DEPARTMENT: **PHYSICAL SCIENCES**　　　DATE: **Spring 2019**

Title of Course(s) or Degree Change:
PSQ 000A QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES A (0 crs. 1 eq. crs. 2 hrs. 12 wks.)
PSQ 000B QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES B (0 crs. 1 eq. crs. 2 hrs. 12 wks.)
PSQ 000C QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES C (0 crs. 1 eq. crs. 2 hrs. 12 wks.)
PSQ 000D QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES D (0 crs. 1 eq. crs. 2 hrs. 12 wks.)

Change(s) Initiated: (Please Check)

__ Closing of Degree　　　　　　　__ Change in Degree or Certificate Requirements
__ Closing of Certificate　　　　　__ Change in Degree Requirements (adding concentration)
__ New Certificate Proposal　　　　__ Change in Pre/Co-Requisite
__ New Degree Proposal　　　　　 __ Change in Course Designation
_X_ New Course　　　　　　　　　 __ Change in Course Description
__ New 82 Course　　　　　　　　 __ Change in Course Title, Numbers Credit and/or Hour
__ Deletion of Course　　　　　　　__ Change in Academic Policy
　　　　　　　　　　　　　　　　　　_ Pathways Submission:
　　　　　　　　　　　　　　　　　　_ Life and Physical Science
　　　　　　　　　　　　　　　　　　_ Math and Quantitative Reasoning
　　　　　　　　　　　　　　　　　　_ A. World Cultures and Global Issues
　　　　　　　　　　　　　　　　　　_ B. U.S. Experience in its Diversity
　　　　　　　　　　　　　　　　　　_ C. Creative Expression
　　　　　　　　　　　　　　　　　　_ D. Individual and Society
　　　　　　　　　　　　　　　　　　_ E. Scientific World

__ Other (please describe):

PLEASE ATTACH PERTINENT MATERIAL TO ILLUSTRATE AND EXPLAIN ALL CHANGES

I.　DEPARTMENTAL ACTION
Action by Department &/or Departmental Curriculum Committee, if required:

Date approved:　　　　　　　　　　Signature, Committee Chairperson:

Signature, Department Chair:　　　　　　　　　　　　　　　Date:

New course PROPOSAL FORM

1. DEPARTMENT, COURSE NUMBER, AND TITLE (SPEAK TO ACADEMIC SCHEDULING FOR NEW COURSE NUMBER ASSIGNMENT):

PHYSICAL SCIENCES

PSQ 000A QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES A (0 crs. 1 eq. crs. 2 hrs. 12 wks.)
PSQ 000B QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES B (0 crs. 1 eq. crs. 2 hrs. 12 wks.)
PSQ 000C QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES C (0 crs. 1 eq. crs. 2 hrs. 12 wks.)
PSQ 000D QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES D (0 crs. 1 eq. crs. 2 hrs. 12 wks.)

Composed of modules of:
PSQ 0101 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0100
PSQ 0102 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0102
PSQ 0103 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0103
PSQ 0201 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0201
PSQ 0301 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0301
PSQ 0302 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0302
PSQ 0401 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0401
PSQ 0501 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0501
PSQ 0601 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0601
PSQ 0701 QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES 0701

To provide general "just in time" support for college-level courses in the physical sciences:
CHM 1100 – GENERAL CHEMISTRY I
CHM 1200 – GENERAL CHEMISTRY II
EGR 2200 – INTRODUCTION TO ELECTRICAL ENGINEERING
EGR 2300 – INTRODUCTION TO ENGINEERING THERMODYNAMICS
EPS 3100 – METEOROLOGY
EPS 3200 – OCEANOGRAPHY
EPS 3300 – PHYSICAL GEOLOGY
EPS 3500 – INTRODUCTION TO ASTRONOMY
EPS 3600 – PLANETOLOGY: A TRIP THROUGH THE SOLAR SYSTEM
EPS 3800 – INTRODUCTION TO EARTH SCIENCE
PHY 1100 – GENERAL PHYSICS I
PHY 1200 – GENERAL PHYSICS II
PHY 1300 – ADVANCED GENERAL PHYSICS I
PHY 1400 – ADVANCED GENERAL PHYSICS II

To provide specific "just in time" support for college-level courses for majors in the physical sciences as follows:

CHM 1100 – GENERAL CHEMISTRY I
Prerequisite: MAT 900 & CHM 01; OR **CHM11 Skills Proficient**; OR Department Permission

EGR 2200 – INTRODUCTION TO ELECTRICAL ENGINEERING
Prerequisite: PHY14 OR Department Permission
Pre/Corequisite: MAT 5500 & MAT5600; OR **EGR2200 Skills Proficient**; OR Department Permission Contact

EGR 2300 – INTRODUCTION TO ENGINEERING THERMODYNAMICS
Prerequisite: CHM12 & PHY13 & MAT1600; OR **EGR2300 Skills Support**; OR Department Permission. Contact

PHY 1100 – GENERAL PHYSICS I
Co/Prerequisite: MAT 1400; OR **PHY1100 Skills Proficient**; OR Department Permission

PHY 1300 – ADVANCED GENERAL PHYSICS I
Pre/Corequisite: MAT 1500; OR **PHY1300 Skills Proficient**; OR Department Permission

PHY 1400 – ADVANCED GENERAL PHYSICS II
Pre/Corequisite: MAT 1600; OR **PHY1400 Skills Proficient**; OR Department Permission

2. DOES THIS COURSE MEET A GENERAL EDUCATION/CUNY CORE CATEGORY? NO
   - ☐ **Life and Physical Science**
   - ☐ **Math and Quantitative Reasoning**
   - ☐ **A. World Cultures and Global Issues**
   - ☐ **B. U.S. Experience in its Diversity**
   - ☐ **C. Creative Expression**
   - ☐ **D. Individual and Society**
   - ☐ **E. Scientific World**

   IF YES, COMPLETE AND SUBMIT WITH THIS PROPOSAL A CUNY COMMON CORE SUBMISSION FORM.

3. DESCRIBE HOW THIS COURSE TRANSFERS (REQUIRED FOR A.S. DEGREE COURSE). IF A.A.S. DEGREE COURSE AND DOES NOT TRANSFER, JUSTIFY ROLE OF COURSE, E.G. DESCRIBE OTHER LEARNING OBJECTIVES MET:

   The objective of these support course modules is to provide "just in time" support for a college-level course focused only on building skills that are essential for success in the college-level course.

4. BULLETIN DESCRIPTION OF COURSE:

PSQ 100A-H QUANTITATIVE SKILLS FOR PHYSICAL SCIENCES (0 crs. 1 eq. crs. 2 hrs. 12 wks.)
A co-requisite support course in the quantitative skills required in the physical sciences. This course is non crediting bearing and is not equivalent to any MAT course.

    PSQ 0101 A co-requisite support module in the basic skills of algebra required in the physical sciences. This course is non crediting bearing and is not equivalent to any MAT course.

    PSQ 0102 A co-requisite support module in the basic skills of geometry required in the physical sciences. This course is non crediting bearing and is not equivalent to any MAT course.

    PSQ 0103 A co-requisite support module in the basic skills of trigonometry required in the physical sciences. This course is non crediting bearing and is not equivalent to any MAT course.

PSQ 0201 A co-requisite support module in the basic skills of vector products required in the physical sciences.   This course is non crediting bearing and is not equivalent to any MAT course.

PSQ 0301 A co-requisite support module in the basic skills of differential calculus required in the physical sciences. This course is non crediting bearing and is not equivalent to any MAT course.

PSQ 0302 A co-requisite support module is a continuation of the basic skills of differential calculus required in the physical sciences. This course is non crediting bearing and is not equivalent to any MAT course.

PSQ 0401 A co-requisite support module in the basic skills in integral calculus required in the physical sciences. This course is not equivalent to any MAT.

PSQ 0501 A co-requisite support module in the basic skills in series expansion required in the physical sciences. This course is not equivalent to any MAT.

PSQ 0601 A co-requisite support module in the basic skills in linear algebra required in the physical sciences. This course is not equivalent to any MAT.

PSQ 0701 A co-requisite support module in the basic skills in differential equations required in the physical sciences. This course is not equivalent to any MAT.

CREDITS AND HOURS* (PLEASE CHECK **ONE** APPROPRIATE BOX BELOW BASED ON CREDITS):

1-credit:	☐ 1 hour lecture ☐ 2 hours lab/field/gym
2-credits:	☐ 2 hours lecture ☐ 1 hour lecture, 2 hours lab/field ☐ 4 hours lab/field
3-credits:	☐ 3 hours lecture ☐ 2 hours lecture, 2 hours lab/field ☐ 1 hour lecture, 4 hours lab/field ☐ 6 hours lab/field
4-credits:	☐ 4 hours lecture ☐ 3 hours lecture, 2 hours lab/field ☐ 2 hours lecture, 4 hours lab/field ☐ 1 hour lecture, 6 hours lab/field ☐ 8 hours lab/field

More than 4-credits: Number of credits: _____ (explain mix lecture/lab below)

___ Lecture   ____La

Explanation: _____

Other: Number of credits: 0 crs. 1 eq. crs. 2 hrs. 12 wks for 3 modules of 4 weeks each

*Hours are hours per week in a typical 12-week semester

NUMBER OF EQUATED CREDITS IN ITEM #5:_ 0 crs. 2 eq. crs. 2 hrs. 12 wks for 3 modules of 4 weeks each

5. COURSE PREREQUISITES AND COREQUISITES (IF NONE PLEASE INDICATE FOR EACH)

   A. PREREQUISITE(S):

   B. COREQUISITE(S): CHM11 Skills Proficient, PHY1100 Skills Proficient, PHY1300 Skills Proficient, PHY1400 Skills Proficient, EGR2200 Skills Proficient, or EGR2300 Skills Proficient determination. Contact Department of Physical Sciences for Skills Proficient information

   C. PRE/COREQUISITE(S):

6. BRIEF RATIONALE TO JUSTIFY PROPOSED COURSE TO INCLUDE:

   A. ENROLLMENT SUMMARY IF PREVIOUSLY OFFERED AS AN 82 (INCLUDE COMPLETE 4-DIGIT 82 COURSE NUMBER) NOT APPLICABLE

   B. PROJECTED ENROLLMENT 24

   C. SUGGESTED CLASS LIMITS: 32

   D. FREQUENCY COURSE IS LIKELY TO BE OFFERED: EVERY SEMESTER

   E. ROLE OF COURSE IN DEPARTMENT'S CURRICULUM AND COLLEGE'S MISSION

   To adhere to and to comport with changes to: Math Placement; Math Ready; Math Ready to Calculus Ready sequence; Calculus Ready through Calculus sequence; Hidden Pre-requisite; Degree in 60 Credits; and Degree in 4 Academic Semesters policies and practices.

7. LIST COURSE(S), IF ANY, TO BE WITHDRAWN WHEN COURSE IS ADOPTED (NOTE THIS IS NOT THE SAME AS DELETING A COURSE): NONE

8. IF COURSE IS AN INTERNSHIP, INDEPENDENT STUDY, OR THE LIKE, PROVIDE AN EXPLANATION AS TO HOW THE STUDENT WILL EARN THE CREDITS AWARDED. THE CREDITS AWARDED SHOULD BE CONSISTENT WITH STUDENT EFFORTS REQUIRED IN A TRADITIONAL CLASSROOM SETTING: NOT APPLICABLE

9. PROPOSED TEXT BOOK(S) AND/OR OTHER REQUIRED INSTRUCTIONAL MATERIAL(S):

   Higher Engineering Mathematics 8th Edition, by John Bird

   Section A   Number and algebra
   Section B   Geometry and trigonometry
   Section E   Matrices and Determinants
   Section F   Vector Geometry
   Section G   Introduction to Calculus
   Section H   Differential Calculus
   Section I   Integral Calculus
   Section J   Differential equations

10. REQUIRED COURSE FOR MAJOR OR AREA OF CONCENTRATION? NO

    IF YES, COURSE IS REQUIRED, SUBMIT A SEPARATE CURRICULUM TRANSMITTAL COVER PAGE INDICATING A "CHANGE IN DEGREE OR CERTIFICATE REQUIREMENTS" AS WELL AS A PROPOSAL THAT MUST INCLUDE A RATIONALE AND THE FOLLOWING ADDITIONAL PAGES: A "CURRENT" DEGREE WITH ALL PROPOSED DELETIONS (STRIKEOUTS) AND ADDITIONS (BOLDED TEXT) CLEARLY INDICATED, AND A "PROPOSED" DEGREE, WHICH DISPLAYS THE DEGREE AS IT WILL APPEAR IN THE CATALOG (FOR A COPY OF THE MOST UP-TO-DATE DEGREE/CERTIFICATE REQUIREMENTS CONTACT AMANDA KALIN, EXT. 4611).

    NYSED GUIDELINES OF 45 CREDITS OF LIBERAL ARTS COURSE WORK FOR AN ASSOCIATE OF ARTS DEGREE (A.A.), 30 CREDITS FOR AND ASSOCIATE OF SCIENCE DEGREE (A.S.), AND 20 CREDITS FOR AN APPLIED ASSOCIATE OF SCIENCE DEGREE (A.A.S.) MUST BE ADHERED TO FOR ALL 60 CREDIT PROGRAMS.

13. IF OPEN ONLY TO SELECTED STUDENTS SPECIFY POPULATION: NONE

14. EXPLAIN WHAT STUDENTS WILL KNOW AND BE ABLE TO DO UPON COMPLETION OF COURSE:
    Student will demonstrate basic skills quantitative skills required for credit bearing courses in the physical sciences
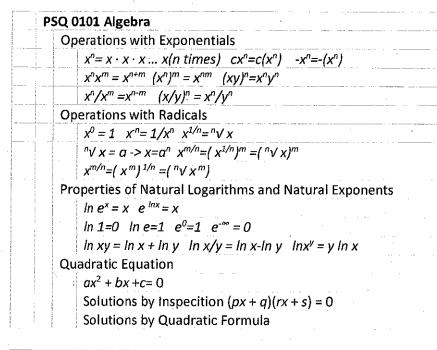   See --- Addendum for specific skills

15. METHODS OF TEACHING –E.G. LECTURES, LABORATORIES, AND OTHER ASSIGNMENTS FOR STUDENTS, INCLUDING
    ANY OF THE FOLLOWING: DEMONSTRATIONS, GROUP WORK, WEBSITE OR E-MAIL INTERACTIONS AND/OR
    ASSIGNMENTS, PRACTICE IN APPLICATION OF SKILLS, ETC.:
    Laboratory, Practice Assignments, Weekly Quiz and Module Exams

16. **ASSIGNMENTS TO STUDENTS:**
    Weekly Revision Practice & Quizzes
    Module Revision Exams

17. DESCRIBE METHOD OF EVALUATING LEARNING SPECIFIED IN #15 – INCLUDE PERCENTAGE BREAKDOWN FOR
    GRADING. IF A <u>DEVELOPMENTAL COURSE</u> INCLUDE HOW THE NEXT LEVEL COURSE IS DETERMINED AS WELL AS
    NEXT LEVEL PLACEMENT.
    R   Not Proficient (may repeat without prejudice)
    F   Failed (may not repeat after second R)

18. TOPICAL COURSE OUTLINE FOR THE 12 WEEK SEMESTER (WHICH SHOULD BE SPECIFIC REGARDING TOPICS
    COVERED, LEARNING ACTIVITIES, AND ASSIGNMENTS): SEE ADDENDUM BELOW

PSQ 0101 Algebra

Operations with Exponentials

$x^n = x \cdot x \cdot x \ldots x (n\ times)$ $cx^n = c(x^n)$ $-x^n = -(x^n)$

$x^n x^m = x^{n+m}$ $(x^n)^m = x^{nm}$ $(xy)^n = x^n y^n$

$x^n / x^m = x^{n-m}$ $(x/y)^n = x^n/y^n$

Operations with Radicals

$x^0 = 1$ $x^{-n} = 1/x^n$ $x^{1/n} = \sqrt[n]{x}$

$\sqrt[n]{x} = a \rightarrow x = a^n$ $x^{m/n} = (x^{1/n})^m = (\sqrt[n]{x})^m$

$x^{m/n} = (x^m)^{1/n} = (\sqrt[n]{x^m})$

Properties of Natural Logarithms and Natural Exponents

$\ln e^x = x$ $e^{\ln x} = x$

$\ln 1 = 0$ $\ln e = 1$ $e^0 = 1$ $e^{-\infty} = 0$

$\ln xy = \ln x + \ln y$ $\ln x/y = \ln x - \ln y$ $\ln x^y = y \ln x$

Quadratic Equation

$ax^2 + bx + c = 0$

Solutions by Inspecition $(px + q)(rx + s) = 0$

Solutions by Quadratic Formula

PSQ 0102 Geometry

Triangle and Quadrangles

General, Similar, Equilateral & Isosceles Triangles: Angles, Sides & Area

Right Triangles

Rectangles, Square, Parallelogram & Trapezoid: Angles, Perimeter & Area

Circles, Spheres and Cylinders

Circles: Circumference & Area; Sector of Circles: Arc Length & Area

Spheres: Surface Area & Volume

Cylinder: Surface Area & Volume

Coordinates, Distance, Midpoint, Slope

Points, midpoint between points & distance between points

Slope of line passing through two points, Vertical Lines & Horizontal Lines

Horizontal, Vertical, Parallel & Perpendicular Lines

Equations of Line

Point Slope Form $y = mx + b$

PSQ 0103 Trigonometry

Angles & Trigonometric Functions

Degrees and Radians

Right Triangle Definition of $\sin\theta$, $\cos\theta$, $\tan\theta$

Evaluating Trigonometric Functions

No Calculator: For Common Angles (Degrees and Radians)

Calculator: Degrees and Radians

Graphs Common Trigonometric Functions

Trigonometric Formulas & Identities

$\sin(\pi/2 - \vartheta) = \cos\vartheta$ $\cos(\pi/2 - \vartheta) = \sin\vartheta$ $\sin^2\theta + \cos^2\theta = 1$

$\sin 2\theta = 2\sin\theta\cos\theta$ $\cos 2\theta = 2\cos^2\theta - \sin^2\theta$

$\sin(\vartheta \pm \varphi) = \sin(\vartheta)\cos(\varphi) \pm \cos(\vartheta)\sin(\varphi)$ $\cos(\vartheta \pm \varphi) = \cos(\vartheta)\cos(\varphi) \mp \sin(\vartheta)\sin(\varphi)$

Trigonometric Application

Evaluating   a Trig $(b\,t - c\,\pi)$

Sketching   a Trig $(b\,t - c\,\pi)$

PSQ 0201 Vectors

Vectors $i, j, k;$ $r, \vartheta, \varphi;$ r, φ, z

Two Dimensional Cartesian and Three Dimensional Cartesian Coordinates

Polar and Spherical Coordinates

Cylindrical Coordinates

Dot Products $A \cdot B$

Two Dimensional Cartesian

Three Dimensional Cartesian Coordinates

Cross Products $A \times B$

Two Dimensional Cartesian

Three Dimensional Cartesian Coordinates

Dot Products $A \cdot B$ & Cross Products $A \times B$

Polar, Spherical and Cylindrical Coordinates

PSQ 0301 Differentials 1

Derivative Formulas

Derivative as the slope of the tangent line to the graph of a function

$\lim x_2 \to x_1 (f(x_2)-f(x_1))/(x_2-x_1)$

$d/dx\, c = 0$ $d/dx\, x = 1$ $dcu/dx = c\, du/dx$

Power Rule $d/dx\, x^r = r\, x^{r-1}$ *r any real number*

$r \to$ Polynomial $d/dx\, x$ $d/dx\, x^2$ $d/dx\, x^3$ .....

$r \to$ Real Integer $d/dx\, x^1$ $d/dx\, x^2$ $d/dx\, x^3$ .....

Derivatives of Natural Exponential Function and Natural Logarithmic Function

$d/dx\, e^x = e^x$

$d/dx\, \ln x = 1 / x$

Derivatives of Trigonometric Functions

$d/dx\, \sin x = \cos x$

$d/dx\, \cos x = -\sin x$

PSQ 0302 Differentials 2

Sum Rule & Product Rule

$d/dx\, (u + v) = du/dx + dv/dx$

$d/dx\, (u \cdot v) = u \cdot dv/dx + u \cdot dv/dx$

Differential of sums and products of x^r, trig x, e^x & $\ln x$

Second Order Derivatives d^2/dx^2

$d^2/dx^2\, x^r$,

$d^2/dx^2\, e^x$ & $\ln x$

d^2/dx^2 trig x

Chain Rule

$d/dx\, (u\, (v(x))) = du/dv \cdot dv/dx$

$d/dx\, e^{u(x)} = e^{u(x)} \cdot du(x)/dx$ $d/dx\, \ln u(x) = 1/u \cdot du /dx$

$d/dx\, \sin u(x) = \cos u(x) \cdot du(x)/dx$ $d/dx\, \cos u(x) = -\sin u(x) \cdot du(x)/dx$

Other Common Differentials

Differentials of composite functions of x^r, trig x, e^x & $\ln x$

Differentials of composite functions of x^r, trig x, e^x & $\ln x$

PSQ 0401 Integrals

Integration Formulas

Definition of Integral

$\int dx = x + c \qquad \int a\,f(x)\,dx = a \int f(x)\,dx$

$\int f(x) \pm g(x)\,dx = \int f(x)\,dx \pm \int g(x)\,dx$

Common Integrals of Algebraic Form

$\int x^n dx = x^{n+1}/(n+1) + c \quad n \text{ integer } \; n \neq 1$

$\int (a+bx)^n dx = 1/b \cdot (a+bx)^{n+1}/(n+1) + c \quad n \text{ integer } \; n \neq 1$

$\int (a+bx)^r dx = 1/b \cdot (a+bx)^{r+1}/(r+1) + c \quad r \text{ real } \; n \neq 1$

Integrals of Exponential Functions & Logarithmic Functions

$\int e^{ax} dx = e^{ax}/a$

$\int dx/x = \ln x + c \qquad \int dx/(a+bx) = 1/b \cdot \ln(a+bx) + c$

Common Indefinite Integrals Yielding Logarithm Functions & Inverse Trigonometric Functions

$\int \cos x\,dx = \sin x + c \qquad \int \cos(a\,x + b)\,dx = \sin(ax+b)/a + c$

$\int \sin x\,dx = -\sin x + c \qquad \int \sin(a\,x + b)\,dx = -\cos(ax+b)/a + c$

PSQ 0501 Series

Maclaurin Series Expansions

$f(x) = f(0) + \frac{f'(0)}{1!}(x) + \frac{f''(0)}{2!}(x)^2 + \frac{f'''(0)}{3!}(x)^3 + \ldots$

Series Expansions

$\sin x = x - x^3/3! + x^5/5! - x^7/7! + \ldots, \; -\infty < x < \infty$

$\cos x = 1 - x^2/2! + x^4/4! - x^6/6! + \ldots, \; -\infty < x < \infty$

More Series Expansions

$e^x = 1 + x + x^2/2! + x^3/3! + x^4/4! + x^5/5! + \ldots \; -\infty < x < \infty$

$\ln x = (x-1) - (x-1)^2/2 + (x-1)^3/3 - (x-1)^4/4 + \ldots \; 0 < x \leq 2$

Even More Series Expansions

$1/x = 1 - (x-1)^1 + (x-1)^2 - (x-1)^3 + (x-1)^4 - \ldots + (-1)^n (x-1)^n + \ldots, \; 0 < x < 2$

$1/(1+x) = 1 - x^1 + x^2 - x^3 + x^4 - x^5 + \ldots + (-1)^n x^n + \ldots, \; -1 < x < 1$

PSQ 0601 Matrices

Basic Definitions and Operations

Elements in terms of the rows and columns

Addition of Matrices and Multiplication of a matrix by a constant

$A + B = B + A \qquad A + (B + C) = (A + B) + C \qquad c(A + B) = cB + cA \qquad (c + k)A = cA + kA$

Matrix Multiplication $C = A \cdot B$

Forming element c_{jk} by taking the scalar product of row j of A and column k of B.

$AB \neq BA \text{ in general} \qquad AB=0 \text{ does not imply } A=0 \text{ or } B=0 \text{ or } BA = 0 \qquad AC=AD \text{ does not imply } C = D$

$(kA)B = k(AB) = A(kB) \qquad A(BC) = (AB)C \qquad (A + B)C = AC + BC$

Determinants

Determinants of 2x2 Matrices

Determinants of 3x3 Matrices

Cramer's Rule

Solving Two Simultaneous Equations

Solving Three Simultaneous Equations

PSQ 0701 First & Second Order Linear ODEs with Constant Coefficients

Solutions to $\frac{d}{dt} x(t) + a\, x(t) = b$

$x(t) = (1/a)\, (b - e^{-at-ca})$

Solutions to $\frac{d}{dt} x(t) + a\, x(t) = b$ (continued)

Graphs of $x(t) = (1/a)\, (b - e^{-at-ca})$

Solutions to $\frac{d^2}{dt^2} x(t) + a\, \frac{d}{dx} x(t) + b\, x(t) = 0$

$$x = c_1 e^{\frac{(-a-\sqrt{a^2-4b})}{2}} + c_2 e^{\frac{(-a-\sqrt{a^2-4b})}{2}}$$

Solutions to $\frac{d^2}{dt^2} x(t) + a\, \frac{d}{dx} x(t) + b\, x(t) = c$

Graphs and Cases of $x = x_{homogenous} + x_{particular}$