cartesian, cylindrical and spherical coordinates, The wave equation in one dimension and higher dimensions, The heat equation, Axially symmetric solutions.

Recommended Books:

7. I. N. Sneddon, Elements of Partial Differential Equations (Dover Publishing, Inc., 2006)
8. R. Dennemyer, Introduction to Partial Differential Equations and Boundary Value Problems (McGraw Hill Book Company, 1968)
9. M. Humi and W. B. Miller, Boundary Value Problem and Partial Differential Equations (PWS-Kent Publishing Company, Boston, 1991)
10. C. R. Chester, Techniques in Partial Differential Equations (McGraw Hill Book Company, 1971)
11. 5.R. Haberman, Elementary Applied Partial Differential Equations, 2nd edition (Prentice Hall Inc., New Jersey, 1987)
12. E. Zauderer, Partial Differential Equations of Applied Mathematics (Wiley-Interscience, Englewood Cliff, New York, 2006)

Course Title: Numerical Analysis-I

Course Code: Math-442

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are to:

- Describe basic ideas of number system and errors.
- Explore ideas for solution of non-linear equations.

- Understand ideas of interpolation and polynomial approximation.

Course Outcomes:

Students will able to:

- Understand basic ideas of number system and errors.
- Determine solution of non-linear equations.
- Understand the concept of interpolation and polynomial approximation.

Course Outline

Number Systems and Errors: Round off errors and computer arithmetic, Error estimation, Floating point arithmetic

Solution of Non-Linear Equations: Iterative methods and convergence: Bisection method, fixed point iterative method, Regula Falsi, Secant and Newton's method

Systems of Linear Equations: Direct methods: Gaussian elimination method, Gauss-Jordan method, matrix inversion method, factorization (Doolittle, Crout and Cholesky) method and its various forms, Iterative methods and convergence: Gauss-Jacobi method and Gauss-Seidel method, Ill-condition system and condition number, Eigen values and eigenvectors, Power and Rayleigh quotient method

Interpolation and Polynomial Approximation: Difference operators, Interpolation with unequal intervals: Lagrange's interpolation formula, Newton's divided, difference formula, error in polynomial interpolation, Interpolation with equal intervals: Gregory Newton forward/backward interpolation, formula, error in polynomial interpolation, Central difference interpolation formulae: Gauss's forward/backward interpolation, formula, Stirling's formula, Laplace Everett's and Bessel's formula.

Recommended Books:

6. Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 6th edition, (Addison-Wesley Pearson Education, 2003)
7. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 6th edition, (Brooks/Cole Publishing Company, 1997)
8. John H. Mathews, Numerical Methods for Mathematics, 3rd edition (Prentice Hall International, 2003)
9. V. N. Vedamurthy and N. Ch. S. N. Iyenger, Numerical Methods, (Vikas Publishing House Pvt. Ltd, 2002)
10. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, 3rd edition, (McGraw Hill International Edition, 1998)

Course Title: Mathematical Statistics-I

Course Code: Math-431

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of probability distributions with examples.
- Apply ideas of mathematical expectations.
- Know special probability distributions and special probability densities.
- Understand ideas of random variables and sampling distributions.

Course Outcomes:

Studens will able to:

- Construct probability distributions with examples.
- Use ideas of mathematical expectations.
- Understand special probability distributions and special probability densities.
- Understand the concepts of random variables and sampling distributions.

Course Outline:

Probability Distributions: The postulates of probability, Some elementary theorems, Addition and multiplication rules, Baye's rule and future Baye's theorem, Random variables and probability functions.

Discrete Probability Distributions: Uniform, Bernoulli and Binomial distribution, Hypergeometric and geometric distribution, Negative binomial and Poisson distribution

Continuous Probability Distributions: Uniform and exponential distribution, Gamma and beta distributions, Normal distribution.

Mathematical Expectations: Moments and moment generating functions, Moments of binomial, hypergeometric, Poisson, gamma, beta and normal distributions

Recommended Books:

1. J. E. Freund, Mathematical Statistics, (Prentice Hall Inc., 1992)
2. Hogg and Craig, Introduction to Mathematical Statistics, (Collier Macmillan, 1958)
3. Mood, Greyill and Boes, Introduction to the Theory of Statistics, (McGraw Hill)
4. R. E. Walpole, Introduction to Statistics, 3rd edition, (Macmillan Publishing Company London, 1982)
5. M. R. Spiegel and L. J. Stephens, Statistics, (McGraw Hill Book Company, 1984)

Course Title: Programming in MATLAB

Course Code: Math-471

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of MATLAB Environment.
- Provide basic knowledge of programming in MATLAB.

Course Outcomes:

Studens will able to:

- understand basic idea of MATLAB Environment.
- Make programs in MATLAB.

Course Outline:

The MATLAB Environment: The Advantages of MATLAB**,** MATLAB Desktop, Command Window, Command History Window, Start Button, Edit/Debug Window, Figure Windows, Docking and Undocking Windows, MATLAB Workspace, Getting Help

MATLAB Basics: Variables and Arrays, Initializing Variables in MATLAB, Multidimensional Arrays, Subarrays, Special Values, Displaying Output Data, Scalar and Array Operations, Built-in MATLAB Functions, Introduction to Plotting.

Branching Statements and Program Design: Introduction to Top-Down Design Techniques, Use of Pseudocode, The Logical Data Type: Relational Operators, A Caution About the == and ~= Operators , Logic Operators, Logical Functions. Branches: The if Construct, Examples Using if Constructs, The switch Construct, The try/catch Construct. Additional Plotting Features: Controlling x- and y-axis Plotting Limits, Plotting Multiple Plots on the Same Axes, Creating Multiple Figures, Subplots , Enhanced Control of Plotted Lines.

Loops: The while loop, The for loop: Details of Operation, The MATLAB Just-in-Time (JIT) Compiler, The break and continue Statements, Nesting Loops. Logical arrays and vectorization: Creating the Equivalent of if/else Constructs with Logical Arrays.

Recommended Books:

5. S.J. Chapman, MATLAB programming for engineers, (Nelson Education, 2015).
6. S. Attaway, Matlab: a practical introduction to programming and problem solving, (Butterworth-Heinemann, 2013).
7. F. B. Gross, Smart antennas with MATLAB, (McGraw-Hill Education, 2015).
8. S.J. Chapman, Essentials of MATLAB programming, (Cengage Learning, 2016)

Course Title: Advanced Group Theory-I

Course Code: Math-403

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Define automorphisms and products in groups with examples.
- Understand the concept of permutation groups.
- Understand the concept of series in groups.

Course Outcomes:

Students will able to:

- Understand the concept of automorphisms and products in groups with examples.
- Understand the concept of permutation groups.
- Understand the concept of series in groups.

Course Outline:

Automorphisms and Products in Groups: Characteristic and fully invariant subgroups, Normal products of groups, Holomorph of a group

Permutation Groups: Symmetric or permutation group, Permutability of permutations, Transposions, Generators of the symmetric and alternating group, Cyclic permutations and orbits, the alternating group, Generators of the symmetric and alternating groups, Simplicity of $A, n \geq 5$, The stabiliser subgroups,

Series in Groups: Series in groups, Zassenhaus lemma, Normal series and their refinements, Composition series

Recommended Books:

1. J. Rotman, The Theory of Groups, 2nd edition, (Allyn and Bacon, London, 1978)
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-Weseley Publishing Co.)
3. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company Mass, 1972)
4. J. A. Gallian, Contemporary Abstract Algebra, 4th edition, (Narosa Publishers, 1998)
5. J. S. Rose, A Course on Group Theory, (Dover Publications, New York, 1994)
6. K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Course Title: Rings and Modules

Course Code: Math-454

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic ideas of rings and modules with examples.
- Differentiate rings through some homomorphism.
- Know concretely about function of bounded variation and properties.
- Understand ideas of fields and finite fields.

Course Outcomes:

Students will able to:

- Understand basic concepts of rings and modules with examples.
- Understand basic concepts of rings through some homomorphism.
- Understand concretely about function of bounded variation and properties.
- Understand basic concepts of fields and finite fields.

Course Outline:

Ring Theory: Construction of new rings, Direct sums, polynomial rings, Matrix rings, Divisors, units and associates, Unique factorisation domains, Principal ideal domains and Euclidean domains

Field Extensions: Algebraic and transcendental elements, Degree of extension, Algebraic extensions, Reducible and irreducible polynomials, Roots of polynomials.

Recommended Books:

1. I. N. Herstein, Topics in Algebra, (Xerox Publishing Company Mass, 1972)
2. B. Hartley & T. O. Hauvkes, Rings, Modules & Linear Algebra, (Chapmann and Hall Ltd., London)
3. R. B. Allenly, Rings, Fields and Groups:An Introduction to Abstract Algebra, (Edward Arnold, 1985)
4. J. Rose, A Course on Rings Theory, (Cambridge University Press, 1978)
5. G. Birkhoff and S. Maclane, A Survey of Modern Algebra, (Macmillan, New York, 1964)

Course Title: Advance Number Theory-I

Course Code: Math-469

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Describe basic details of congruences.
- Understand the ideas of number-theoretic functions.
- Grip ideas of primitive roots and indices.

Course Outcomes:

Students will able to:

- Understand basic details of congruences.
- Use ideas of number-theoretic functions.
- Understand the concept of primitive roots and indices.

Course Outline:

Congruences: Elementary properties of prime numbers, Residue classes and Euler's function, Linear congruences and congruences of higher degree, Congruences with prime moduli, The theorems of Fermat, Euler and Wilson

Number-Theoretic Functions: Möbius function, The function [x], the symbols O and their basic properties

Primitive roots and indices: Integers belonging to a given exponent, Composite moduli, primitive roots modulo a prime, Determination of integers having primitive roots indices

Recommended Books:

1. W. J. Leveque, Topics in Number Theory, (Vols. I and II, Addison-Wesley Publishing Co., 1956)
2. Tom M. Apostol, Introduction to Analytic Number theory, (Springer International, 1998)
3. David M. Burton, Elementary Number Theory, 6th edition, (McGraw Hill Company, 2007)
4. A. Andrew, The Theory of Numbers, (Jones and Barlett Publishers London, 1995)
5. Harry Pollard, The Theory of Algebraic Numbers, (John Wiley and Sons, Inc, 1950)

Course Title: Quantum Mechanics-I

Course Code: Math-449

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide understanding of the basic principles and techniques in quantum mechanics.
- Special emphasis is put on providing the student with skills to independently perform quantum mechanical analysis of atomic and electro-magnetic systems.

Course Outcomes:

Students will able to:

- Understand the basic principles and techniques in quantum mechanics.
- To perform quantum mechanical analysis of atomic and electro-magnetic systems.

Course Outline:

Inadequacy of Classical Mechanics: Black body radiation, Photoelectric effect, Compton effect, Bohr's theory of atomic structure, Wave -particle duality, The de Broglie postulate, Heisenberg uncertainty principle

The Postulates of Quantum Mechanics: Operators, Eigenfunctions and Eigenvalues , Observables and operators, Measurement in quantum mechanics, The state function and expectation values, Time development of the state function (Schrödinger wave equation), Solution to the initial-value problem in quantum mechanics, Parity operators

Preparatory Concepts: Function Spaces and Hermitian Operators**,** Particle in a box, Dirac notation, Hilbert space, Hermitian operators, Properties of Hermitian operators

Additional One-Dimensional Problems: Bound and Unbound States, General properties of the 1-dimensional Schrodinger equation, Unbound states, One-dimensional barrier problems, The rectangular barrier: Tunneling

Recommended Books:

1. H. D. Dehmen, The Picture Book of Quantum Mechanics (Springer, 2001).
2. H. F. Hameka, Quantum Mechanics: A Conceptual Approach (Wiley-IEEE, 2004).
3. R. L. Liboff, Introductory Quantum Mechanics (Addison-Wesley Publishing Co., 2003).
4. V. K. Thankappan, Quantum Mechanics (New Age Publishers, 1993).
5. D. R. Bès, Quantum Mechanics: A Modern and Concise Introductory Course (Springer, 2004).

Course Title: Analytical Dynamics

Course Code: Math-404

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide an understanding of the concepts of Lagrange's Theory of Holonomic systems.
- To provide an understanding of the concepts of Hamilton's Theory, Lagrange's Theory of Non-Holonomic systems, Canonical Transformations and Hamilton-Jacobi theory.

Course Outcomes:

Students will able to:

- Understand the concepts of Lagrange's Theory of Holonomic systems.
- Understand the the concepts of Hamilton's Theory, Lagrange's Theory of Non-Holonomic systems, Canonical Transformations and Hamilton-Jacobi theory.

Course Outline:

Lagrange's Theory of Holonomic Systems : Generalized coordinates, Holonomic and non-holonomic systems, D'Alembert's principle, d-delta rule, Lagrange equations, Generalization of Lagrange equations, Quasi-coordinates, Lagrange equations in quasi-coordinates, First integrals of Lagrange equations of motion, Energy integral

Hamilton's Theory: Hamilton's principle, Generalized momenta and phase space, Hamilton's equations, Ignorable coordinates, Routhian function, Derivation of Hamilton's equations from a variational principle, The principle of least action

Lagrange's Theory of Non-Holonomic Systems: Lagrange equations for non-holonomic systems with and without Lagrange multipliers, Hamilton's Principle for non-holonomic systems

Canonical Transformations: The equations of canonical transformations, Examples of canonical transformations, The Lagrange and Poisson brackets, Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation

Hamilton-Jacobi Theory: The Hamilton-Jacobi equation for Hamilton's principal function, The harmonic oscillator problem as an example of the Hamilton-Jacobi method, The Hamilton-Jacobi equation for Hamilton's characteristic function, Separation of variables in the Hamilton-Jacobi equation

Recommended Books:

7. D. T. Greenwood, Classical Dynamics (Dover, 1997).
8. F. Chorlton, Chorlton Text Book of Dynamics (Ellis Horwood, 1983).
9. H. Goldstein, C. P. Poole & J. L. Safko, Classical Mechanics, Addison-Wesley Publishing Co., 2003)
10. S. D. Lindenbaum, Analytical Dynamics: Course Notes (World Scientific, 1994).
11. E. J. Saleton and J. V. José, Classical Dynamics: A Contemporary Approach (Cambridge, 1998).
12. J. B. Marion and S. T. Thornton, Classical Dynamics of Particles and Systems (Thomson Learning, 2003)

Course Code: Math-419

Course Title: Electromagnetic Theory-I

Credit Hours: 3(3+0)

Course Objectives:

The objectives of the course are as follows:

- To deepen students understanding of Electromagnetic theories.

- To strengthen student's problem solving skills for electromagnetic problems that are considerably more abstract and difficult than the problems encountered in introductory Physics.
- To find both physical and formal mathematical similarities and connections between Electromagnetic Theory and other areas of Physics.

Course Outcomes:

Students will able to:

- Understand the concept of Electromagnetic theories.
- Solve electromagnetic problems
- Learn both physical and formal mathematical similarities and connections between Electromagnetic Theory and other areas of Physics.

Course Outline:

Electrostatic Fields: Coulomb's law, the electric field intensity and potential, Gauss's law and deductions, Poisson and Laplace equations, Conductors and condensers, Dipoles, the linear quadrupole, Potential energy of a charge distribution, Dielectrics, The polarization and the displacement vectors, General solutions of Laplace's equation, Solutions of Laplace's equation in spherical coordinates, Legendre's equation, Legendre's polynomials

Magnetostatic Fields: The Magnetostatic law of force, The magnetic induction, The Lorentz force on a point charge moving in a magnetic field, The divergence of the magnetic field, The vector potential, The conservation of charge and the equation of continuity, The Lorentz condition, The curl of the magnetic field, Ampere's law and the scalar potential

Steady and Slowly Varying Currents: Electric current, linear conductors, Conductivity, resistance, Kirchhoff's laws, Current density vector, Magnetic field of straight and circular current, Magnetic flux, vector potential, Forces on a circuit in magnetic field.

Recommended Books:

6. G. E. Owen, Introduction to Electromagnetic Theory (Dover, 2003).
7. D. Corrison and P. Lorrison, Introduction to Electromagnetic Fields and Waves (W.H. Freeman and Company, London, 1962).
8. J. R. Reitz, F. J. Milford and R. W. Christy, Foundations of Electromagnetic Theory (Addison Wesley Publishing Co.,1993).
9. J. D. Jackson, Classical Electrodynamics (Wiley, 1999).
10. D. J. Griffiths, Introduction to Electrodynamics (Prentice-Hall, 1999).

Course Title: Operations Research-I

Course Code: Math-444

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide an understanding of the concepts of linear programming and duality
- To provide the basic concept of sensitivity analysis and transportation models.

Course Outcomes:

Students will able to:

- Understand the concepts of linear programming and duality.
- Apply both sensitivity analysis and transportation models.

Course Outline:

Linear Programming: Linear programming, formulations and graphical solution, Simplex method, M-Technique and two-phase technique, Special cases

Duality and Sensitivity Analysis: The dual problem, primal-dual relationships, Dual simplex method, Sensitivity and postoptimal analysis

Transportation Models: North-West corner, Least-Cost and Vogel's approximations methods, The method of multipliers, The assignment model, The transhipment model, Network minimization

Recommended Books:

5. Hamdy A. Taha, Operations Research - An Introduction, (Macmillan Publishing Company Inc., New York, 1987)
6. B. E. Gillett, Introduction to Operations Research, (Tata McGraw Hill Publishing Company Ltd., New Delhi)
7. F. S. Hillier and G. J. Liebraman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974)
8. C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979)

Course Title: Theory of Approximation and Splines-I

Course Code: Math-470

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are:

- To provide an understanding about the concepts of Euclidean geometry, curve fitting and Interpolation.

Course Outcomes:

Students will able to:

- Understand the concepts of Euclidean geometry, curve fitting and Interpolation.

Course Outline:

Euclidean Geometry: Basic concepts of Euclidean geometry, Scalar and vector functions, Barycentric coordinates, Convex hull, matrices of affine maps: translation, rotation, scaling, reflection and shear

Curve Fitting: Least squares line fitting, least squares power fit, data linearization method for exponential functions, nonlinear least-squares method for exponential functions, transformations for data linearization, linear least squares, polynomial fitting.

Polynomial Approximation: Taylor series, laguerre polynomial approximation, Chebyshev Polynomials, Pade approximations, cubic spline.

Recommended Books:

6. David A. Brannan, Geometry, (Cambridge University Press, 1999).
7. Gerald Farin, Curves and Surfaces for Computer Aided Geometric Design: A Practical Guide, 5th edition, (Academic Press. Inc., 2002).
8. Richard H. Bartels, John C. Bealty, and John C. Beatty, An Introduction to Spline for use in Computer Graphics and Geometric Modeling, (Morgan Kaufmann Publisher 2006).
9. John H. Mathews, Numerical Methods for Mathematics, Science and Engineering, 2nd edition (Prentice-Hall International Editions, 1992).
10. Steven C. Chapra and Raymond P. Canale, Numerical edition, (McGraw Hill International Edition, 1998).

Course Title: Fluid Mechanics-I

Course Code: Math-422

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of conservation of matter
- The fundamental of nature of forces in the fluid field
- The importance of two-dimensional and irrotational motions

Course Outcomes:

The students would be able to:

- Learn the two-dimensional and irrotational flows
- Know the conservation of mass and equation of continuity
- Explore the viscous and inviscid fluids and laminar and turbulent flows

Course Outline:

Conservation of Matter: Fields and continuum concepts, Lagrangian and Eulerian specifications, Local, convective and total rates of change, Conservation of mass, Equation of continuity, Boundary conditions

Nature of Forces in a Fluid Field and their Effects: Surface and body forces, Stress at a point, Viscosity and Newton's viscosity law, Viscous and inviscid flows, Laminar and turbulent flows, Compressible and incompressible flows

Irrotational Fluid Motion: Velocity potential from an irrotational velocity field, Streamlines, Vortex lines and vortex sheets, Kelvin's minimum energy theorem, Conservation of linear momentum, Bernoulli's theorem and its applications, Circulations, rate of change of circulation (Kelvin's theorem), Aaxially symmetric motion, Stokes's stream function

Two-dimensional Motion: Stream function, Complex potential and complex velocity, Uniform flows, Sources, sinks and vortex flows, Flow in a sector, Flow around a sharp edge, Flow due to a doublet

Recommended Books:

7. H. Schlichting, K. Gersten, E. Krause and H. Oertel, Jr.: Boundary-Layer Theory,8th edition (Springer, 2004).
8. Yith Chia-Shun: Fluid Mechanics (McGraw Hill, 1974).
9. I. L. Distsworth: Fluid Mechanics (McGraw Hill, 1972).
10. F. M. White: Fluid Mechanics (McGraw Hill, 2003).
11. I. G. Curie: Fundamentals of Mechanics of Fluids, Third edition (CRC, 2002).
12. R. W. Fox, A. T. McDonald and P. J. Pritchard: Introduction to Fluid Mechanics (John Wiley and Sons, 2003)

Semester-IV

Course Title: Measure Theory and Lebesgue Integration

Course Code: Math-437

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of this course are to:

- Understand Riemann and Riemann-Stieltjes integrable functions.
- Understand Lebesgue measurable sets, non-measurable sets, cantor set.
- Understand Lebesgue integral and Lebesgue spaces.

Course Outcomes:

Students are able to:

- Define Riemann and Riemann-Stieltjes integrable functions.
- Define Lebesgue measurable sets, non-measurable sets, cantor set.
- Determine Lebesgue integral and Lebesgue spaces with examples.

Course Outline:

Measurable Sets: Outer measure, Lebesgue measure, Lebesgue measurable sets, Borel sets, Non measurable sets

Measurable Functions: Lebesgue measurable functions, Simple functions, characteristic functions, Borel measurable function, Littlewood three principle

The Lebsegue Integration: Review of the Riemann integral, Lebsegue integral, Integral of a non-negative function, Integral of measurable functions, Convergence in measure.

Recommended Books:

6. D. Smith, M. Eggen and R. St. Andre, A Transition to Advanced Mathematics, (Brooks, 2001)
7. Seymour Lipshcutz, Set Theory and Related Topics, (Mc-Graw Hill Book Company, 1999)
8. H. L. Royden, Real Analysis, (Macmillam, 1968)
9. D. L. Cohan, Measure Theory, (Bir Khauser, 1980
10. P.R. Halmos, Measure Theory, (Von Nostrand, New York, 1950)

Course Title: Methods of Mathematical Physics

Course Code: Math-438

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Fourier, Laplace and Hankel transforms
- To understand the Green's functions and perturbation methods

- To explore the Euler's and Lagrange's equations

Course Outcomes:

The students would be able to:

- Learn the Fourier, Laplace and Hankel transforms
- Know the Green's functions and perturbation methods
- Explore the Euler's and Lagrange's equations

Course Outline:

Fourier Methods: The Fourier transform, Fourier analysis of generalized functions, The Laplace transform, Hankel transforms for the solution of PDE and their application to boundary value problems

Green's Functions and Transform Methods: Expansion for Green's functions, Transform method, Closed form Green'sfunction, Perturbation methods for algebraic equations, Perturbation methods for differential equations

Variational Methods: Euler-Lagrange equations, Integrand involving one, two, three and n variables, Special cases of Euler-Lagranges equations, Necessary conditions for existence of an extremum of a functional, Constrained maxima and minima.

Recommended Books:

6. D. L. Powers, Boundary Value Problems and Partial Differential Equations, 5th edition(Academic Press, 2005)
7. W. E. Boyce, Elementary Differential Equations, 8th edition, (John Wiley and Sons, 2005)
8. M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, Problems and Exercises in the Calculus of Variations, (Imported Publications, Inc., 1985)
9. J. W. Brown and R. V. Churchill, Fourier Series and Boundary Value Problems(McGraw Hill, 2006)
10. A. D. Snider, Partial Differential Equations: Sources and Solutions (Prentice Hall Inc.,1999)

Course Title: Numerical Analysis-II

Course Code: Math-443

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are to:

- Describe basic ideas of numerical differentiation and Integration.
- Explore ideas for the formulaion and solution of differential equations.

Course Outcomes:

Students will able to:

- Understand basic ideas of numerical differentiation and Integration.
- Formulate and determine solutions of differential equations.

Course Outline:

Numerical Differentiation: Derivatives using: Lagrange's interpolation formula, Newton's divided difference formula, Gregory Newton forward/backward interpolation formula, Gauss's forward/backward interpolation formula, Stirling's formula, Laplace Everett's formula, Bessel's formula

Numerical Integration: Newton-Cotes formulae, Trapezoidal rule, Simpson rule, Weddle's rule, Boole's rule, Errors in quadrature formulae, Gaussian quadrature formulae

Formulation of Difference Equations: Analogy of difference equations, Linear homogeneous difference equations with constant coefficients, Linear non-homogeneous difference equations with constant coefficients

Ordinary Differential Equations: Introduction to ODEs, Taylor's series method: Simultaneous first order and higher order differential equations, Euler's, improved Euler's, modified Euler's and Runge-Kutta methods with error analysis, Predictor-corrector methods for solving initial value problems

Recommended Books:

6. Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 6th edition,(Addison-Wesley Publishing Co. Pearson Education, 2003)
7. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 6th edition, (Brooks/Cole Publishing Company, 1997)
8. John H. Mathews, Numerical Methods for Mathematics, Science and Engineering, 3rd edition (Prentice Hall International, 2003)
9. V. N. Vedamurthy and N. Ch. S. N. Iyenger, Numerical Methods, (Vikas Publishing House Pvt. Ltd, 2002)
10. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers 3rd edition, (McGraw Hill International Edition, 1998)

Course Title: Mathematical Statistics-II

Course Code: Math-432

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of functions of random variables
- The introduction of sampling distributions

- The importance of regression and correlation

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of functions of random variables
- An understanding of sampling distributions
- Considerable knowledge about regression and correlation

Course Outline:

Functions of Random Variables: Distribution function technique,Transformation technique: One variable, several variables, Moment-generating function technique

Sampling Distributions: The distribution of the mean, The distribution of the mean: Finite populations, The Chi-Square distribution, The t distribution, The F distribution

Regression and Correlation: Linear regression, The methods of least squares,Normal regression analysis, Normal correlation analysis, Multiple linear regression and its matrix notation.

Recommended Books:

6. J. E. Freund, Mathematical Statistics, (Prentice-Hall Inc., 1992).
7. Hogg and Craig, Introduction to Mathematical Statistics, (Collier Macmillan, 1958)
8. Mood, Greyill and Boes, Introduction to the Theory of Statistics, (McGraw Hill).
9. R. E. Walpole, Introduction to Statistics, 3rd edition,(Macmillan Publishing Company London, 1982)
10. M. R. Spiegel, L. J. Stephens, Statistics, (McGraw Hill Book Company, 1984)

Course Title: Computer Application

Course Code: Math-472

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of Flow Chart and Algorithm
- The concept of Programming of the Numerical Methods
- The importance of Mathematica and their applications

Course Outcomes:

The students would be able to:

- Learn the Programming of Jacobi's iterative and Gauss-Seidel methods
- Know the Programming of Euler's, Runge-Kutta and predictor-corrector methods

- Explore the numerical and algebraic calculations in Mathematica

Course Outline:

Flow Chart, Algorithm and Programming of the following Numerical Methods: System of linear equations, Jacobi's iterative method, Gauss-Seidel method, Solutions of non-linear equations, Bisection method, Newton-Raphson method, Secant method, Regula Falsi method, Interpolation, Langrage interpolation, Newton's divided and forward difference interpolation, Numerical integration: Rectangular rule, Trapezoidal rule, Simpson's rule, Booles rule, Weddles rule, Differential equations: Euler's method, Runge- Kutta methods, predictor-corrector methods

Mathematica: Introduction of mathematica, numerical calculations, algebraic calculations, symbolic andnumerical mathematics, numbers, mathematical functions, algebraic manipulations,manipulating equations, series, limits and residues, linear algebra, graphs

Recommended Books:

6. Michel Metcalf, John Reid and Malcolm Cohen, Fortran 95/2003 Explained, (Oxford University Press, 2004)
7. Stephen Wolfram, The Mathematica, 3rd edition, (Cambridge University Press 1996)
8. V. Rajaraman, Computer Programming in Fortran 90 and 95, (Prentice Hall of India, New Delhi, 1999)
9. Roman E. Maeder, Computer Science with Mathematics, (Cambridge University Press, 2000)
10. Martha L. Abell, James P. Braselton, The Mathematica Handbook, (Academic Press Inc., 1992)

Course Title: Advanced Group Theory-II

Course Code: Math-473

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Solvable groups and their examples
- To understand the Nilpotent and Linear Groups
- To explore the upper and lower central series and Frattini subgroups

Course Outcomes:

The students would be able to:

- Learn the solvable and Super-solvable groups
- Know the characterisation of finite nilpotent groups

- Explore the types and representations of linear groups

Course Outline:

Solvable Groups: Solvablegroups, definition and examples, Theorems on solvable groups**,** Super-solvable groups.

Nilpotent Groups, Characterisation of finite nilpotent groups, Upper and lowercentral series**,** Frattini subgroups, free groups, basic theorems**,** Definition and examples of free products of groups

Linear Groups: Linear groups, types of linear groups, Representation of linear groups**,** Group algebras and representation modules

Recommended Books:

1. J. Rotman, The Theory of Groups, 2nd edition, (Allyn and Bacon, London, 1978)
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7^{th} edition, (Addison-Wesley Publishing Co., 2003)
3. H. Marshall, The Theory of Groups, (Macmillan, 1967)
4. J. A. Gallian, Contemporary Abstract Algebra, 4^{th} edition, (Narosa 1998)
5. J. S. Rose, A Course on Group Theory, (Dover Publications, New York, 1994)
6. K. Hoffman, Linear Algebra, 2^{nd} edition, (Prentice Hall, 1971)

Course Title: Theory of Modules

Course Code: Math-457

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of Modules and Homomorphisms
- The fundamental of Submodules and Quotient modules
- The importance of matrices over rings and their connection with basis of a free module

Course Outcomes:

The students would be able to:

- Learn the Torsion and Free modules
- Know the Basis, rank and endomorphisms of free modules
- Explore the Direct sums of modules and their applications

Course Outline:

Modules: Definition and examples, Submodules**,** Homomorphisms**,** Quotient modules**,** Direct sums of

modules, Finitely generated modules, Torsion modules**,** Free modules**,** Basis, rank and endomorphisms of free modules**,** Matrices over rings and their connection with the basis of a free module, A module as the direct sum of a free and a torsion module

Recommended Books:

6. J. Rotman, The Theory of Groups, 2nd edition, (Allyn and Bacon, London, 1978)
7. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-WeseleyPublishing Co., 2003)
8. J. A. Gallian, Contemporary Abstract Algebra, 4th edition, (Narosa Publishing House,1998)
9. J. S. Rose, A Course on Group Theory, (Dover Publications, New York, 1994)
10. K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Course Title: Advance Number Theory-II

Course Code: Math-474

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Algebraic Number Theory and Quadratic Residues
- To understand the Jacobi and Legendre symbols
- To explore the applications of Einstein irreducibility criterion

Course Outcomes:

The students would be able to:

- Learn the conjugates and discriminants
- Know the Lorentz and Poincare groups
- Explore the units and primes in a quadratic field

Course Outline:

Quadratic Residues: Composite module, Legendre symbol, Law of quadratic reciprocity, The Jacobi symbol**,** Diophantine Equations, Equations and Fermat's conjecture for n = 2, n = 4

Algebraic Number Theory: Polynomials over a field, Divisibility properties of polynomials, Gauss's lemma**,** The Einstein irreducibility criterion, Symmetric polynomials**,** Extensions of a field**,** Algebraic and transcendental numbers**,** Bases and finite extensions, properties of finite extensions, Conjugates and discriminants**,** Algebraic integers in a quadratic field, integral bases, Units and primes in a quadratic field**,** Ideals, arithmetic of ideals in an algebraic number field**,** The norm of an ideal, prime ideals, units of algebraic number field.

Recommended Books:

2. W. J. Leveque, Topics in Number Theory, Vols. I and II (Addison-Wesley Publishing Co. Publishing Co., 1956)
2. Tom M. Apostol, Introduction to Analytic Number Theory, (Springer International, 1998)
3. David M. Burton, Elementary Number Theory, 6th edition, (McGraw Hill Company, 2007)
4. A. Andrew, The Theory of Numbers, (Jones and Barlett Publishers London, 1995)
5. Harry Pollard, The Theory of Algebraic Numbers, (John Wiley and Sons, 1950)

Course Title: Quantum Mechanics-II

Course Code: Math-450

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of Harmonic oscillator and problems in Three-Dimensions
- The introduction of angular momentum
- The importance of Scattering and Perturbation Theories

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of Eigenvalues and Eigenfunctions of operators L2 and Lz
- An understanding of Scattering amplitude and Born approximation
- Considerable knowledge about motion in three dimensions

Course Outline:

Harmonic Oscillator and Problems in Three-Dimensions: The harmonic oscillator, Eigenfunctions of the harmonic oscillator, The harmonic oscillator in momentum space, Motion in three dimensions, Spherically symmetric potential and the hydrogen atom

Angular Momentum: Basic properties, Eigenvalues of the angular momentum operators, Eigenfunctions of the orbital angular momentum operators L_2 and L_z, Commutation relations between components of angular momentum and their representation in spherical polar coordinates

Scattering Theory: The scattering cross-section, Scattering amplitude, Scattering equation, Born approximation, Partial wave analysis

Perturbation Theory: Time independent perturbation of non-degenerate and degenerate cases, Time-dependent perturbations

Recommended Books:

1. R. L. Liboff, Introductory Quantum Mechanics (Addison-Wesley Publishing, 2003)
2. H. D. Dehmen, The Picture Book of Quantum Mechanics (Springer, 2001)
3. H. F. Hameka, Quantum Mechanics: A Conceptual Approach (Wiley-IEEE, 2004)
4. V. K.Thankappan, Quantum Mechanics (New Age Publishers, 1993).
5. D. R. Bès, Quantum Mechanics: A Modern and Concise Introductory Course (Springer, 2004)

Course Title: Special Theory of Relativity

Course Code: Math-455

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the derivation of Special Relativity
- To understand the Four-Vector formulation of Special Relativity
- To explore the applications of electromagnetism in Special Relativity

Course Outcomes:

The students would be able to:

- Learn the Maxwell's equations and electromagnetic waves
- Know the Lorentz and Poincare groups
- Explore the Einstein's formulation of special relativity

Course Outline:

Introduction: Fundamental concepts

Derivation of Special Relativity: Einstein's formulation of special relativity, The Lorentz transformation**,** Length contraction, time dilation and simultaneity, The velocity addition formulae**,** Three dimensional Lorentz transformations.

The Four-Vector Formulation of Special Relativity: The four-vector formalism**,** The Lorentz transformations in 4-vectors, The Lorentz and Poincare groups, The null cone structure**,** Proper time**.**

Electromagnetism in Special Relativity, Review of electromagnetism, The electric and magnetic field intensities, The electric current, Maxwell's equations and electromagnetic waves, The four-vector formulation of Maxwell's equations

Recommended Books:

1. M. Saleem and M. Rafique, Special Relativity (Ellis Horwood, 1992)

2. W. G. V. Rosser, Introductory Special Relativity (Taylor & Francis, 1991)
3. W. Ringler, Introduction to Special Relativity (Oxford, 1991)
4. A. Qadir, An Introduction to Special Theory of Relativity (World Scientific 1989)
5. G. Barton, Introduction to the Relativity Principle (Wiley, 1999)

Course Title: Electromagnetic Theory-II

Course Code: Math-475

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of steady and slowly varying currents
- The introduction of equations of electromagnetism
- The importance of electromagnetic waves

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of electromagnetic field of a moving charge
- An understanding of propagation plane electromagnetic waves in non-conductors
- Considerable knowledge about Maxwell's equations in free space and material media

Course Outline:

Steady and Slowly Varying Currents: The Faraday induction law, Induced elecromotance in a moving system, Inductance and induced electromotance, Energy stored in a magnetic field.

The Equations of Electromagnetism, Maxwell's equations in free space and material media, Solution of Maxwell's equations

Electromagnetic Waves: Plane electromagnetic waves in homogeneous and isotropic media, The Poynting vector in free space**,** Propagation plane electromagnetic waves in non-conductors, Propagation plane electromagnetic waves in conducting media, Reflection and refraction of plane waves**,** Guided waves; coaxial line; hollow rectangular wave guide, Radiation of electromagnetic waves**,** Electromagnetic field of a moving charge

Recommended Books:

6. J. R. Reitz, F. J. Milford and R. W. Christy, Foundations of Electromagnetic Theory (Addison-Wesley Publishing Co., 1993)
7. C.G. Someda, Electromagnetic Waves (CRC, 2006).
8. J. D. Jackson,Classical Electrodynamics (Wiley, 1999).

9. J. V. Stewart, Intermediate Electromagnetic Theory (World Scientific, 2001).
10. G. E. Owen, Introduction to Electromagnetic Theory (Dover, 2003).

Course Title: Operations Research-II

Course Code: **Math-445**

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To study the Shortest-Route algorithms for acyclic networks
- To understand the Maximal-flow problem and decomposition algorithm
- To explore the applications of integer programming

Course Outcomes:

The students would be able to:

- Learn the zero-one implicit enumeration
- Know the parametric linear programming and Branch-and-bound method
- Explore the revised simplex method and bounded variables

Course Outline:

Shortest-Route algorithms for acyclic networks, Maximal-flow problem, Matrix definition of LP problem, Revised simplex method, bounded variables, Decomposition algorithm, Parametric linear programming, Applications of integer programming, Cutting-plane algorithms, Branch-and-bound method, Zero-one implicit enumeration, Elements of dynamic programming, Problem of dimensionality, Programmes by dynamic programming

Recommended Books:

5. Hamdy A. Taha, Operations Research-An Introduction, (Macmillan Publishing Company Inc., New York, 1987)
6. B. E. Gillett, Introduction to Operations Research, (Tata McGraw Hill Publishing Company Ltd., New Delhi)
7. F. S. Hillier and G. J. Liebraman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974)
8. C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979)

Course Title: Theory of Approximation and Splines-II

Course Code: Math-476

Credit Hours: 3(3+0)

Course Objectives:

The course is aimed that the student should learn about:

- The basics of cubic algebraic, Hermite and control point forms
- The introduction of Bernstein Bezier and B-Spline cubic forms
- The importance of Convex hull, Affine invariance and Variation diminishing properties

Course Outcomes:

Students that are expected through this course:

- Sufficient knowledge of clamped, natural and 2nd Derivative conditions
- An understanding of general, natural and periodic splines
- Considerable knowledge about Bernstein Bezier form spline functions

Course Outline:

Parametric Curves: Cubic algebraic form**,** Matrix forms of parametric curves, Cubic Hermite form**,** Cubic control point form**,** Bernstein Bezier cubic form, Bernstein Bezier general form, B-Spline cubic form, Rational quadratic form**,** Rational cubic form**,** Tensor product surface, Bernstein Bezier cubic patch, quadratic by cubic Bernstein Bezier patch, Bernstein Bezier quartic patch**,** Convex hull property**,** Affine invariance property**,** Variation diminishing property,

Spline Functions: Introduction to splines, Cubic Hermite splines, End conditions of cubic splines: clamped conditions, natural conditions, 2nd Derivative

conditions, periodic conditions, not a knot conditions, General Splines: natural splines, periodic splines, Truncated power function, representation of spline in terms of truncated power functions, Algorithms to compute Bernstein Bezier form Spline Functions.

Recommended Books:

6. Gerald Farin, Curves and Surfaces for Computer Aided Geometric Design: A Practical Guide, 5th Edition (Academic Press. Inc., 2002).
7. I. D. Faux, Computational Geometry for Design and Manufacture, (Ellis Horwood, 1979).
8. Richard H. Bartels, John C. Bealty, and John C. Beatty, An Introduction to Spline for use in Computer Graphics and Geometric Modeling, (Morgan Kaufmann Publisher, 2006).
9. Carl de Boor, A Practical Guide to Splines, (Springer Verlag, 2001).
10. Larry L. Schumaker, Spline Functions: Basic Theory, (John Wiley and Sons, 1993).

Course Title: Fluid Mechanics-II

Course Code: Math-478

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To introduce two and three-dimensional potential flows.
- To understand viscous flows of incompressible fluids.
- To study Simplified approach to fluid flow problems.

Course Outcomes:

Students will able to:

- Learn two and three-dimensional potential flows.
- Learn about viscous flows of incompressible fluids.
- Explore simplified approach to fluid flow problems.

Course Outline:

Two and Three-Dimensional Potential Flows: Circular cylinder without circulation, Circular cylinder with circulation, Blasius theorem, Kutta condition and the flat-plate airfoil, Joukowski airfoil, Vortex motion, Karman's vortex street, Method of images, Velocity potential, Stoke's stream function, Solution of the Potential equation, Uniform flow, Source and sink, Flow due to a doublet,

Viscous Flows of Incompressible Fluids: Constitutive equations, Navier-Stokes's equations, exact solutions of Navier-Stokes's equations, Steady unidirectional flow, Poiseuille flow, Couette flow, Flow between rotating cylinders, Stokes' first problem, Stokes' second problem

Simplified Approach to Fluid Flow Problems: Similarity from a differential equation, Dimensional analysis, One dimensional, steady compressible flow.

Recommended Books

7. H. Schlichting, K. Gersten, E. Krause and H. Oertel, Jr. Boundary-Layer Theory, 8th edition (Springer, 2004)
8. Yith Chia-Shun: Fluid Mechanics (McGraw Hill, 1974)
9. I. L. Distsworth: Fluid Mechanics (McGraw Hill, 1972)
10. F. M. White: Fluid Mechanics (McGraw Hill, 2003)
11. I. G. Curie: Fundamentals of Mechanics of Fluids, Third edition (CRC, 2002)
12. R. W. Fox, A. T. McDonald and P. J. Pritchard: Introduction to Fluid Mechanics (John Wiley and Sons, 2003)

Course Title: Integral Equations

Course Code: Math-426

Credit Hours: 3(3+0)

Course Objectives:

The main objectives of the course are:

- To introduce integral equations and its types.
- To learn methods for solving linear and Non-linear Integral equations.

Course Outcomes:

Students will able to:

- Identify the types of integral quations.
- Solve linear and Non-linear Integral equations.

Course Outline

Integral Euations: Introduction to IEs and types, Leibnitz rule, conversion of IVPs to VIEs and Vice versa, conversion of BVPs to FIEs and Vice versa.

Fredholm Integral Equations: Resolvent kernel and solution of IEs by resolvent kernel method, Hilbert Schmidt method solution of FIEs by Direct computation method, Decomposition method, modified decomposition method, successive approximation method, successive substitution method,

Volterra Integral Equations: Solution of VIEs by Direct computation method, Decomposition method, modified decomposition method, successive approximation method, successive substitution method, series solution method, solution of Integro-differential equations. Singular integral equations

Non-Linear Integral Equations: Methods to solve nonlinear integral equations.

Recommended Books:

13. Integral equations by Abdul Majeed Wazwaz.
14. Linear integral, R.P. Kanwal, 1st edition, 1971, Academic Press.
15. Elementary Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, R. Haberman, (3rd Edition), Prentice Hall.
16. Integral equations by Abdul Majeed Wazwaz.
17. Mathematical Methods in the Physical Sciences, Mary L. Boas, (3rd Edition), 2006, John Wiley & Sons.
18. Problems and Exercises in the Calculus of Variations, M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, 1984, Mir Publishers Moscow.