Sana'a University
Faculty of Engineering
Electrical Engineering Department
B.Sc. of Computer and Control Engineering

22. Course Specification of Differential Equations

I. Course Identification and General Information:

1.	Course Title:	Differential Equations				
2.	Course Code & Number:	BR122				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	Tr.	
		2	-	2	-	3
4.	Study level/ semester at which this course is offered:	Second Year - Second Semester				
5.	Pre –requisite (if any):	Linear Algebra (BR121)				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Electrical Engineering				
8.	Language of teaching the course:	English/Arabic				
9.	Location of teaching the course:	Classes at the Faculty of Engineering				
10.	Prepared By:	Asst. Prof. Dr. Adnan Al-Salihi				
11.	Date of Approval	March 2020				

II. Course Description:

This course introduces the student to differential equations that will be used for solving mathematical problems that arise in science and engineering. Students will develop the methods to formulate basic engineering problems. In addition, topics to be covered include: Basic concepts, classification and formation of differential equations (ODEs and PDEs), general and particular solutions. Solutions of ordinary differential equations (first order, second order and higher orders) by various methods, geometric and physical applications, Laplace transform; properties and applications; solutions of differential equations using Laplace transform; Introduction to Partial differential equations.

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	Asst. Prof. Dr. Adel Ahmed Al-Shakiri	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

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	III. Course Intended learning outcomes (CILOs) of the course	Referenced PILOs
a1	Recognize the definitions, basic properties and theorems of the Laplace Transforms, and differential equations including their solutions and applications.	A1
a2	Identify the most important and appropriate techniques for solving various types of differential equations.	A2
b1	Classify the differential equations according to their types, order, degree, linearity and homogeneity and suggest the suitable method for solving every kind.	B1
b2	Demonstrate proficiency in choose appropriate mathematical methods for solve a Electrical engineering problems governing by the ordinary and partial differential equations, as well as analyze, interpret the results and predict behavior.	B2, B3
c1	Apply the theorems and techniques for solving differential equations to solve practical problems in field of electoral engineering.	C1
c2	Build a mathematics models and solve problems in electoral engineering applications using Laplace transforms.	
c3	Solve the different types of DEs analytically (e.g. exact, homogeneous, linear, systems of linear DEs and linear higher order, etc.) that describe models occurring in Electrical engineering.	C4
d1	Effectively manage tasks, time, and resources.	D1
d2	Communicate and work effectively in group and individually.	D4

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies

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a1- Recognize the definitions, basic properties and theorems of the Laplace Transforms, and differential equations including their solutions and applications.	- Active lectures - tutorials	- Written tests - Homework - presentations
a2- Identify the most important and appropriate techniques for solving various types of differential equations.	- Active lectures - Tutorials	- Written tests - Homework - presentations

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Classify the differential equations according to their types, order, degree, linearity and homogeneity and suggest the suitable method for solving every kind.	-Active lectures -Tutorials	- Written tests - Homework - Presentations
b2- Demonstrate proficiency in choose appropriate mathematical methods for solve an Electrical engineering problem governing by the ordinary and partial differential equations, as well as analyze, interpret the results and predict behavior.	-Active lectures -Tutorials	- Written tests - Homework - presentations

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1- **Apply** the theorems and techniques for solving differential equations to solve	- Active lectures	- Written tests - Homework

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	practical problems in field of electoral engineering.	- Team work (group learning)	- presentations
c2-	Build a mathematics models and solve problems in engineering applications using Laplace transforms.	- Active lectures - Team work (group learning)	- Written tests - Homework - presentations
c3-	Solve the different types of DEs analytically (e.g. exact, homogeneous, linear, systems of linear differential equations and linear higher order, etc.) that describe models occurring in Electrical engineering.	- Active lectures - Team work (group learning)	- Written tests - Homework - presentations

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:			
Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
d1-	Effectively manage tasks, time, and resources.	Team work (group learning)	- Presentations, - Reports
d2-	Communicate and work effectively in group and individually.	Team work (group learning)	- Presentations, - Reports

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Introduction, Formulation and solutions	a1, b1	▪ Basic concepts and definitions.	2	4

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	of differential equations.		▪ Classification of differential equations, types, order and degree, linearity and homogeneous. ▪ Formulation of Des. ▪ Solution of D.Es ▪ Boundary and initial conditions.		
2.	First order ordinary differential equations.	a1, a2, b2, c3,	▪ Separable equations and equations reducible to Separable. ▪ Exact equations and equations reducible to exact. ▪ Linear equations and equations reducible to linear (Bernoull's and Riccati equation).	2	4
3.	Modeling with First-Order Differential Equations	a1, b2, c1,	▪ Growth and Decay ▪ Newton's Law of Cooling / Warming ▪ Mixtures ▪ Series Circuits ▪ Population Dynamics ▪ Logistic Equation ▪ Chemical Reactions.	1	2
4.	Higher order ODEs	a1, a2, b1, b2, c3	▪ Linear independence and linear dependence ▪ Homogenous equations with constant coefficients. ▪ NonHomogenous equations with constant coefficients	2	4

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			▪ Operator method. ▪ Undetermined coefficients method. ▪ Method of variations of parameter. ▪ equations with variable coefficients ▪ Cauchy-Euler Equation. ▪ Lagrange Equation. ▪ Applications on nth order differential equations.		
5.	Modeling with Higher-Order Differential Equations	a1, b2, c1,	▪ Spring/Mass Systems: Free Undamped Motion ▪ Double Spring Systems ▪ Spring/Mass Systems: Free Damped Motion ▪ Spring/Mass Systems: Driven Motion ▪ Series Circuit Analogue ▪ Deflection of a Beam ▪ Eigenvalues and Eigenfunctions ▪ Buckling of a Thin Vertical Column ▪ Rotating String	1	2
6.	Systems of Differential Equations and modeling with Systems	a1,b2, c3	▪ Radioactive Series ▪ Mixtures ▪ A Predator–Prey Model ▪ Competition Models ▪ Networks.	1	2

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	of First-Order DEs				
7.	Introduction to Laplace Transform (Definitions and Properties)	a1, c2, d1	▪ Definition of Laplace transforms. ▪ Laplace transform of elementary functions. ▪ Properties and theorem of Laplace transform. ▪ Laplace transform of special functions: unit step function, Dirac-delta function and periodic functions. ▪ Generalization of Laplace Transforms by means of Gamma functions.	2	4
8.	Inverse Laplace Transform	a1, c2, d1	▪ Basic concepts and definitions. ▪ Properties and theorems of Inverse Laplace transform. ▪ Inverse Laplace transform by partial fraction and convolution theorem.	1	2
9.	Solving Initial Value Problems and Linear Systems with Laplace Transforms and Applications	a1, c1, c2,d2	▪ Solving Initial Value Problems and Linear Systems of ODEs with Laplace Transforms ▪ Coupled Springs ▪ Networks	1	2

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10.	Introduction of Partial Differential Equations	a1, a2, b1, c2,	▪ Introduction and classification of PDEs. ▪ PDEs in Physics and Engineering (heat, wave and Laplace equations)	1	2
Number of Weeks /and Units Per Semester				**14**	**28**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes
1.	Introduction, Formulation and solutions.	2	4	a1, a2, b1, b2, c1, c2, c3, d1
2.	First order ordinary differential equations.	2	4	a1, a2, b1, b2, c1, c2, c3, d1
3.	Modeling with First-Order Differential Equations	1	2	a1, a2, b1, b2, c1, c2, c3, d1
4.	Higher order ODEs	2	4	a1, a2, b1, b2, c1, c2, c3, d1,d2
5.	Modeling with Higher-Order Differential Equations	1	2	a1, a2, b1, b2, c1, c2, c3, d1,d2
6.	Systems of Differential Equations and modeling with Systems of First-Order DEs	1	2	a1, a2, b1, b2, c1, c2, c3, d1,d2
7.	Introduction to Laplace Transform (Definitions and Properties)	2	4	a1, a2, b1, b2, c1, c2, c3, d1,d2
8.	Inverse Laplace Transform	1	2	a1, a2, b1, b2, c1, c2, c3, d1,d2

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9.	Solving Initial Value Problems and Linear Systems with Laplace Transforms and Applications	1	2	a1, a2, b1, b2, c1, c2, c3, d1,d2
10.	Introduction of Partial Differential Equations	1	2	a1, a2, b1, b2, c1, c2, c3, d1
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching strategies of the course:

- Active lectures
- Tutorials
- Interactive class discussions and Presentations
- Exercises and home works
- Case studies ,and The use of communication and information technology

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Assignments on solving first order differential equations.	a1, a2, b1, b2, c1, c3, d1,d2	2nd	2
2.	Assignments on solving higher order differential equations.	a1, a2, b2, c1,c3 d1,d2	4th	2
3.	Assignments on Modeling with First-Order and higher order differential equations.	a1, a2, b2, c1, c3, d1,d2	6th	2
4.	Assignments on using Laplace Transform	a1, c2, d1,d2	9th	2
5.	Assignments on solving PDEs .	a1, a2, b1, c1,c3	11th	2
	Total			**10**

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VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Assignments	3rd, 5th, 9th, 11th	7.5	5%	a1, a2, b1, b2, c1, c2, c3,d2
2.	Quizzes	2nd ,4th ,6th ,8th ,10th	7.5	5%	a1, a2, b1, b2, c1, c2, c3,d1
3.	Mid-Term Exam	8th	30	20 %	a1, a2, b1, b2, c1, c3,d2
4.	Final Exam	16th	105	70 %	a1, a2, b1, b2, c1, c2, c3,d2
	Total		**150%**	**100%**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. Dennis G. Zill, 2017, Advanced Engineering Mathematics, 6th Edition, USA, Jones & Bartlett Learning.
2. Rajesh Pandey , 2010, A Text Book Of Engineering Mathematics, Vol (II),, word press, First edition.

2- Essential References.

1. Erwin Kreyszig, 2011, Advanced Engineering Mathematics, 10th Edition, USA, John Wiley & Sons, Inc.
2. Alan Jeffrey, 2002, Advanced Engineering Mathematics, USA, Harcourt/Academic Press.
3. Higher Engineering Mathematics, Fifth Edition by John Bird, Elsevier Ltd. 2006.

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	4. Frank Ayres, Jr, 1981, Schaum's Outline of Theory and problems of Differential Equations in SI Metric Units, First Edition, McGRAW-HILL BOOKCOMPANY.
3- Electronic Materials and Web Sites etc.	
	1. wolframMathworld **2.** http://mathworld.wolfram.com/topics/CalculusandAnalysis.html

IX. Course Policies:

1.	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic
2.	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:** A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam-
4.	**Assignments & Projects:** The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time-
5.	**Cheating:** For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty-
6.	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.
7.	**Other policies:**

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	- Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

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Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Assoc. Prof. Dr. Riyad A. Muharram.**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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22. Template for Course Plan of Differential equations

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Dr. Adnan Alsalihi	**Office Hours**					
Location& Telephone No.	Sana'a university 770499879	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	Adnans2000@gmail.com						

II. Course Identification and General Information:

1.	Course Title:	Differential equations				
2.	Course Number & Code:	BR122				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	Tr.	
		2	-	2	-	3
4.	Study level/year at which this course is offered:	Second Year - Second Semester				
5.	Pre –requisite (if any):	Linear Algebra(BR121)				
6.	Co –requisite (if any):	None				
7.	Program (s) in which the course is offered	Electrical Engineering				
8.	Language of teaching the course:	English/Arabic				
9.	System of Study:	Credit Hours				
10.	Mode of delivery:	Full Time				
11.	Location of teaching the course:	Classes at the Faculty of Engineering				

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III. Course Description:

This course introduces the student to differential equations that will be used for solving mathematical problems that arise in science and engineering. Students will develop the methods to formulate basic engineering problems. In addition, topics to be covered include: Basic concepts, classification and formation of differential equations (ODEs and PDEs), general and particular solutions. Solutions of ordinary differential equations (first order, second order and higher orders) by various methods, geometric and physical applications, Laplace transform; properties and applications; solutions of differential equations using Laplace transform; Introduction to Partial differential equations.

IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Recognize the definitions, basic properties and theorems of the Laplace Transforms, and differential equations including their solutions and applications.
2. Identify the most important and appropriate techniques for solving various types of differential equations.
3. Classify the differential equations according to their types, order, degree, linearity and homogeneity and suggest the suitable method for solving every kind.
4. Demonstrate proficiency in choose appropriate mathematical methods for solve an Electrical engineering problem governing by the ordinary and partial differential equations, as well as analyze, interpret the results and predict behavior.
5. Apply the theorems and techniques for solving differential equations to solve practical problems in field of electoral engineering.
6. Build a mathematics models and solve problems in electoral engineering applications using Laplace transforms.
7. Solve the different types of DEs analytically (e.g. exact, homogeneous, linear, systems of linear DEs and linear higher order, etc.) that describe models occurring in Electrical engineering.
8. Effectively manage tasks, time, and resources.

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9.	Communicate and work effectively in group and individually.

V. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact hours
1.	Introduction, Formulation and solutions of differential equations.	▪ Basic concepts and definitions. ▪ Classification of differential equations, types, order and degree, linearity and homogeneous. ▪ Formulation of Des. ▪ Solution of D.Es ▪ Boundary and initial conditions.	1st ,2nd	4
2.	First order ordinary differential equations.	▪ Separable equations and equations reducible to Separable. ▪ Exact equations and equations reducible to exact. ▪ Linear equations and equations reducible to linear (Bernoull's and Riccati equation).	3rd ,4th	4
3.	Modeling with First-Order Differential Equations	▪ Growth and Decay ▪ Newton's Law of Cooling / Warming ▪ Mixtures ▪ Series Circuits ▪ Population Dynamics ▪ Logistic Equation ▪ Chemical Reactions.	5th	2
4.	Higher order ODEs	▪ Linear independence and linear dependence ▪ Homogenous equations with constant coefficients.	6th ,7th	4

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		▪ NonHomogenous equations with constant coefficients ▪ Operator method. ▪ Undetermined coefficients method. ▪ Method of variations of parameter. ▪ equations with variable coefficients ▪ Cauchy-Euler Equation. ▪ Lagrange Equation. ▪ Applications on nth order differential equations.		
5.	Mid-Term Exam		8th	2
6.	Modeling with Higher-Order Differential Equations	▪ Spring/Mass Systems: Free Undamped Motion ▪ Double Spring Systems ▪ Spring/Mass Systems: Free Damped Motion ▪ Spring/Mass Systems: Driven Motion ▪ Series Circuit Analogue ▪ Deflection of a Beam ▪ Eigenvalues and Eigenfunctions ▪ Buckling of a Thin Vertical Column ▪ Rotating String	9th	2
7.	Systems of Differential Equations and modeling with Systems of First-Order DEs	▪ Radioactive Series ▪ Mixtures ▪ A Predator–Prey Model ▪ Competition Models ▪ Networks.	10th	2
8.	Introduction to Laplace Transform	▪ Definition of Laplace transforms. ▪ Laplace transform of elementary functions.	11th ,12th	4

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	(Definitions and Properties)	▪ Properties and theorem of Laplace transform. ▪ Laplace transform of special functions: unit step function, Dirac-delta function and periodic functions. ▪ Generalization of Laplace Transforms by means of Gamma functions.		
9.	Inverse Laplace Transform	▪ Basic concepts and definitions. ▪ Properties and theorems of Inverse Laplace transform. ▪ Inverse Laplace transform by partial fraction and convolution theorem.	13th	2
10.	Solving Initial Value Problems and Linear Systems with Laplace Transforms and Applications	▪ Solving Initial Value Problems and Linear Systems of ODEs with Laplace Transforms ▪ Coupled Springs ▪ Networks	14th	2
11.	Introduction of Partial Differential Equations	▪ Introduction and classification of PDEs. ▪ PDEs in Physics and Engineering (heat, wave and Laplace equations)	15th	2
12.	Final Exam		16th	2
Number of Weeks /and Units Per Semester			**16**	**32**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours
1.	Introduction, Formulation and solutions.	1st ,2nd	4
2.	First order ordinary differential equations.	3rd ,4th	4

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3.	Modeling with First-Order Differential Equations	5^{th}	2
4.	Higher order ODEs	6^{th} ,7^{th}	4
5.	Modeling with Higher-Order Differential Equations	8^{th}	2
6.	Systems of Differential Equations and modeling with Systems of First-Order Des	9^{th}	2
7.	Introduction to Laplace Transform (Definitions and Properties)	10^{th} ,11^{th}	4
8.	Inverse Laplace Transform	12^{th}	2
9.	Solving Initial Value Problems and Linear Systems with Laplace Transforms and Applications	13^{th}	2
10.	Introduction of Partial Differential Equations	14^{th}	2
Number of Weeks /and Units Per Semester		**14**	**28**

VI. Teaching strategies of the course:

- Active lectures
- Tutorials
- Interactive class discussions and Presentations
- Exercises and home works
- Case studies ,and The use of communication and information technology

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Assignments on solving first order differential equations.	a1, a2, b1, b2, c1, c3, d1,d2	2^{nd}	2
2.	Assignments on solving higher order differential equations.	a1, a2, b2, c1,c3 d1,d2	4^{th}	2
3.	Assignments on Modeling with First-Order and higher order differential equations.	a1, a2, b2, c1, c3, d1,d2	6^{th}	2

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4.	Assignments on using Laplace Transform	a1, c2, d1,d2	9th	2
5.	Assignments on solving PDEs .	a1, a2, b1, c1,c3	11th	2
	Total			**10**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1.	Assignments	3rd, 5th, 9th, 11th	7.5	5%
2.	Quizzes	2nd ,4th ,6th ,8th ,10th	7.5	5%
3.	Mid-Term Exam	8th	30	20 %
4.	Final Exam	16th	105	70 %
	Total		**150%**	**100%**

IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. Dennis G. Zill, 2017, Advanced Engineering Mathematics, 6th Edition, USA, Jones & Bartlett Learning.
2. Rajesh Pandey , 2010, A Text Book Of Engineering Mathematics, Vol (II),, word press, First edition.

2- Essential References.

1. Erwin Kreyszig, 2011, Advanced Engineering Mathematics, 10th Edition, USA, John Wiley & Sons, Inc.
2. Alan Jeffrey, 2002, Advanced Engineering Mathematics, USA, Harcourt/Academic Press.
3. Higher Engineering Mathematics, Fifth Edition by John Bird, Elsevier Ltd. 2006.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
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	4. Frank Ayres, Jr, 1981, Schaum's Outline of Theory and problems of Differential Equations in SI Metric Units, First Edition, McGRAW-HILL BOOKCOMPANY.
3- Electronic Materials and Web Sites etc.	
	1. WolframMathworld **2.** http://mathworld.wolfram.com/topics/CalculusandAnalysis.html

X. Course Policies:

1.	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic
2.	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:** A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam-
4.	**Assignments & Projects:** The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time-
5.	**Cheating:** For cheating in exam, a student will be considered as failure. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty-
6.	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.

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7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

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