

## Course Structure along with credit distribution

### Second Year – NHEQF Level- 5

Course Category	Semester-III			Semester-IV		
	Subject/Title	No. of paper	Credits	Subject /Title	No. of paper	Credits
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Major-I (Mathematics)	DSC (Major)-III Analytical Geometry	1	5	DSC (Major)-V Real Analysis	1	5
Minor-I (Mathematics)	DSC (Minor)-III Analytical Geometry	1	4	DSC (Minor)-IV Real Analysis	1	4
SEC	SEC (Major)-IV Numerical Methods	1	3	SEC (Major)-VI Linear Programming Problems	1	3
M.D/I.D (Minor)	M.D/I.D (M)-III Basic Calculus	1	4	M.D/I.D (M)-IV Basic Differential Equations	1	4
AEC (Language based courses)	Indian, Modern, Regional Language-I	1	2	Indian, Modern, Regional Language-II	1	2
VAC/AEC	AEC-Indian Knowledge System Or VAC-Culture, traditions and moral values	1	2	AEC-Indian Knowledge System Or VAC-Culture, traditions and moral values	1	2
Total		6	20		6	20
NHEQF Level 5	<i>Student on exit after successfully completing Second year (i.e., securing minimum required 80 credits + 4 Credits in one vocational course/skills-enhancement course of 4 credits) will be awarded "Undergraduate Diploma" of two year, in related field/discipline/subject.</i>					
<b>IKS- Indian Knowledge System- AEC</b>						
<b>Culture, Traditions and Moral Values- VAC</b>						
Students are required to study both courses — <i>Indian Knowledge System (IKS)</i> and <i>Culture, traditions and moral values</i> — during the 3rd and 4th semesters. However, they will have the flexibility to study one course in each semester.						
IMR Language- 'Indian, Modern, Regional Language'- Hindi, Sanskrit and English (Student have to study 2 different languages in the second year with one language in one semester and other language in another semester). One additional course titled "Heritage of Indian Languages" shall be offered, which students may opt for in lieu of any one prescribed language course, subject to the applicable regulations of the programme.						
<b>The department may offer a 3-credit SEC Major course as either a fully theory-based or fully practical-based module.</b>						
<i>Note: Student will continue with the same Discipline specific major &amp; Minor in the second year (III &amp; IV Semester) as studied in the first year (I &amp; II semester) of the FYUP.</i>						

**DSC (Major-I)****Credits-05**

<b>Course Name</b>	<b>Analytical Geometry</b>		
<b>Programme</b>	UG	<b>Credits</b>	3+1+0
<b>Pre-requisite of Course</b>	Coordinate Geometry		
<b>Course Objectives</b>	<p>The objectives of this course are to introduce:</p> <ol style="list-style-type: none"> <li>1. Understanding the concepts of direction cosines and direction ratios and working with for vectors in three-dimensional space.</li> <li>2. Understanding a plane using different forms such as the general form, normal form, and intercept form.</li> <li>3. Analyzing the general and standard forms of a sphere, cylinder and sphere.</li> <li>4. Exploring Paraboloid, Ellipsoid, Hyperboloid, and their tangent planes and normal.</li> </ol>		
<b>Course Outcomes</b>	<p>After the completion of the course, the learner will be able to</p> <ol style="list-style-type: none"> <li>1. Apply direction cosines and direction ratios effectively in vector representation, solving problems related to direction and orientation.</li> <li>2. Derive and manipulate equations of planes, spheres, cylinders, and cones.</li> <li>3. Master in dealing with various conicoid such as paraboloids, ellipsoids, and hyperboloids, including tangent planes and normal.</li> <li>4. Develop strong problem-solving skills, applying mathematical concepts to analyze and solve complex problems related to three-dimensional geometry.</li> </ol>		
<b>Units</b>	<b>Topics</b>		
1	3-D Cartesian Co-ordinates system, Section formula, Direction Cosines, Direction Ratios, Projection. Equation of plane in different forms, Angles between planes, Position of point with respect to a plane, Perpendicular distance of a point from a plane. Angle bisector of two planes.		
2	Equation of straight line in general and symmetrical form, Angles between a line and plane, Perpendicular distance of a point from a line, shortest distance between two lines, Intersection of three planes. Sphere: Equation in different forms, Plane section of a sphere, Section of two spheres, Equation of tangent plane, Angle of intersection of two sphere, Radical plane and line, Co-axial systems of spheres.		
3	Cylinder: Equation of a cylinder, Enveloping cylinder of a Sphere, Right circular cylinder. Cone: Cone with vertex at origin, Condition for general equation of second degree to represent a cone, Right circular cone, Intersection of cone by a plane, Condition for three mutually perpendicular generators.		
4	Conicoid: Paraboloid, Ellipsoid, Hyperboloid, and their tangent planes and normal. Generating Lines: Ruled surfaces, Generating lines of hyperboloid of one sheet, Paraboloid.		

<b>Text Books</b>	<ol style="list-style-type: none"> <li>1. S. Narayan and P. K. Mittal: Analytic Solid Geometry, S. Chand Publishing Co. (2007).</li> <li>2. P. K. Jain and K. Ahmad: A Text Book of Analytical Geometry, New Age Publications (2022).</li> <li>3. R. J. T. Bell: Elementary Treatise on Coordinate Geometry of Three Dimensions. Forgotten Books (2018).</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. D. Chatterjee: Analytical Geometry of Two and Three Dimensions, Narosa Publishing House (2009).</li> <li>2. B. Lal: New Analytical Solid Geometry, Atma Ram and Sons (1966).</li> </ol>

**DSC (Minor-I)**

**Credits-04**

<b>Course Name</b>	<b>Analytical Geometry</b>		
<b>Programme</b>	UG	<b>Credits</b>	3+1+0
<b>Pre-requisite of Course</b>	Coordinate Geometry		
<b>Course Objectives</b>	<p>The objectives of this course are to introduce:</p> <ol style="list-style-type: none"> <li>1. Understanding the concepts of direction cosines and direction ratios and working with for vectors in three-dimensional space.</li> <li>2. Understanding a plane using different forms such as the general form, normal form, and intercept form.</li> <li>3. Analyzing the general and standard forms of a sphere, cylinder and sphere.</li> <li>4. Exploring Paraboloid, Ellipsoid, Hyperboloid, and their tangent planes and normal.</li> </ol>		
<b>Course Outcomes</b>	<p>After the completion of the course, the learner will be able to</p> <ol style="list-style-type: none"> <li>5. Apply direction cosines and direction ratios effectively in vector representation, solving problems related to direction and orientation.</li> <li>6. Derive and manipulate equations of planes, spheres, cylinders, and cones.</li> <li>7. Master in dealing with various conicoid such as paraboloids, ellipsoids, and hyperboloids, including tangent planes and normal.</li> <li>8. Develop strong problem-solving skills, applying mathematical concepts to analyze and solve complex problems related to three-dimensional geometry.</li> </ol>		
<b>Units</b>	<b>Topics</b>		
1	3-D Cartesian Co-ordinates system, Section formula, Direction Cosines, Direction Ratios, Projection. Equation of plane in different forms, Angles between planes, Position of point with respect to a plane, Perpendicular distance of a point from a plane. Angle bisector of two planes.		

2	Equation of straight line in general and symmetrical form, Angles between a line and plane, Perpendicular distance of a point from a line, shortest distance between two lines, Intersection of three planes. Sphere: Equation in different forms, Plane section of a sphere, Section of two spheres, Equation of tangent plane, Angle of intersection of two sphere, Radical plane and line,
3	Cylinder: Equation of a cylinder, Enveloping cylinder of a Sphere, Right circular cylinder. Cone: Cone with vertex at origin, Condition for general equation of second degree to represent a cone, Right circular cone, Intersection of cone by a plane, Condition for three mutually perpendicular generators.
4	Conicoid: Paraboloid, Ellipsoid, Hyperboloid, and their tangent planes and normal. Generating Lines: Ruled surfaces, Generating lines of hyperboloid of one sheet,
<b>Text Books</b>	1. S. Narayan and P. K. Mittal: Analytic Solid Geometry, S. Chand Publishing Co. (2007). 2. P. K. Jain and K. Ahmad: A Text Book of Analytical Geometry, New Age Publications (2022). 3. R. J. T. Bell: Elementary Treatise on Coordinate Geometry of Three Dimensions. Forgotten Books (2018).
<b>Reference Books</b>	1. D. Chatterjee: Analytical Geometry of Two and Three Dimensions, Narosa Publishing House (2009). 2. B. Lal: New Analytical Solid Geometry, Atma Ram and Sons (1966).

**SEC (Major)-IV**

**Credits-03**

<b>Course Name</b>	<b>Numerical Methods</b>		
<b>Programme</b>	UG	<b>Credits</b>	3+1+0
<b>Pre-requisite of Course</b>	Elementary Calculus		
<b>Course Objectives</b>	The objectives of this course are to introduce: 1. Understanding the concepts of error. 2. Understanding iteration methods 3. Analyzing the interpolate value of dependent variable using past data.		

<b>Course Outcomes</b>	After the completion of the course, the learner will be able to 1. Knowledge of types of errors. 2. Ability to solve non-linear equations using iterative methods. 3. Ability to interpolate value of dependent variable using past data. 4. Ability to differentiate complex functions numerically. Ability to numerically solve complex integrals.
<b>Units</b>	<b>Topics</b>
1	<b>Errors in Computation-</b> Floating point representation of numbers, Significant Digits, Rounding and chopping, Absolute and relative errors, computation of errors using differentials, Truncation error. <b>Solution of non-linear equations:</b> Bisection method, Newton Raphson's method, Successive iteration method.
2	<b>Interpolation-</b> Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, Stirling's and Bessel's formulae, Lagrange's method, Divided differences and Newton's divided difference formula. .
3	<b>Numerical Differentiation</b> - Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula.
4	<b>Numerical Integration:</b> Trapezoidal, Weddle, Simpson's Newton Cotes Formulas, Gaussian Quadrature Formulas.

<b>Text Books</b>	1. G. Hadley: Linear Programming, Narosa Publishing House (1995). 2. F.S. Hillier and G.J. Lieberman: Introduction to Operations Research (SIE) (2021). S. D. Sharma: Operation Research, Kedar Nath Ram Nath Publications (2010).
<b>Reference Books</b>	1. P. R. Thie and G. E. Keough: An introduction to linear programming and game theory (3 <sup>rd</sup> ed.), New Jersey, John Wiley & Sons (2008). 2. M. J. Osborne: An introduction to game theory, New York: Oxford University Press (2009). 3. F. S. Hillier, G. J. Lieberman, B. Nag and P. Basu: Introduction to operations research- concepts and cases (10 <sup>th</sup> ed.), New Delhi: Tata McGraw Hill (Indian print) (2017). 4. H. A. Taha: Operations research-an introduction (10 <sup>th</sup> ed.), New Delhi: Pearson Prentice Hall (Indian print) (2017). S. Mokhtar, Bazaraa, J. John, Jarvis and D. Hanif, Sherali, Linear Programming and Network Flows, 2 <sup>nd</sup> Ed., John Wiley and Sons, India (2004).

**M.D./I.D. (Minor)-III**

**Credits-04**

<b>Course Name</b>	<b>Differential Calculus</b>		
<b>Programme</b>	UG	<b>Credits</b>	3+1+0
<b>Pre-requisite of the Course</b>	10+2 Level Mathematics		
<b>Course Objectives</b>	The objectives of this course are to introduce: <ol style="list-style-type: none"> <li>1. The concept of limit.</li> <li>2. The intuitive idea of limits and rate of change.</li> <li>3. The concept of derivatives.</li> <li>4. Application of derivatives.</li> </ol>		
<b>Course Outcomes</b>	After the completion of the course, the learner will be well-versed with <ol style="list-style-type: none"> <li>1. To apply the formulae of derivatives.</li> <li>2. To develop differential equations.</li> <li>3. To compute the length of the curve, surface area and volume.</li> </ol>		
<b>Units</b>	<b>Topics</b>		
1	<b>Introduction to Calculus</b> What is calculus? History and real-world applications, Functions: definition, types (linear, quadratic, exponential), and graphing, Intuitive idea of limits and rates of change. <b>Activities:</b> Graphing functions, exploring real-world examples (e.g., speed of a car).		
2	<b>Understanding Limits</b> Concept of a limit: approaching a value, Evaluating limits using graphs and tables, One-sided limits and continuity. <b>Activities:</b> Hands-on exercises with limit estimation using calculators or software.		
3	<b>Limits in Practice</b> Limits at infinity and asymptotic behavior, Common limit examples (e.g., $1/x$ as $x$ approaches infinity), Applications: Modelling growth and decay, <b>Activities:</b> Real-world problem sets (e.g., population growth).		
4	<b>Introduction to Derivatives</b> The concept of a derivative: rate of change and slope of a curve, Tangent lines and their significance, Derivative as instantaneous rate of change, Visualizing tangents using graphing tools, Finding maximum and minimum values (optimization), Applications in physics (velocity, acceleration) and economics (cost, revenue), Curve sketching: increasing/decreasing functions, concavity.		
<b>Text Books</b>	<ol style="list-style-type: none"> <li>1. Silvanus P. Thompson, <i>Calculus Made Easy</i>.</li> <li>2. Morris Kline, <i>Calculus: An Intuitive and Physical Approach</i>.</li> <li>3. Online tools: Desmos, GeoGebra, Maxima calculus videos.</li> <li>4. Ghorpade, Sudhir R. and Limaye, B. V. (2006). A Course in Calculus and Real Analysis. Undergraduate Texts in Mathematics, Springer (SIE). Indian Reprint.</li> </ol>		

**DSC (Major)-V****Real Analysis****Credits-05**

<b>Course Name</b>	<b>Real Analysis</b>		
<b>Programme</b>	UG	<b>Credits</b>	3+1+0
<b>Pre-requisite of Course</b>	Algebra, Calculus		
<b>Course Objectives</b>	The main objective of this course is: 1. To develop the basic understanding of sets, limits, continuity, differentiability, sequence, series and tests for their convergence.		
<b>Course Outcomes</b>	At the end of this course, the students will be able to 1. Describe the fundamental properties of Real numbers. 2. Demonstrate an understanding of theory of sequence and series, continuity, differentiability. 3. Understand the theory of limits of functions. 4. Apply the limit, continuity and Uniform continuity of functions.		
<b>Units</b>	<b>Topics</b>		
1.	Countable and uncountable sets, Axioms and properties of real numbers, Infimum and supremum of a set, Order completeness property of $\mathbb{R}$ , Archimedean property of $\mathbb{R}$ , Nested intervals property, Neighborhood, Open set, Limit point, Interior point, Exterior point, Boundary points, Closed set, Derived set, Closure of a set, Bolzano-Weierstrass theorem (statement only).		
2.	Sequence of real numbers, Monotone sequences, Bounded sequence, Convergent and non-convergent sequences, limit points of a sequence, Cauchy's sequence, Cauchy's general principle of convergence, Subsequences, Cauchy's first and second theorem on limits, Monotone convergence Theorem, Bolzano Weierstrass Theorem for Sequences.		
3.	Infinite series, Convergence and divergence of infinite series, Test for convergence of positive term series, Comparison test, Ratio test, Raabe's test, Logarithm ratio test, De Morgan's and Bertrand's test Root test, Gauss's test, Cauchy's condensation test, Cauchy's Integral test, Alternating series, Leibnitz test, Absolute and conditional convergent.		
4.	Limits of functions ( $\epsilon$ - $\delta$ approach), Sequential criterion for limits, Continuous functions, Sequential criterion for continuity & discontinuity, Properties of continuous functions on closed and bounded intervals, Boundedness theorem, Intermediate value theorem, Fixed point theorem, Uniform continuity, Differentiability of a function at a point & in an interval.		

<b>Text Books</b>	<ol style="list-style-type: none"> <li>1. R. G. Bartle and D. R. Sherbert: Introduction to Real Analysis (4th ed.). Wiley India Edition. New Delhi (2015).</li> <li>2. T. M Apostol: Mathematical Analysis, 2<sup>nd</sup> edition, Narosa Publishing House, India (1985).</li> <li>3. M. K. Singhal and A. R. Singhal: Topics in Analysis, R. Chand &amp; Co. (2015).</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. R. R. Goldberg, Methods of Real Analysis: Oxford and IBH Publishing Co. (2020).</li> <li>2. W. Rudin, Principles of Mathematical Analysis, 3<sup>rd</sup> edition, McGraw-Hill, New York, 145 (2017).</li> </ol>

**DSC (Minor)-V**

**Real Analysis**

**Credits-04**

<b>Course Name</b>	<b>Real Analysis</b>		
<b>Programme</b>	UG	<b>Credits</b>	3+1+0
<b>Pre-requisite of Course</b>	Algebra, Calculus		
<b>Course Objectives</b>	<p>The main objective of this course is:</p> <ol style="list-style-type: none"> <li>1. To develop the basic understanding of sets, limits, continuity, differentiability, sequence, series and tests for their convergence.</li> </ol>		
<b>Course Outcomes</b>	<p>At the end of this course, the students will be able to</p> <ol style="list-style-type: none"> <li>1. Describe the fundamental properties of Real numbers.</li> <li>2. Demonstrate an understanding of theory of sequence and series, continuity, differentiability.</li> <li>3. Understand the theory of limits of functions.</li> <li>4. Apply the limit, continuity and Uniform continuity of functions.</li> </ol>		
<b>Units</b>	<b>Topics</b>		

1.	Countable and uncountable sets, Axioms and properties of real numbers, Infimum and supremum of a set, Order completeness property of $\mathbb{R}$ , Archimedean property of $\mathbb{R}$ , Nested intervals property, Neighborhood, Open set, Limit point, Interior point, Exterior point, Boundary points, Closed set, Derived set, Closure of a set.
2.	Sequence of real numbers, Monotone sequences, Bounded sequence, Convergent and non-convergent sequences, limit points of a sequence, Cauchy's sequence, Cauchy's general principle of convergence, Subsequences, Cauchy's first and second theorem on limits, Monotone convergence Theorem.
3.	Infinite series, Convergence and divergence of infinite series, Test for convergence of positive term series, Comparison test, Ratio test, Raabe's test, Logarithm ratio test, De Morgan's and Bertrand's test Root test, Gauss's test, Cauchy's condensation test, Cauchy's Integral test, Alternating series, Leibnitz test, Absolute and conditional convergent.
4.	Limits of functions ( $\epsilon$ - $\delta$ approach), Sequential criterion for limits, Continuous functions, Sequential criterion for continuity & discontinuity, Properties of continuous functions on closed and bounded intervals, Boundedness theorem, Intermediate value theorem, Fixed point theorem, Uniform continuity.
<b>Text Books</b>	<ol style="list-style-type: none"> <li>1. R. G. Bartle and D. R. Sherbert: Introduction to Real Analysis (4th ed.). Wiley India Edition. New Delhi (2015).</li> <li>2. T. M Apostol: Mathematical Analysis, 2<sup>nd</sup> edition, Narosa Publishing House, India (1985).</li> <li>3. M. K. Singhal and A. R. Singhal: Topics in Analysis, R. Chand &amp; Co. (2015).</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. R. R. Goldberg, Methods of Real Analysis: Oxford and IBH Publishing Co. (2020).</li> <li>2. W. Rudin, Principles of Mathematical Analysis, 3<sup>rd</sup> edition, McGraw-Hill, New York, 145 (2017).</li> </ol>

**SEC (Major)-VI**

**Credits-03**

<b>Course Name</b>	<b>Linear Programming Problems (LPP)</b>		
<b>Programme</b>	UG	<b>Credits</b>	3+1+0
<b>Pre-requisite of Course</b>	Coordinate Geometry and Inequalities		
<b>Course Objectives</b>	<p>The course objectives are aimed to:</p> <ol style="list-style-type: none"> <li>1. Learn the techniques of optimization of a given objective function with constraints.</li> </ol>		

<b>Course Outcomes</b>	<p>After the completion of the course, the learner will be able to</p> <p>After completing this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Get basic idea about the operations research and solution methodology to get optimal solution of real problem.</li> <li>2. Apply the knowledge of LLP to formulate real-life problems and able to solve using the concept of duality.</li> <li>3. Learn the application of transportation, and assignment in real life.</li> </ol>
<b>Units</b>	<b>Topics</b>
1	<b>Interpolation:</b> Error, Finite Difference Operator, Newton's Forward and Backward Interpolation, Lagrange's Interpolation, Newton's Divided Difference Interpolation, Inverse Interpolation. Derivatives from Difference Tables, Higher Order Derivatives, Newton – Cotes quadrature formula, Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule, Boole's Rule, Weddle's Rule, Romberg's Method.
2	<b>Solution of Transcendental Equations:</b> Bisection Method, False Position Method, Method of Iteration, Newton-Raphson Method, Secant Method, Rate and Order of Convergence of Iterative Methods, Existence of the Solution of Iterative Methods.
3	<b>Solution of System of Linear and Non-linear Equations:</b> Pivoting, Gauss Elimination Method, Gauss-Jacobi Method, Gauss – Seidel Method, Computation of Eigen Values of a Matrix by Power Method, Inverse Power Method, Scaled Power Method, Newton's Method for Non-linear Equations.
4	<b>Numerical solution to Ordinary Differential Equations:</b> Picard's Method, Taylor's Method, Euler Method and Modified Euler Method, Runge-Kutta Method, Milne's Method.

<b>Text Books</b>	<ol style="list-style-type: none"> <li>1. Jain, M. K.(1997): Numerical Solution of Differential Equations, John Wiley.</li> <li>2. Gerald, C. F. and Wheatly P. O. (2002): Applied Numerical Analysis, 6th Ed., Addison-Wesley Publishing .</li> <li>3. Balagurusamy, E. (1999): Numerical Methods, Tata McGraw Hill Publication.</li> <li>4. Bradie, B. (2006): A Friendly Introduction to Numerical Analysis. Pearson Education, India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.</li> </ol>
<b>Reference Books</b>	Sastry, S.S. (2012): Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd.

**M.D./I.D. (Minor)-I**

**Credits-04**

<b>Course Name</b>	<b>Differential Equations</b>		
<b>Programme</b>	UG	Credits	3+0+1
<b>Pre-requisite of Course</b>	Mathematics at 10+2 Level		
<b>Course Objectives</b>	The main objectives of the course are to introduce the students with: <ol style="list-style-type: none"> <li>1. Different types of differential equations.</li> <li>2. Various methods to solve the differential equations.</li> <li>3. Their applications and mathematical modeling.</li> </ol>		
<b>Course Outcomes</b>	Upon completion of this course, the students will be able to: <ol style="list-style-type: none"> <li>1. Classify and identify various types of differential equations.</li> <li>2. Solve first and second-order differential equations using appropriate methods.</li> <li>3. Apply differential equations to model physical, biological, and economic systems.</li> <li>4. Interpret and analyze solutions graphically using mathematical software.</li> <li>5. Develop algorithmic thinking for numerical and symbolic solutions</li> </ol>		
<b>Units</b>	<b>Topics</b>		
1	<b>Introduction and First Order Equations</b> Definitions: order, degree, general and particular solutions, Formation of differential equations, Solutions of first-order, first-degree equations		
2	<b>Applications of First-Order Equations</b> Population growth and decay, Newton's law of cooling, Radioactive decay, Orthogonal trajectories (Cartesian and polar forms), Chemical reaction rates		
3	<b>Systems and Series Solutions</b> Simultaneous differential equations (basic examples) Series solution near ordinary point (basic ideas only), Brief idea of singular points Skills developed		
4	Graphical visualization of slope fields and solutions, Solving ODEs using Python or Excel, Real-world modeling: cooling, decay, motion, Animating simple harmonic motion, Numerical vs analytical comparison for selected problems.		
<b>Text Books</b>	<ol style="list-style-type: none"> <li>1. Simmons, George F. — Differential Equations with Applications and Historical Notes</li> <li>2. Shepley L. Ross — Differential Equations</li> <li>3. E.D. Rainville &amp; P.E. Bedient — Elementary Differential Equations</li> <li>4. Schaum's Outline Series — Differential Equations</li> <li>5. Zill &amp; Wright — A First Course in Differential Equations</li> </ol>		

