University of Karachi

Department of Health, Physical Education and Sports Sciences

2016 *Session*

HPED 400.1: Functional Mathematics for HPED (3+0)

Activity	Dates	Class Schedule
Introduction day	January 20, 2016	Registrar's Notification No.
Teaching	January 21 - May 20, 2016	AF.8 (1), 170/2016 dated 21-01-2016
Semester Examinations	May 23 - June 6, 2016	Thursday 1100h-1350h
Summer Holidays	June 7 - July 15, 2016	*Venue:* HPED Building

Course Supervisor: **Professor Dr. Syed Arif Kamal**; *Telephone*: + 92 21 9926 1077; +92 21 9926 1300-15 ext. 2255
PhD (Mathematical Neuroscience); MSc *summa cum laude*, BSc (Hons) *summa cum laude* (Karachi); MA (Johns Hopkins, USA); MS (Indiana, Bloomington, USA); Member, Subject Committee for Physical Education, Health and Sport Sciences, National Testing Service (NTS) Pakistan; Ex-Member, American Association of Physical Education, Health and Recreation
Professor of Mathematics, Chairman HPED and Dean, Faculty of Science, University of Karachi.
Homepage: http://ngds-ku.org/kamal; *e-mail*: sakamal@uok.edu.pk

Handout Address: http://ngds-ku.org/HPED/HPED4001_16.pdf

Course Objectives

To give the students an introduction of functional mathematics, with applications of the concepts and the techniques taught to the discipline of Health, Physical Education and Sports Sciences.

Course Outline

Real numbers, absolute value, fractions (addition, subtraction, multiplication and division), exponents and laws of exponents, polynomial expressions, addition, subtraction, multiplication and division of polynomial expressions, formulae: $x^2 + (a + b)x + ab = (x + a)(x + b)$; $(x + a)^2$; $(x - a)^2$; $x^2 - a^2$; $x^3 + a^3$; $x^3 - a^3$, definition of an equation, solving linear equation with one unknown, solving two linear equations with two unknowns, solving factorable quadratic equations, quadratic formula and their applications, logarithms and exponentials, permutations and combinations, mathematical induction, applications of the above topics (general and discipline specific)

Recommended Reading

i) Dolicini, M. P., W. Wooton, E. F. Beckenbach and S. Sharron, *Algebra 2 and Trigonometry*, Houghton Mifflin, Boston, Massachusetts, United States

ii) Budnik, F. S. (1995) *Applied Mathematics for Business, Economics and the Social Sciences*, McGraw Hill, Singapore

Motivational Reading

a) Kamal, S. A. (2008, December 20-23). Role of mathematics in sports sciences and technologies. *The Thirty-Fifth All Pakistan Science Conference (Genomics for Health and Prosperity)*, University of Karachi, Karachi, Pakistan, p. 75, abstract#72: http://www.ngds-ku.org/Presentations/Sports.pdf; *Karachi University Journal of Science*, **36:** 5

b) Kamal S. A. (2014, May 17). Sports and anthromathematics. *The Fifty-Fifth Annual Prize Distribution Function*, Government College, Hyderabad, Pakistan (seminar), abstract:
http://www.ngds-ku.org/Presentations/Sport_Mathematics.pdf

c) Kamal, S. A. and S. A. Khan (2015). Hairstyle, footwear and clothing for gymnastic activities in the primary-school setting. *Pumukkale Journal of Sport Sciences*, **6:** 46-64, full text: http://www.ngds-ku.org/Papers/J37.pdf

Sample Papers

http://www.ngds-ku.org/HPED/Exams400/4001-14_Model.pdf
http://www.ngds-ku.org/HPED/Exams400/4001-14_Paper.pdf

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Course Plan

Class on Thursdays

Date	*Topics (to be covered)*
	JANUARY
28	Introduction
	FEBRUARY
04	Real numbers and absolute value, applications conversions from *cm* to *ft-in* and *kg* to *lb-oz*
11	Fractions and its applications**:** Age computation, body-mass index (*BMI*), percentages and percentiles
18	Further applications**:** *STATUS* (*h*), *STATUS* (μ), growth charts and built classification — Table 1
25	Exponents and their laws
	MARCH
03	Polynomial expressions **(**addition, subtraction, multiplication and division) and applications (adult-mid-parental height and net mass from clothed mass)
10	Factorization**:** $x^2 + (a + b)x + ab = (x + a)(x + b)$; $(x + a)^2$; $(x – a)^2$; $x^2 – a^2$; $x^3 + a^3$; $x^3 – a^3$
17	Definition of an equation, solving linear equation with one unknown, slope-*y*-intercept form, slope-*x*-intercept form, 2-point form (basis of linear interpolation and extrapolation), slope-1-point form, *x*- and *y*-intercept form, applications (computation of estimated-adult height, estimated-adult mass, estimated-adult *BMI* and percentiles of army-cutoff heights, Growth-and-Obesity Roadmaps) — Tables 2 and 3
24	*Holliday (Holi) — No class*
31	Solving two linear equations with two unknowns (simultaneous equations)**:** Different methods (substitution, comparison, elimination, cross-multiplication and graphical) and qualitative analysis (existence of solution, parallel, intersecting and identical lines, corresponding to over-determined, critically determined and under-determined systems) — Table 4
	APRIL
07	*Mid-term review*
14	Quadratic equations and applications**:** CDC percentiles to Pakistani percentiles, potential-energy curve Different methods of solution (graphical, factorization, completing the square, quadratic formula, remainder method) and qualitative analysis (discriminant and its sign**:** zero, one and two real solutions) — Table 5
21	Exponentials and logarithms**:** applications in human physiology (response of ear)
28	Permutations and combinations**:** applications in team selection
	MAY
05	Mathematical induction and applications
12	*Course review and solution of sample papers (model and* 2014 *Final Exam)*
19	*Final Exam* 1100h-1400h, *after proper permission (for conduct of exam ahead of schedule) from the competent authority*

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Table 1. Classification of a child's built, useful in forming sport teams

Classification	*Sum of Percentiles*	*Dominance*	*Suitable for*
Small	$0 \le P(h) + P(\mu) < 50$	Brain function	Intellectual work, planning and development tasks
Medium	$50 \le P(h) + P(\mu) < 150$	Equal contribution	May adapt to brain- or body-dominating tasks
Big	$150 \le P(h) + P(\mu) < 200$	Body function	Tasks involving strength and speed

Table 2. Heights important for an athlete

Nomenclature	*Depends on Child's Height*	*Depends on Parents' Heights*	*Based on Country-Wide Standards*	*Corresponding Percentile*
Estimated-Adult Height	Yes	No	No	$P(h)$
Target (Adult-Mid-Parental) Height	No	Yes	No	P_{MP}
Army-Cutoff Height	No	No	Yes	$P_{\text{army}-\text{cutoff}}$

Table 3. Different forms of equation of straight line

Given	*Equation*	*Known as*
Slope (m), y intercept (c)	$y = mx + c$	Slope-intercept form (in reality 'slope-y-intercept form')
Slope (m), x intercept (b)	$y = m(x - b)$	Slope-x-intercept form
2 points $(x_1, y_1), (x_2, y_2)$	$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$	Two-point form
1 point (x_1, y_1), slope (m)	$y - y_1 = m(x - x_1)$	Point-slope form
1 point (x_1, y_1), y intercept (c)	$y = \frac{y - y_1}{x - x_1}x + c$	Point-y-intercept form
1 point (x_1, y_1), x intercept (b)	$y = \frac{y - y_1}{x - x_1}(x - b)$	Point-x-intercept form
x intercept (b), y intercept (c)	$cx + by - bc = 0$	x-y-intercept form

Enrichment Notes

- Two lines are parallel, if their slopes are equal (y intercepts different), *e. g.*, $y = mx + c_1$ and $y = mx + c_2$ are parallel.
- Two lines are perpendicular, if the product of their slopes is –1, *e. g.*, $y = mx + c_1$ and $y = -\frac{1}{m}x + c_2$ are perpendicular.
- If $c = 0$, the relationship is called *proportionality*.
- If $m > 0$, one variable increases as the other does so (*positive correlation* in the data).
- If $m < 0$, one variable increases as the other decreases (*negative correlation* in the data).

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Best-Fitted Line: At times when one is plotting the experimental data all the points do not appear to lie on a straight line although the theoretical relationship among them is a straight line. This may be due to errors. A straight line may help eliminate large random errors by pointing to the experimenter such large deviations. These points may be excluded while drawing a best-fitted line. Strategy is to draw a line such that half of the points lie below it whereas half of the points lie above it.

Uses of Straight-Line Equation: The straight line is used to determine constants in an equation. Use of slope is recommended instead of computation of constants using coördinates of a single point (in the case of proportionality) because systematic errors shall be avoided by this method.

Table 4. Qualitative analysis of solutions of pair of simultaneous equations ($ax + by + c = 0;\ a'x + b'y + c' = 0$)

Condition	*Number of Solutions*	*Nature of Graph*	*Outcome (in case a solution is attempted)*	*Example*
$\frac{a}{a'} \neq \frac{b}{b'}$ or $ab' - a'b \neq 0$	1	Intersecting Lines	Unique Solution (system critically determined)	$3x + y = 14$ $x - 3y = 14$
$\frac{a}{a'} = \frac{b}{b'} \neq \frac{c}{c'}$	0	Parallel Lines	Contradiction: False Statement (system over-determined)	$6x + 3y = 7$ $2x + y = 1$
$\frac{a}{a'} = \frac{b}{b'} = \frac{c}{c'}$	∞	Identical Lines	Identity: True Statement (system under-determined)	$x - 5y = 13$ $2x - 10y = 26$

Table 5. Parabola properties

Equation of Parabola	*Axis*	*Equation of Directrix*	*Coördinates of Focus*	*Opening towards*
$x^2 = 4my$	y axis	$y = -m$	$(0, m)$	top
$y^2 = 4mx$	x axis	$x = -m$	$(m, 0)$	right
$x^2 = -4my$	y axis	$y = m$	$(0, -m)$	bottom
$y^2 = -4mx$	x axis	$x = m$	$(-m, 0)$	left

General Equation of Parabola: $y = ax^2 + bx + c$

Applications of Parabola: (*a*) CDC percentiles to Pakistani percentiles, (*b*) parabolic mirrors, (*c*) projectile motion, (*d*) stock-market behavior, (*e*) potential energy of harmonic oscillator, (*f*) ICP model of child growth (childhood curve), (*g*) orbits in two-body problem, when potential energy (although negative) is numerically equal to kinetic energy

Solution of quadratic equation $ax^2 + bx + c = 0$ may be expressed as $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ (quadratic formula). The expression $b^2 - 4ac$ is termed as *discriminant*. By examining discriminant, one may conclude about the nature of real roots (qualitative analysis). If $b^2 - 4ac > 0$, there exist two, real and distinct roots (geometrically, the parabola $y = ax^2 + bx + c$ intersects x axis at two points), whereas if $b^2 - 4ac = 0$, the two roots are identical (quadratic expression is a complete square; geometrically, the parabola $y = ax^2 + bx + c$ is tangent to x axis). In case, $b^2 - 4ac < 0$, no real root exists (geometrically, the parabola $y = ax^2 + bx + c$ does not intersect x axis at all).

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Pedagogical Strategy

Lesson Plan		*Problem Solving*
Background and Concept		Given (Data)
Definition		To Find/To Draw/To Prove (Objective)
Algebraic Representation		Feasibility Study
Geometrical Representation		Setting up of the Problem
General Applications		Solution of the Problem
Applications in HPED		Results