

SECOND ENGINEER REG III/2 MATHEMATICS

LIST OF TOPICS

- A Arithmetic
- B Algebra
- C Logarithms
- D Graphs
- E Trigonometry
- F Mensuration
- G Calculus: Differentiation
- H Calculus: Integration

A ARITHMETIC

- 1. Expresses quantities in the form of a ratio, proportion or percentage.**
 - 1.1 Compares two quantities of the same kind by expressing one as a Ratio of the other.
 - 1.2 States that proportion is an equation of ratios.
 - 1.3 States that percentage is a ratio multiplied by 100.
 - 1.4 Expresses fractional and decimal quantities in the form of a percentage.
 - 1.5 Expresses an increase or gain as a percentage.
 - 1.6 Expresses a decrease or contraction as a percentage.
 - 1.7 Expresses an error as a percentage.
 - 1.8 Solves problems related to 1.1 to 1.7.
 - 1.9 Understands similarity and proportion; simple objects to scale (length, area, volume and mass).
 - 1.10 Understands rates, averages, proportional rates of doing work and cost.
 - 1.11 Understands concepts such as "man hours", "kWh", etc.
 - 1.12 Solves problems related to 1.9 to 1.11.

B ALGEBRA

2. Uses the rules of Algebra and solves associated problems.

- 2.1 Represents quantities by numbers, letters and symbols.
- 2.2 Adds algebraic quantities, both positive and negative.
- 2.3 Subtracts algebraic quantities, both positive and negative.
- 2.4 States the effect of plus or minus signs in front of a bracketed quantity or quantities.
- 2.5 States the effect of the plus or minus signs in the multiplication and division of quantities.
- 2.6 Defines the term index (power).
- 2.7 States what is meant by fractional, negative and zero indices.
- 2.8 States the rules for addition, subtraction and product of indices.
- 2.9 Solves problems related to 2.6, 2.7 and 2.8.
- 2.10 States the 'Law of Distribution'.
- 2.11 States the product of two binomial expressions.
- 2.12 States the square of a binomial expression $(a \pm b)^2$.
- 2.13 States the product of the sum and difference of two algebraic quantities $(a + b)(a - b)$.
- 2.14 Expands $(a \pm b)^3$ and factors of $a^3 \pm b^3$.
- 2.15 Solves problems involving the multiplication and division of polynomial expressions by binomial expressions.
- 2.16 Factorises expressions which have one factor consisting of one term only.
- 2.17 Factorises expressions of four terms which can be expressed as the product of two binomials.
- 2.18 Factorises expressions of the type $ax^2 + bx + c$, where a , b and c have numerical values, including both
 - (a) cases when a is equal to 1;
 - (b) cases when a is not equal to 1.
- 2.19 Factorises trinomials which form a perfect square.
- 2.20 Factorises the difference of two squares.

- 2.21 Solves problems involving the addition and subtraction of algebraic fractions.
- 2.22 Solves problems involving the multiplication and division of algebraic fractions (both 2.21 and 2.22 to be limited to polynomials no greater than binomial expressions).
- 2.23 Defines an equation as a statement of equality.
- 2.24 Simplifies and solves linear equations.
- 2.25 Understands the axioms
- (a) if equal quantities be added to two quantities that are already equal, the results will be equal;
 - (b) if equal quantities be subtracted from two quantities that are already equal, the remainders will be equal;
 - (c) equal quantities when multiplied or divided by the same quantity will give results that are equal.
- 2.26 Solves problems on the transposition of algebraic expressions.
- 2.27 Develops linear equations consistent with data provided in a question, and finds the solution to these equations.
- 2.28 Solves linear simultaneous equations of two unknowns
- (a) by the method of substitution;
 - (b) by the method of elimination.
- 2.29 Solves linear simultaneous equations of three unknowns.
- 2.30 Develops linear simultaneous equations of two unknowns consistent with data provided in a question, and finds the solution to those equations.
- 2.31 States what is meant by the roots of a quadratic equation.
- 2.32 Solves quadratic equations that factorise.
- 2.33 States the general formula for solution of a quadratic $ax^2 + bx + c = 0$.
- 2.34 Solves quadratic equations using the general formula.
- 2.35 Solves simultaneous equations of two unknowns consisting of linear and quadratic equations.
- 2.36 Describes direct and inverse variation.
- 2.37 Describes the use of the constant of variation.
- 2.38 Solves problems involving 2.35 and 2.36.

C LOGARITHMS

3. Uses logarithms to under take simple calculations (not directly examinable but such knowledge will be assumed).

- 3.1 Define's logarithms.
- 3.2 States laws of logarithms.
- 3.3 Uses laws of logarithms to evaluate powers etc.
- 3.4 States base of natural logarithms.
- 3.5 Evaluates expressions involving natural logarithms.

D GRAPHS

4. Discusses the graphic representations of numerical quantities.

- 4.1 States that graph axis are abscissa and ordinate, and indicates their positions.
- 4.2 Defines the dependent and independent variables.
- 4.3 Identifies the axis on which the dependent and independent variables are plotted.
- 4.4 Determines plotting points, having been given or having calculated x and y values.
- 4.5 Determines suitable scales for plotting values calculated at 4.4.
- 4.6 Plots linear and non-linear graphs (scales to be given in examination).
- 4.7 States that for a linear graph, only two plotting points are required.
- 4.8 States that plotting points may be given in the form: $x = 1$, $y = 2$, or $(1,2)$.
- 4.9 States that the law of a straight line graph is of the form: $y = ax + b$, and defines a and b.
- 4.10 Writes the equation $y = aX^2 + b$ in the form of a straight line.
- 4.11 Solves graphically problems of the form $pV^n = C$, where n is unknown.
- 4.12 States that two simultaneous equations plotted as graphs on the same axis have solutions where the graphs intersect.
- 4.13 States that the solution to a quadratic equation is given by the points where the graph of the quadratic equation crosses the x-axis, i.e. where $y = 0$.
- 4.14 States that the solution to simultaneous quadratic equations is given by the points where the graphs of the equations intersect.

- 4.15 Solves equations by graphical addition.
- 4.16 Solves graphic problems of trigonometric form no more complex than $y = a \sin mx + b \cos nx$, and finds the solution of simultaneous equations involving such graphs.
- 4.17 Solves graphical problems of the form $y = a \tan mx$.

E TRIGONOMETRY

5. Discusses and uses the basic laws of trigonometry.

- 5.1 States that angles are measured in degrees or radians and relates the two.
- 5.2 Defines acute, right, obtuse and reflex angles.
- 5.3 Defines complementary angles and supplementary angles.
- 5.4 Defines Sine, Cosine, Tangent, Secant, Cosecant, Cotangent and the relationships between them.
- 5.5 Determines Sin, Cos and Tan from given right angled triangle.
- 5.6 Reads values of Sin, Cos, Tan, Sec, Cosec and Cot for any angle between 0° and 90° .
- 5.7 Determines an angle from tables knowing its sin, cos, tan, sec, cosec or cot.
- 5.8 Determines values of sin, etc, for angles $90^\circ - 360^\circ$ and also is able to obtain an angle ($0^\circ - 360^\circ$) knowing its sin, etc.
- 5.9 States the theorem of Pythagoras.
- 5.10 Solves right angled triangles for any side or angle.
- 5.11 States the Sine Rule.
- 5.12 States the Cosine Rule.
- 5.13 Solves any triangle for any side or angle using the above rules.

F Mensuration

6. Solves problems related to plane figures and solids.

- 6.1 States the formulae for the determination of the areas of a rectangle, parallelogram, triangle, polygon, trapezium, circle, annulus, ellipse, segment and sector.
- 6.2 Determines the area of a triangle, given

- (a) all three sides;
 - (b) two sides and an included angle;
 - (c) the base and vertical height.
- 6.3 Solves problems involving 6.1 and 6.2 to include the application of trigonometry and geometry as specified in previous objectives.
- 6.4 Determines the mean height of a figure from area and length.
- 6.5 States the formulae for determining the volume of a cube, oblong, cylinder, cone, square, pyramid and sphere.
- 6.6 Determines masses of solids at 6.5.
- 6.7 Determines the surface area of solids given at 6.5 (formulae for sphere to be given).

G CALCULUS - DIFFERENTIATION

7. Discusses differential calculus and solves associated problems.

- 7.1 Determines the gradient of a chord.
- 7.2 Discusses the concept of elemental lengths x and y .
- 7.3 Discusses the meaning of the limiting value of $\delta y/\delta x$ as $X \rightarrow 0$, defining it as dy/dx
- 7.4 Derives the derivative of ax^n where n is +ve or -ve.
- 7.5 Determines the derivatives of multinomial algebraic expressions.
- 7.6 States the derivative of a constant.
- 7.7 Discusses the concept of 2nd derivatives.
- 7.8 Repeats 7.5 for 2nd derivatives.
- 7.9 States the derivatives for $\sin x$, $\cos x$ and $\ln x$.
- 7.10 Determines the 1st derivatives of functions involving
- 7.11 Discusses the concept of rate of change.
- 7.12 Determines velocity from displacement-time functions and acceleration from velocity-time functions.
- 7.13 States that at the turning point of a curve, the differential coefficient is zero.
- 7.14 Discusses the concept of maximum and minimum.

- 7.15 Identifies max/min values for examination of 2nd derivative.
- 7.16 Determines the max and/or min volumes for given functions.
- 7.17 Writes derivatives in terms of functional notation.

H CALCULUS - INTEGRATION

8. Discusses integral calculus and solves associated problems.

- 8.1 States that integration is the reverse of differentiation.
- 8.2 Discusses the concept of the indefinite integral and the need for a constant.
- 8.3 States the integral of ax^n where $n \neq -1$.
- 8.4 Determines the integrals of multinomial algebraic expressions by applying 8.3.
- 8.5 Determines the constant of integration from given conditions.
- 8.6 Discusses the concept of limits.
- 8.7 Repeats 8.4 and includes limits.
- 8.8 States the integrals of $\sin x$ and $\cos x$.
- 8.9 Determines the integrals of functions involving 8.8.
- 8.10 Discusses the concept of elemental summation to determine areas and volumes and relates this to integration.
- 8.11 Determines areas and volumes by integration given the law of the boundary curve and limits.
- 8.12 Derives expressions for the area under the curve, given by $pV^n = C$.
- 8.13 Solves problems relating to 8.12.