TVET FIRST

Part 1
2023 implementation

TVET N4–N6 CURRICULUM GUIDE

A summary of all the changes to the NATED Business and Engineering curricula

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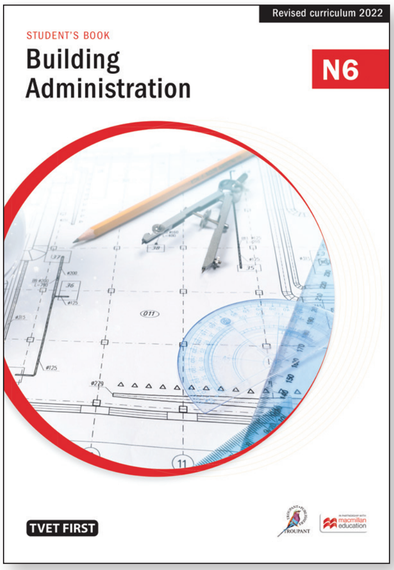
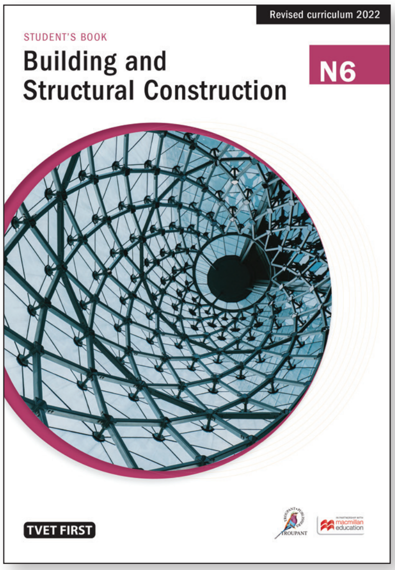
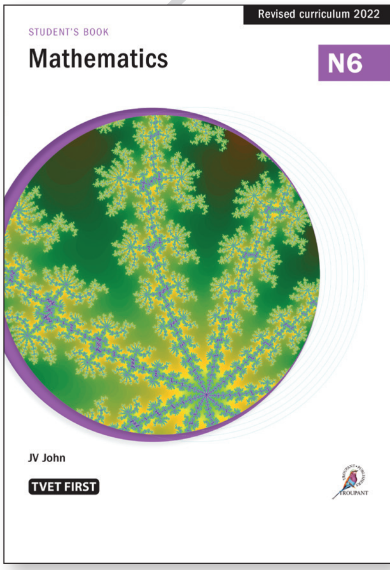
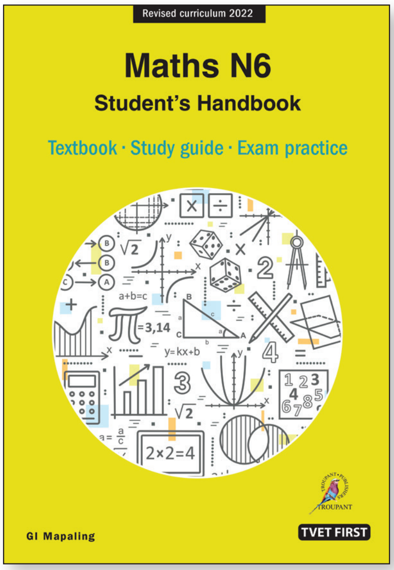
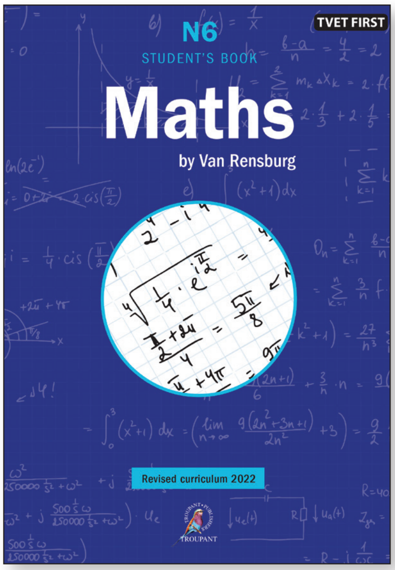
Engineering

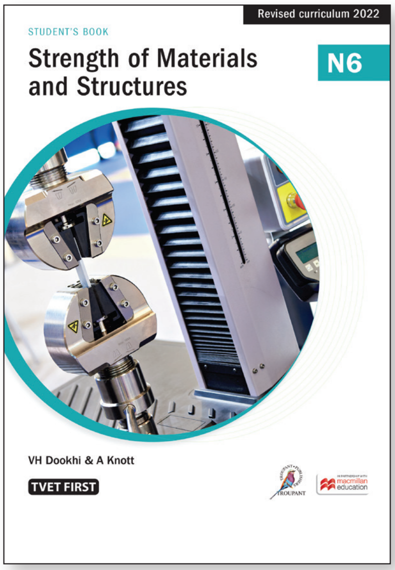












SUPPORTING LECTURERS NATED 2023 CURRICULUM IMPLEMENTATION

Building Administration N6

This document contains important information about the revised curriculum for Building Administration N6 for implementation in January 2023.

Overview of main curriculum changes

- The syllabus for Building Administration N6 has been fully reworked and updated.
- It has been restructured and reordered and is now divided into eight weighted modules with learning content and detailed learning outcomes.
- Both the learning content and the learning outcomes have been completely reworded, and much more detail has been provided for all sections.
- Topics have been organised more logically.
- Module 1 focuses more clearly on the process and procedures of tenders.
- Module 2 covers both pre- and post-tendering requirements.
- Module 3 focuses on tender costings. This topic was previously called Module 2: Estimating.
- Module 4 covers management, leadership, welfare, and personnel in more detail than the old Module 7.
- Module 5 on work study and performance addresses the old Module 1. The section on performance management and measurement is new.
- Module 6 focuses entirely on the Occupational Health and Safety Act. Previously Health and Safety was just a topic in Module 7: Management and Welfare.
- Module 7 covers much new content and includes quality control and assessment, specifications, and ethics in construction.
- The content of old Module 6 (Programme charts) is no longer covered.
- Module 8 covers the law of contract as it pertains to the construction industry and the current labour legislation. The old apartheid-era legislation that was previously specified has been entirely replaced.
- The aims of the new syllabus are:
  - to give students a thorough background in the administration of a construction site
  - to develop the students' ability to manage construction sites
  - to ensure that students have a good understanding of industry regulations, and that they adhere to all prescribed safety standards and procedures.

Structure and weighting changes

Previous syllabus (1981)

Old curriculum modules (no weighting given)
1. Work study
2. Estimating
3. Pre-tendering
4. Tendering

Building Administration N6

Old curriculum modules (no weighting given)
5. Building laws, by-laws, insurance and taxation
6. Programme charts
7. Management and welfare

New syllabus (2023)

New curriculum modules	Weighting
1. Tendering and contracts	10
2. Pre and post tendering	10
3. Costing	15
4. Management, welfare and personnel	15
5. Work study and performance	10
6. Occupational Health and Safety Act (OHSA)	15
7. Quality and ethics in construction	10
8. Contract laws and labour laws	15
Total	**100**

Detailed curriculum changes

Previous curriculum (1981)	New curriculum (2023)
Module 4: Tendering	**Module 1: Tendering**
	1.1 **Tendering**
4.1 Invitation; advertising; negotiation; contracts etc. 4.2 Contract documents; drawings specification; bills of quantities; form of contract; subcontracts 4.5 Tender regulations	1.1.1 Explain the process and procedures of tendering: • Invitation to tender • Types of tenders • Tender documents • Preparation of tender • Tendering by laws
	1.2 **Contracts** 1.2.1 Explain the various contracts and its documentations:
4.4 Bonds and guarantees	• Types of contracts • Contract documents • Bonds and guarantees
4.3 Costs	

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Previous curriculum (1981)	New curriculum (2023)
Module 3: Pre-tendering 3.1 Proposed work requirements; type of work plant and equipment 3.2 Available labour force 3.3 Subcontractors required 3.4 Holding of meetings with departmental heads	**Module 2: Pre and post tendering** **2.1 Pre-tendering** 2.1.1 Explain the pre-tender process: • Pre-tendering plan • Pre-tender meetings • Site investigation • Capability of handling the contract • Master plan **2.2 Post tender planning** 2.2.1 Explain the post tender process: • Contract planning • Capital availability • Organising the site • Organogram of the site
Module 2: Estimating 2.1 Measuring and costing of labour, material and plant 2.2 Detailed costing in workshops and on site 2.3 Analysis and scheduling of costs for estimating and pricing	**Module 3: Costing** **3.1 Cost** 3.1.1 Explain the objectives, types, and methods of costing 3.1.2 Calculate the costing of the following: • Costs • Equipment hiring costs • Duration of activities • Number of workers required
Module 7: Management and welfare 7.1 Leadership; motivation; incentives; competition; co-operation; working conditions 7.2 Personnel psychology; duties of personnel officer; staff records; recruitment; training; welfare 7.3 Human relations	**Module 4: Management, welfare and personnel** **4.1 Management and welfare** 4.1.1 Describe various aspects of management: • Leadership • Motivation • Incentives • Competition • Cooperation • Working conditions • Welfare

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Previous curriculum (1981)	New curriculum (2023)
	4.2 Personnel management **4.2.1** Describe the various aspects of personnel management: ● Personnel policy of a company ● Staff recruiting ● Training ● Value of training ● Social needs ● Maslow's hierarchy of needs
Module 1: Work study **1.1** Types of work programmes **1.2** Production, jobbing, etc. **1.3** Organising of flow of work, operations loading, dispatch and general process and method **1.4** Time study	**Module 5: Work study and performance** **5.1 Work study** **5.1.1** Explain work study and the uses: ● Types of work programmes ● Flow of work ● Work measurement ● Time study ● Techniques of method study ● Work content and standard time **5.2 Performance** **5.2.1** Evaluate the performance of various aspects in a site: ● Performance standards ● Performance measurement ● Performance evaluation ● Corrective actions
Module 7: Management and welfare (cont.) **7.4** Safety of workers and public **7.5** Causes of accidents, prevention and protection with reference to the Factories Machinery and Building Work Act	**Module 6: Occupational Health and Safety Act (OHSA)** **6.1 OHSA** **6.1.1** Explain safety regulations on a construction site: ● Advisory council ● Duties of employer and employees in safety ● Health and safety representative ● Health and safety committee ● Safety inspector and functions ● Compliance at site ● Safety manual ● Common causes of accidents ● Cost of accidents

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Previous curriculum (1981)	New curriculum (2023)
	• Safety signs • Unsafe conditions • Unsafe acts
	Module 7: Quality and ethics in construction 7.1 **Quality in construction** 7.1.1 Describe how to maintain quality at a site: • Quality control • Quality systems • Factors affecting quality • Compliance with BOQ and specification • Quality about standard building regulations 7.1.2 Judge the quality of a project: • Review • Inspection • Sampling • Defects • Quality levels 7.2 **Specification** 7.2.1 Describe the importance of specification: • Technical specification • Performance specification • Functional specification • Tolerance • Zero defect 7.3 **Ethics in construction** 7.3.1 Summarise the ethics to be followed by the various parties involved at a construction site: • Individuals • Organisations • Suppliers • Employers • Employees

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Previous curriculum (1981)	New curriculum (2023)
Module 5: Building laws, by-laws, insurance and taxation:	**Module 8: Contract laws and labour laws**
	8.1 **Contract laws**
5.1 Legal aspects; standard forms of building contract; arbitrations; building regulations; building and drainage by-laws 5.2 Insurance; income tax; sales tax (rendering of returns) 5.3 Reference to the applicable sections from the following: • Apprenticeship Act • Training of Artisans Act • Electrical Wiremen and Contractors Act • Building Workers Act for Black Workers • Wage measures for the building industry • Industrial Conciliation Act • Unemployment Insurance Act	8.1.1 Explain the impact of various laws regarding contracts: • Lawful contract • Contract formalities to be completed • Void and voidable contracts • Misrepresentations • Oral contracts • Breach of contract • Termination of contracts • Arbitration • Insurances
	8.2 **Labour laws**
	8.2.1 Explain various labour laws pertaining to construction industry: • Organisational rights • Closed shop agreement • Collective agreement • Bargaining councils • Statutory councils • Dismissal procedures • Unfair dismissals • Dispute procedures • Strikes and procedures
Not in the new syllabus: **Module 6: Programme charts** Financial; labour; material; plant and equipment; progress	

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Building Administration N6

Features and benefits of *TVET First Building Administration N6*

TVET First is the ideal textbook to guide Building Administration students towards success in their studies. This high-quality Student's Book includes practical advice from a practising building professional. It is packed with features that take students through the complete curriculum and prepare them for examination success. Features of the textbook include:

- clear and simple writing with explanations of new terminology
- a simple, step-by-step approach to problem solving
- plenty of varied activities to consolidate students' knowledge and prepare them for examinations
- lots of photographs and clear diagrams to make learning easier
- case studies that link the content and activities to real-life situations
- summaries at the end of each module to help with revision
- summative assessments modelled on examinations to provide helpful examination practice.

TVET First authors

B Afrika & N Atkinson

SUPPORTING LECTURERS NATED 2023 CURRICULUM IMPLEMENTATION

Building and Structural Construction N6

This document contains important information about the revised curriculum for Building and Structural Construction N6 for implementation in January 2023.

Overview of main curriculum changes

- The syllabus for Building and Structural Construction N6 has been fully reworked and updated.
- All learning content and learning outcomes are clearly numbered.
- Both the learning content and the learning outcomes have been completely reworded.
- There is much more detail in all sections.
- Unlike the N4 and N5 syllabi, the BSC N6 syllabus contains only three modules. Essentially, the new Module 1 and Module 3 mirror the old Part A: Concrete, and Part B: Iron and steel.
- Module 2 covers Bending schedules, which previously appeared in Part A: Concrete.
- The only old topic that does not appear in the new syllabus is 2.7 Columns (axially loaded): Universal steel columns, rectangular tubular steel columns and pipe columns with gusset plated bases on reinforced concrete bases.
- The aims of the new syllabus are:
  - to give students a thorough background knowledge of the theory and methodology applied in building and structural construction
  - to introduce students to the application of technological principles and practices in the building and structural construction industry
  - to provide learners with the knowledge and skills used for structural design in the industry.

Structure and weighting changes

Previous syllabus (1981)

Section	Old curriculum modules (no weighting given)
A Concrete	**1.** Material
	2. Reinforced concrete beams
	3. T-beams and L-beams of reinforced concrete
	4. One way/Uni-directional reinforced concrete slabs
	5. Reinforced concrete steps
	6. Reinforced concrete columns
	7. Bending schedules: of beams, leafwork and columns

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Section	Old curriculum modules (no weighting given)
B **Iron and steel**	**1.** Materials
	2. Binding joints
	3. Frame connecting joints (axially loaded)
	4. Eccentric loads, beam connections and angle irons
	5. Welding
	6. Beams
	7. Columns (axially loaded)

New syllabus (2023)

New curriculum modules	Weighting
1. Concrete	50
2. Bending schedule	5
3. Iron and steel	45
Total	**100**

Detailed curriculum changes

Previous curriculum (1981)	New curriculum (2023)
PART A: Concrete	
Module 1:	**Module 1: Concrete**
1.1 Material:	On completion of this module, the student should be able to understand and analyse the nature and behaviour of concrete materials and reinforced concrete calculations design.
Materials necessary – with reference to desirable and non-desirable properties. ● Tests such as slump tests, pressure tests, bending tests and tests for the expansion of sand ● Strength development of concrete; impact and influence of after treatment; the influence of water/cement proportions ● Cubic strength and permissible compression	**1.1 Concrete materials** **1.1.1** Define concrete by listing and explaining the materials that are used to mix concrete **1.1.2** Determine, by means of calculation, the relation between the quantity of mixing water and the amount of cement in a concrete mix known as water:cement ratio **1.1.3** Explain the importance of curing of concrete using the following curing methods: ● Sawdust

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Previous curriculum (1981)	New curriculum (2023)
	• Hessian • Polythene sheeting • Curing compound • Pounding • Water sprinkling • Curing by leaving the formwork in place or un-removed **1.1.4** Distinguish by explaining the following tests that are done in concrete: • Slump test • Cube test • Bending test • Water permeability test • Concrete abrasion test
1.2 Reinforced concrete beams: • Simply supported at both ends, with pull, pull and thrust, with or without extension arms/rods, with ring-shaped, circular steel • Bond stress of arms/rods	**1.2 Reinforced concrete beams design** **1.2.1** Determine, by means of calculation, the following on a simply supported reinforced concrete beam with effective depth and suitable reinforcement (live load and point loads): • Effective span, if not given • Maximum bending moment due to imposed load • Effective depth • Overall depth • Dead load • Maximum bending moment due to dead load • Total bending moment • Value of 'K' • Distance of lever arm (z) • Tension reinforcement • Check minimum reinforcement • Check maximum area of reinforcement • Check shear stress (v) • Maximum design shear stress • Shear reinforcement • Anchorage for links

Building and Structural Construction N6

<table>
<tr><th>Previous curriculum (1981)</th><th>New curriculum (2023)</th></tr>
<tr><td></td><td>1.2.2 Determine, by means of calculation, the following on a simply supported reinforced concrete beam with maximum distributed load (tension and compression reinforcement):
• Area steal in tension
• Check minimum reinforcing
• Distance of lever arm (z)
• Maximum moment of resistance in tension
• Area steal in compression
• Check minimum reinforcing
• Maximum moment of resistance in compression
• Total load
• Dead load
• Maximum imposed load</td></tr>
<tr><td></td><td>1.2.3 Determine, by means of calculation, the following on a simply supported reinforced concrete beam with maximum distributed load (tension reinforcement):
• Area steal in tension
• Check minimum reinforcement
• Check maximum reinforcement
• Distance of lever arm (z)
• Maximum moment of resistance
• Total load
• Dead lead
• Maximum imposed load</td></tr>
<tr><td></td><td>1.2.4 Determine, by means of calculation, the following on a simply supported reinforced concrete beam (given uniformly distributed live load and a point load):
• The design loads for the given beam
• Reactions RL and RR
• The shear force and bending moment diagram
• The value of 'K'</td></tr>
</table>

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Previous curriculum (1981)	New curriculum (2023)
	1.3 **Rectangular reinforced concrete beams design**
	1.3.1 Determine, by means of calculation, the following on a simply supported rectangular reinforced concrete beam.
	• The effective depth of the reinforced concrete beam • Suitable tension reinforcement for the reinforced concrete beam. • Minimum and maximum required main reinforcement
1.4 T-beams and L-beams of reinforced concrete:	1.4 **T-beams (flanged) of reinforced concrete**
• Simply supported at both ends	1.4.1 Determine the following by means of calculation if $x < hf$ the neutral axis lies within the flange:
	• Lever arm (z) • Neutral axis (x) • Total design load • Maximum bending moment • Tension reinforcement • Minimum distance between bars • Minimum reinforcing • Maximum area of reinforcements • Check shear stress (v) • Maximum design shear stress • Maximum spacing (0,75d) • Anchorage for links
	1.4.2 Determine, by means of calculation, the required tension reinforcement if neutral axis is within the flange of the flanged beam.
	1.5 **L-beams (flanged) of reinforced concrete**
	1.5.1 Determine, by means of calculation, the required tension reinforcement if the neutral axis is within the flange.
	Note: *Use clause 4.3.1.5 to calculate width 'x' of the L-beam.*

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Previous curriculum (1981)	New curriculum (2023)
	1.5.2 Determine, by means of calculation, the suitable tension reinforcement for a simply supported L-beam the following: ● Effective span, if not given ● Imposed load ● Dead load ● Maximum bending moment ● The value of 'K' ● Distance of lever arm (z) ● Tension reinforcement ● Minimum distance between bars ● Check minimum reinforcing
1.3 One way/Uni-directional reinforced concrete slab:	**1.6** **One way or uni-directional reinforced concrete slabs**
● Simply supported at both ends with an overhang	**1.6.1** Determine, by means of calculation, the following on a simply supported reinforced concrete slab with effective depth and suitable reinforcement (live load): ● Effective span, if not given ● Effective depth ● Overall depth (D) ● Dead load ● Total design load ● Maximum bending moment ● Value of 'K' ● Distance of lever arm (z) ● Tension reinforcement ● Minimum mean reinforcement ● Secondary reinforcement Also show, by means of a neat sketch, the plan view and vertical section showing all dimensions calculated for the slab.
	1.6.2 Determine, by means of calculation, the following on a simply supported reinforced concrete slab with maximum distributed load per-square meter: ● Area of steal ● Distance of lever arm (z) ● Maximum moment of resistance

Building and Structural Construction N6

Previous curriculum (1981)	New curriculum (2023)
	• Total load • Dead load • Imposed load • Maximum area of reinforcement • Check shear stress (v) • Maximum design shear stress • Shear reinforcement • Anchorage for links
	1.6.3 Determine, by means of calculation, the suitable tension and secondary reinforcement for a one-directional simple supported reinforced concrete slab using the following specifications:
	• Span • Live load • Concrete grade • Density of concrete • Main reinforcement • Secondary reinforcement • Self-weight of the slab included/not included
	1.6.4 Determine, by means of calculation, the following on a simply supported reinforced concrete slab given the following specifications:
	• Effective span • Length of the slab • Overall depth • Density of concrete • Supported by I-profile parallel flange beams **Calculate:**
	• The total design dead load of the slab • Suitable I-parallel flange steel beam to support the slab
1.5 Reinforced concrete steps: • Straight flight of stairs with or without a bearer beam at the end, with a balustrade of steel or steel and glass.	**1.7 Reinforced concrete stairs** **1.7.1** Calculate the following using relevant code references where necessary: • Total design, dead and imposed loads.

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Previous curriculum (1981)	New curriculum (2023)
	● Maximum bending moment ● The value of the constant 'K' ● Size and spacing of suitable main and secondary reinforcements
1.6 Reinforced concrete columns: ● (Only axially loaded) square, rectangular and round columns (the latter with binder or spiral binder steel) ● Columns with reinforced concrete bases	**1.8 Reinforced concrete columns design** 1.8.1 Determine, by means of calculation, a square, rectangular and round axially loaded column the following: The required number and diameter of the longitudinal bars ● The maximum and minimum percentage of the steel reinforcement ● The diameter and pitch of the helical binder ● The net area of the concrete ● The axial load the column can withstand ● The required diameter and spacing of the bindersv 1.8.2 Determine, by means of calculation, the size and suitable reinforcement of pad foundation using the following: ● Imposed load ● Dead load ● Self-weight ● Given bearing pressure on the ground
Module 1: Concrete 1.7 Bending schedules: of beams, leafwork and columns	**Module 2: Bending schedule** On completion of this module, the student should be able to have a better understanding of structural detailing work in construction. **2.1 Structural detailing** 2.1.1 Interpret and make references of the SANS 282 summary of shape codes 2.1.2 Identify and categorise the details of a completed reinforcement bending bar schedule, with a clear understanding of the sections listed below:

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Previous curriculum (1981)	New curriculum (2023)
	• Member (concrete staircase, concrete columns, concrete beams, concrete slabs and base foundations) • Bar mark • Type and size of reinforcement • Number of members • Number of bars in each member • Total number of bars • Length of each bar • The shape code • Column A–E in nearest 5 mm dimension
Module 2: Iron and Steel	**Module 3: Iron and steel**
2.1 Materials: • Raw materials that are used in the manufacturing processes • Method of production with the blast furnace, open-hearth furnace, Bessemer converter and the electric furnace • Non-ferrous metals and the use thereof for structural work	3.1 **Materials** 3.1.1 Describe the raw material used in the process of production of iron and steel by means of the following: • Copula • Open heart furnace Bessemer converter • Electric furnace 3.1.2 Describe non-ferrous metals and their uses in structural work.
2.2 Binding joints: • Bolted bending joints of plates, flat iron, angle irons with tie plate, complying with stress, pressure and extension loads (tension according to the tables in the Standard Building Regulations)	3.2 **Binding joints** 3.2.1 Determine, by means of calculation, the maximum load the connection can support safely within the thread of the shear plan using the following: 1. *Shearing formulae* • Shear stress • Area • Shear load 2. *Bearing formulae* • Bearing stress • Area • Bearing load 3. *Tearing formulae* • Tensile stress • Area • Tensile load

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Previous curriculum (1981)	New curriculum (2023)
2.3 Frame connecting joints (axially loaded): ● Bolted joints of roof frames and bridge construction frames with gusset plates	**3.3** **Roof frame connection joints** (cantilever or full frame structure): **3.3.1** Calculate the magnitude of the given forces and distinguish between tension and compression on the parts marked graphically or analytically **3.4** **Roof frame connection joints** (tie beam and rafter) **3.4.1** Determine, by means of a calculation, the following: ● The number of bolts required to secure the parts to the gusset plate safely (the thread of the bolts will be in shearing plane) ● Select a suitable equal-leg angle section for the part marked given the total length
2.4 Eccentric loads, beam connections and angle irons: ● Bolted connecting plates and angle irons against columns for the support of beams etc.	**3.5** **Eccentric loaded beam connections** **3.5.1** Determine, by means of a calculation when given the size and shear stress value of the bolt using the following: ● Vertical load ● Distance from centroid to furthest bolt ● Direct load on the bolt due to imposed load ● The total load of each bolt ● The size of the bolt
2.5 Welding: ● Butt welding and fillet welding of simple binding work	**3.6** **Welding connections** **3.6.1** Determine, by means of a calculation, the maximum tensile load of a fillet welded joint with a given leg size and a given effective length to support safely using the following: ● Effective length ● Throat ● Area of weld ● Allowable stress ● Maximum load

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Previous curriculum (1981)	New curriculum (2023)
2.6 Beams: • Simple steel beams for standard and light beam sections and simple builtup sections of grade 43 steel. (Revision of the moment of inertia and the centre of gravity is advisable at this point)	3.7 **Steel beams** (parallel flange and channel profile placed at the bottom) 3.7.1 Determine, by means of a calculation, the central point load which the compound beam must support safely given the maximum bending stress and ignoring the self-weight of the beam
	3.8 **Steel beam** (parallel flange and channel profile placed at the top and opening up) 3.8.1 Determine, by means of a calculation, the maximum point load the beam can carry at midpoint considering the self-weight of the beam given the following: • Effective length of the beam • Maximum bending stress • Uniformly distributed load (UDL)
	3.9 **Steel beam** (parallel flange and channel profile placed at the top and closing down) 3.9.1 Determine, by means of a calculation, the maximum point load the beam can carry at midpoint considering the self-weight of the beam given the following: • Effective length of the beam • Maximum bending stress • Uniformly distributed load (UDL)
	3.10 **Maximum effective span** 3.10.1 Determine, by means of a calculation, the maximum effective span it can support at mid span given the following: • Self-weight of the beam • Maximum bending stress 3.10.2 Determine, by means of a calculation, a suitable I-parallel flange steel beam to support the given loads using the following:

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Previous curriculum (1981)	New curriculum (2023)
	• Self-weight of the beam included • Maximum bending stress • To calculate: Imposed load as well as its own self weight
	3.11 **Combination of concrete beam and parallel flange steel beam connection**
	3.11.1 Determine, by means of a calculation, the following: • Maximum load that a beam can support at a given point using a given bending stress value. • The magnitude of reactions RR and RL • The number of bolts to secure the steel beam safely to the concrete structure **Note:** • Self-weight of the beam must be included • Tensile stress of the bolts must be given
	3.12 **Position x- and y-axis steel beams** (I-section taper flange as a tension member)
	3.12.1 Determine, by means of a calculation, the following: • Maximum uniformly distributed load (UDL. that each of the beams will be able to carry given a bending stress value) • Explain why the loads of two beams differ • Draw two neat sketches to show how the beams can be joined to form one tension member.
	3.13 **Compound steel beam** (H-section parallel flange or I-section parallel flange supporting rectangular, square, circular, triangular hollow section)

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Previous curriculum (1981)	New curriculum (2023)
	3.13.1 Determine, by means of a calculation, the maximum uniformly distributed load that the structural steel can support safely. **Note: The following must be given:** ● Maximum bending stress ● Assume self-weight for the compound beam ● Density of structural steel ● Span
2.7 Columns (axially loaded): Universal steel columns, rectangular tubular steel columns and pipe columns with gusset plated bases on reinforced concrete bases	**Not covered in the new syllabus**

Features and benefits of *TVET First Building and Structural Construction N6*

TVET First is the ideal textbook to guide Building and Structural Construction students towards success in their studies. Written by a team of industry professionals and experienced TVET College lecturers, this Student's Book will not only ensure students' examination success, but will also prepare them for their future careers in industry.

Features of the Student's Book include:

- easy to follow, clear explanations written in accessible language
- clear, contextualised definitions of all new terminology
- a simple, step-by-step approach to solving problems and completing calculations
- varied activities that consolidate students' knowledge
- links to relevant videos to enhance understanding
- numerous photographs and clear diagrams to aid understanding
- module summaries that help with revision
- summative assessments modelled on examination questions for examination preparation and practice.

TVET First authors

M Masangane & R Nair

SUPPORTING LECTURERS NATED 2023 CURRICULUM IMPLEMENTATION

Mathematics N6

This document contains important information about the revised curriculum for Mathematics N6 for implementation in January 2023.

Overview of main curriculum changes

- The Mathematics N6 syllabus has been *revised, restructured and updated*.
- The content of the syllabus has not changed very much. However, all of the *learning outcomes have been renumbered and most of them have been reworded.*
- The syllabus now comprises eight modules instead of six. The old Module 5 (Application of the definite integral), formerly one module, has now been broken into three separate modules, namely:
  - Module 5: Areas and volumes
  - Module 6: Centroids and centre of gravity
  - Module 7: Second moment of area, moment of inertia and centre of fluid pressure
- Syllabus weightings for the topics remain the same.
- The combined weighting of the new Module 5–7 (old Module 5) is unchanged at 40%. However, these modules have now been weighted individually as follows:
  - Module 5: Areas and volumes (15%)
  - Module 6: Centroids and centre of gravity (10%)
  - Module 7: Second moment of area, moment of inertia and centre of fluid pressure (15%)
- In Module 2 (Integration techniques), a new learning outcome on the integration of products of sin and/or cos with different coefficients (Type: $\int \sin(ax) \cdot \cos(bx)\,dx$) has now been included in the N6 syllabus.
- In some sections, more detail and didactic guidance is provided. Examples:
  - Partial derivatives are now defined, and the syllabus now includes notation for partial derivatives and rules for finding partial derivatives. The learning outcomes now specifically state that students must calculate specific values for first and second order partial derivatives and apply partial differentiation to practical real-life problems.
  - Guidance is provided on how to differentiate parametric equations.
  - The formulae for integration by completing the square are now provided in the syllabus document.
  - The formulae (with graphs) for calculating areas are now provided.
  - The formulae for calculating volumes using the disk and shell methods are now provided.
- Some of the learning outcomes and didactic guidelines have been simplified/summarised. For example, in Module 2, less information is given on the types of equations to be integrated using integration by parts.

Changes to examination assessment

Written assessment must include various cognitive skills listed in Bloom's taxonomy. The following table sets out the skills and weighting that applied in the 1996 syllabus.

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Old standards (1996)

Recall and reproduction	Understanding and application	Analysis, synthesis and evaluation
±20%	±45%	±35%

The table that follows lists the skills that apply in the 2023 syllabus, along with the weighting accorded to each.

New standards (2023)

Remember	Understand	Apply	Analyse	Evaluate	Create
20%	20%	20%	10%	20%	10%

Old and new modules and weightings

Old curriculum (1996)

Module 1	Differentiation	6%
Module 2	Integration techniques	18%
Module 3	Partial fractions	12%
Module 4	Differential equations	12%
Module 5	Application of the definite integral	40%
Module 6	Applications where differentiation and integration techniques are combined	12%
	Total	**100%**

New curriculum (2023)

Module 1	Differentiation	6%
Module 2	Integration techniques	18%
Module 3	Partial fractions	12%
Module 4	Differential equations	12%
Module 5	Area and volumes	15%
Module 6	Centroids and centre of gravity	10%
Module 7	Second moment of area, moment of inertia and centre of fluid pressure	15%
Module 8	Combinations of differentiation and integration	12%
	Total	**100%**

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Detailed comparison of changes to the wording of the syllabus

Previous curriculum (1996)	New curriculum (2023)
Module 1: Differentiation	**Module 1: Differentiation**
7.1.1 **Partial differentiation** On completion of this topic, the students should be able to apply the concept of partial differentiation	8.1.1 **Apply differentiation to first and second order partial derivatives by:**
7.1.1.1 with respect to x; 7.1.1.2 with respect to y; and	8.1.1.1 Partially differentiating a function consisting of two (or more) variables with respect to one variable only If f is a function of two variables, its partial derivatives are the functions f_x and f_y defined by: $f_x(x, y) = \lim_{h\to 0} \frac{f(x+h, y) - f(x, y)}{h}$ $f_y(x, y) = \lim_{h\to 0} \frac{f(x, y+h) - f(x, y)}{h}$ **Notations for partial derivatives:** If $z = f(x, y)$, we write $f_x(x, y) = f_x = \frac{\partial f}{\partial x} = \frac{\partial}{\partial x} f(x, y) = \frac{\partial z}{\partial x} = f_1 = D_1 f = D_x f$ $f_y(x, y) = f_y = \frac{\partial f}{\partial y} = \frac{\partial}{\partial y} f(x, y) = \frac{\partial z}{\partial y} = f_2 = D_2 f = D_y f$ **Rule for finding partial derivatives of** $z = f(x, y)$ 1. To find f_x, regard y as a constant and differentiate $f(x, y)$ with respect to x. 2. To find f_y, regard x as a constant and differentiate $f(x, y)$ with respect to y.
7.1.1.3 To problems where the variables changes simultaneously	8.1.1.2 Using successive differentiation to obtain the second derivatives of a function consisting of two variables **Higher derivatives** If f is a function of two variables, then its partial derivatives f_x and f_y are also functions of two variables, so we can consider their partial derivatives $(f_x)_x$, $(f_x)_y$, $(f_y)_x$ and $(f_y)_y$, which are called the second partial derivatives of f. If $z = f(x, y)$, we use the following notation:

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Previous curriculum (1996)	New curriculum (2023)
	$(f_x)_x = f_{xx} = f_{11} = \frac{\partial}{\partial x}\left(\frac{\partial f}{\partial x}\right) = \frac{\partial^2 f}{\partial x^2} = \frac{\partial^2 z}{\partial x^2}$ $(f_x)_y = f_{xy} = f_{12} = \frac{\partial}{\partial y}\left(\frac{\partial f}{\partial x}\right) = \frac{\partial^2 f}{\partial y\,\partial x} = \frac{\partial^2 z}{\partial y\,\partial x}$ $(f_y)_x = f_{yx} = f_{21} = \frac{\partial}{\partial x}\left(\frac{\partial f}{\partial y}\right) = \frac{\partial^2 f}{\partial x\,\partial y} = \frac{\partial^2 z}{\partial x\,\partial y}$ $(f_y)_y = f_{yy} = f_{22} = \frac{\partial}{\partial y}\left(\frac{\partial f}{\partial y}\right) = \frac{\partial^2 f}{\partial y^2} = \frac{\partial^2 z}{\partial y^2}$
	8.1.1.3 Calculating specific values of the first and second order partial derivative(s) at specified coordinates
	8.1.2 **Apply differentiation to practical (real-life) problems** by analysing, recreating, and applying partial differentiation, then interpreting the results
7.1.2 **Differentiation of parametric equations (first and second order)**	**8.1.3** **Apply differentiation to first and second order parametric equations by:**
7.1.2.1 If $y = f(\theta)$ and $x = g(\theta)$, then	**8.1.3.1** Differentiating two functions consisting of the same variable (parameter) Suppose that x and y are both given as functions of a third variable t (called a parameter) by the equations $x = f(t) \qquad y = f(t)$ *(called parametric equations)*. Each value of t determines a point (x, y), which we can plot in a coordinate plane. Suppose f and g are differentiable functions and we want to find the tangent line at a point on the parametric curve $x = f(t)$, $y = f(t)$, where y is also a differentiable functions of x. Then the chain rule gives $\frac{dy}{dt} = \frac{dy}{dx} \cdot \frac{dx}{dt}$

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Previous curriculum (1996)	New curriculum (2023)
* first order: $\frac{dy}{dx}=\frac{dy/d\theta}{d\theta/dx}$ DIDACTIC GUIDELINES Examples of partial differentiation: a) If z equals a function of x and y, i.e., $z=f(x;y)$, the following must be determined: $\frac{\partial z}{\partial y}:\frac{\partial z}{\partial x}$	If $dx/dt \neq 0$, we can solve for dy/dx: $\frac{dy}{dx}=\frac{\frac{dy}{dt}}{\frac{dx}{dt}} \quad \text{if } \frac{dx}{dt}\neq 0$
	8.1.3.2 Using successive differentiation to obtain the second derivative of two functions consisting of the same variable (parameter) As we know it is also useful to consider d^2y/dx^2. This can be found by replacing y by dy/dx.
* second order: $\frac{d^2y}{dx^2}=\frac{d}{d\theta}\left(\frac{dy}{dx}\right)\frac{d\theta}{dx}$ DIDACTIC GUIDELINES Examples of partial differentiation: a) If z equals a function of x and y, i.e., $z=f(x;y)$, the following must be determined: $\frac{\partial z}{\partial y}:\frac{\partial z}{\partial x}$ $\frac{\partial^2 z}{\partial y^2}:\frac{\partial^2 z}{\partial x}$ and $\frac{\partial^2 z}{\partial y\partial x}:\frac{\partial^2 z}{\partial xdy}$ b) If $A=2\pi rh$ and A is a function of r and h, i.e., $A=f(r;h)$, and r and h changes simultaneously, find the increase or decrease in area Formula: $\Delta A=\frac{\partial A}{\partial r}\cdot\Delta r\pm\frac{\partial A}{\partial h}\cdot\Delta h$ On completion of the topic on parametric equations, the students should be able to solve these equations.	$\frac{d^2y}{dx^2}=\frac{d}{dx}\left(\frac{dy}{dx}\right)=\frac{\frac{d}{dt}\left(\frac{dy}{dx}\right)}{\frac{dx}{dt}}$ **8.1.3.3** Calculating specific values of the derivative(s) at specified coordinates

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Previous curriculum (1996)	New curriculum (2023)
Module 2: Integration techniques	**Module 2: Integration techniques**
7.2.1 Integration by parts On completion of this topic, the student should be able to integrate a product of two functions, where one function is not the derivative of the other function, by using the formula $\int f(x)g'(x)\,dx = f(x)g(x) - \int f'(x)g(x)\,dx$ DIDACTIC GUIDELINES Examples relating to 7.2.1: a) $\int x^n \cdot f(x)\,dx$ (i) for $n \leq 3$ and $f(x)$ an exponential function, logarithmic function, sin x and cos x; and (ii) for n = 1 where $f(x)$ can be one of the following trigonometrical functions: $\tan^2 x$ $\cot^2 x$ $\sec^2 x$ $\mathrm{cosec}^2 x$ b) The integration of $\int g(x) \cdot \phi(x)\,dx$, where $g(x)$ is a linear or exponential function and $\phi(x)$ is sin x or cos x	**8.2.1** **Integrate using integration by parts** Functions of the form $\int f(x)\,g'(x)\,dx = f(x)g(x) - \int g(x)f'(x)\,dx$, where $f(x)$ and $g(x)$ are not derivatives of each other.
7.2.2 Integration of trigonometric functions On completion of this topic, the student should be able to:	**8.2.2** **Integrate trigonometric functions** Apply specific integration techniques to the following functions (m, $n \leq 5$ and some constant a)
7.2.2.1 Integrate the functions $\sin^n ax$ and $\cos^n ax$, where $2 \leq n \leq 5$ and a is a constant.	**8.2.2.1** $\sin^m ax$ and $\cos^n ax$
7.2.2.2 Integrate the functions $\tan^n ax$ and $\cot^n ax$, where $n \leq 5$, and a is a constant.	**8.2.2.2** $\tan^m ax$ and $\cot^n ax$

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Previous curriculum (1996)	New curriculum (2023)
	$\int \sin^2(ax)\,dx, \int \cos^2(ax)\,dx, \int \tan^2(ax)\,dx$ and $\int \cot^2(ax)\,dx$ using the following identities: $\sin^2 x = \frac{1}{2}(1 - \cos 2x)$ $\cos^2 x = \frac{1}{2}(1 + \cos 2x)$ $\cot^2 x = \text{cosec}^2 x - 1$ $\tan^2 x = \sec^2 x - 1$
7.2.2.3 Determine the integral of $\sin^m x \cdot \cos^n x$, where m and n are positive integers. Both m and n may not be even numbers and m or $n \leq 5$	8.2.2.3 $\sin^m ax \cdot \cos^n ax$ $\int \sin^m x \cdot \cos^n x\,dx$ where m and n are positive, m and/or n are odd and m and $n < 3$
	• $\int f'(x) \cdot \sin[f(x)]\,dx$ [The same for the other trigonometric functions] • $\int \sin(ax)\,dx, \int \cos(ax)\,dx, \int \tan(ax)\,dx$ and $\int \cot(ax)\,dx$ • $\int \sin(ax) \cdot \cos(bx)\,dx$ by transforming: $\sin A \cos B = \frac{1}{2}[\sin(A + B) + \sin(A - B)]$ $\cos A \sin B = \frac{1}{2}[\sin(A + B) - \sin(A - B)]$ $\cos A \cos B = \frac{1}{2}[\cos(A + B) + \cos(A - B)]$ $\sin A \sin B = \frac{1}{2}[\cos(A - B) - \cos(A + B)]$
7.2.3 Integration by means of completing the square On completion of this topic, the student should be able to integrate the following expressions by first completing the relevant squares and then stating and applying the standard formulae:	8.2.3 **Integrate by means of completing the square** applied to the following functions:
a) $\frac{1}{\sqrt{ax^2 + bx + c}}$	8.2.3.1 $\frac{1}{\sqrt{ax^2 + bx + c}}$
b) $\frac{1}{ax^2 + bx + c}$	8.2.3.2 $\frac{1}{ax^2 + bx + c}$
c) $\sqrt{c + bx - ax^2}$	8.2.3.3 $\frac{1}{c + bx - ax^2}$
d) $\frac{1}{\sqrt{c + bx - ax^2}}$	8.2.3.4 $\frac{1}{\sqrt{c + bx - ax^2}}$

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Previous curriculum (1996)	New curriculum (2023)
	If given $bx = a \sin \theta$, then: $\int \frac{dx}{\sqrt{a^2 - b^2x}} = \frac{1}{b} \sin^{-1}\left(\frac{bx}{a}\right) + c$ If given $bx = a \tan \theta$, then: $\int \frac{dx}{b^2x + a^2} = \frac{1}{ab} \tan^{-1}\left(\frac{bx}{a}\right) + c$ If given $bx = a \sin^{-1} \theta$, then: $\int \sqrt{a^2 - b^2x^2}\, dx = \frac{a^2}{2b} \sin^{-1}\left(\frac{bx}{a}\right) + \frac{x}{2}\sqrt{a^2 - b^2x^2} + c$
Module 3: Partial fractions On completion of this topic, the student should be able to determine the following integrals by means of partial fractions:	**Module 3: Partial fractions**
7.3.1 $\int \frac{f(x)\, dx}{(ax \pm b)^n}$ where n = 3 and a and b are integers	8.3.1 **Single recursive factor** Fractions where the denominator has a single recursive factor: $\int \frac{f(x)\, dx}{(ax \pm b)^n}$ where $n \leq 3$; a, b are integers.
7.3.2 $\int \frac{f(x)\, dx}{(ax + b)^n (cx + d)^m}$ where m and $n \in \{1; 2; 3\}$ and a, b, c and d are integers	8.3.2 **Two recursive factors** Fractions where the denominator has two recursive factors: $\int \frac{f(x)\, dx}{(ax \pm b)^m (cx \pm d)^n}$ where $m, n \leq 3$; a, b, c and d are integers.
7.3.3 $\int \frac{f(x)\, dx}{(ax^2 + bx + c)(dx + e)^n}$ where $n \in \{1; 2; 3\}$, a, b, c, d and e are integers and the quadratic expression cannot be factorized	8.3.3 **Trinomial factor and recursive factors** Fractions where the denominator has a trinomial factor and recursive factors: $\int \frac{f(x)\, dx}{(ax^2 \pm bx + c)(dx \pm e)^n}$ where $n \leq 3$; a, b, c, d and e are integers.
DIDACTIC GUIDELINE If the degree of $f(x)$ is equal or greater than the degree of the denominator, long division should be done first.	8.3.4 **Improper rational factors** Fractions where the denominator has a higher degree polynomial and has to be reduced using long division to: a) fractions where the denominator has two recursive factors b) fractions where the denominator has a trinomial factor and recursive factors.

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Previous curriculum (1996)	New curriculum (2023)
Module 4: Differential equations	**Module 4: Differential equations**
7.4.1 First order linear equations On completion of this topic, the student should be able to write first order linear equations in the form $\frac{dy}{dx} + Py = Q$ where P and Q are functions of x, and solve the equation with the aid of the integral factor $e^{\int P\,dx}$ and the formulae $y\,e^{\int P\,dx} = \int Q\,e^{\int P\,dx}\,dx$	8.4.1 **First order linear differential equations** 8.4.1.1 By first writing it in standard form $\frac{dy}{dx} + P(x) = Q(x)$ where P and Q are continuous functions 8.4.1.2 then calculating the integrating factor 8.4.1.3 to solve the equation $y^{\int e^{P(x)\,dx}} = \int Q^{\int e^{P(x)}\,dx}\,dx$
7.4.2 Second order equations On completion of this topic, the student should be able to solve equations of the form	8.4.2 **Second order differential equations**
$\frac{d^2y}{dx^2} \pm P\frac{dy}{dx} \pm Qy = R,$ where P and Q are real numbers by determining	8.4.2.1 By first writing it in standard form $\frac{d^2y}{dx^2} + a\frac{dy}{dx} + by = R(x)$ where a and b are real numbers.
a) the complementary function of the equation; and	8.4.2.2 Determine the complimentary function $m^2 + am + b = 0$
b) the particular integral of the equation by means of substitution, e.g.: $R = C$ $R = Cx + d$ $R = Cx^2 + Dx + E$ $R = Ce^{kx}$ DIDACTIC GUIDELINES *Examples relating to 7.4.2: # Auxiliary equations with complex roots are included. # If, for example, $R = e^{2x}$ and $\text{CF} = Ae^{-x} + Be^{2x}$, then the PI: $y = Cxe^{kx}$	8.4.2.3 Determine the particular function $\frac{d^2y}{dx^2} + a\frac{dy}{dx} + by = R(x)$ where $R(x) = \begin{cases} A, \text{ for some constant A} \\ mx + c, \text{ (linear)} \\ ax^2 bx + c, \text{ (parabola)} \\ Ae^{ax} \text{ or } Axe^{ax} \text{ when } m = a, \text{ (exponential)} \end{cases}$

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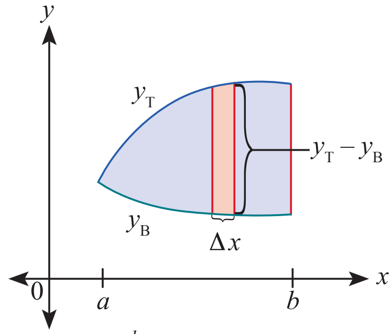
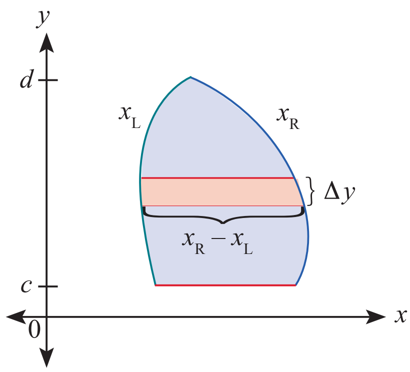
Previous curriculum (1996)	New curriculum (2023)
Module 5: Application of the definite integral	**Module 5: Areas and volumes**
7.5 Module 5: Applications of the definite integral ● ALL THE APPLICATIONS IN THIS MODULE MUST BE DONE AS FOLLOWS:	On completion of this module, the student should be able to:
● DRAW A NEAT SKETCH OF THE RELEVANT CURVES AND CLEARLY INDICATE THE RELEVANT POINTs OF INTERSECTION AFTER SUITABLE CALCULATIONS	● Sketch a function on a given interval ● Calculate and sketch the points of intersection of areas and volumes under two functions
INDICATE THE REPRESENTATIVE STRIP AND THE RELEVANT LIMITS, AS WELL AS THE DISTANCE TO THE REFERENCE AXIS WHEN MOMENTS ARE TO BE DETERMINED	
● GIVE THE EQUATION FOR THE VOLUME, CENTROID, MOMENT, ETC. OF THE REPRESENTATIVE STRIP	
● APPLY THE OPERATION FOR SUMMATION (DETERMINE THE CORRECT DEFINITE INTEGRAL)	● Calculate the areas and volumes of a given function or two functions using a definite integral with respect to:
NB ONLY CURVES PRESCRIBED IN THE N1 TO THE N6 SYLLABI WILL BE EXAMINED.	
	8.5.1 Areas **8.5.1.1** Calculate the area between a curve and one of the reference axes using: ● $A_x = \int_a^b y\ dx$ where $a \leq x \leq b$ $A_y = \int_c^d x\ dy$ where $c \leq y \leq d$ **8.5.1.2** Calculate the area between two curves using: ● $A_x = \int_a^b (y_T - y_B)\ dx$ where a and b are the x-coordinates of the intersections between the two curves

Previous curriculum (1996)	New curriculum (2023)
	 • $A_y = \int_c^d (x_R - x_L)\ dy$ where c and d are the y-coordinates of the intersections between the two curves 
7.5.1 Volumes On completion of this topic, the student should be able to calculate the volume developed when an area enclosed between a given curve and an axis, or between two given curves, is rotated about a reference axis, with the specific application of the representative strip being parallel to the axis about which the area is rotated (the tin effect).	**8.5.2 Volumes** **8.5.2.1** Disk method a) Calculate the volume between a curve and one of the reference axes • $V_x = \pi \int_a^b y^2\, dx$ where $a \leq x \leq b$ • $V_y = \pi \int_c^d x^2\, dy$ where $c \leq y \leq d$ b) Calculate the volume between two curves • $V_x = \pi \int_a^b (y_B^2 - y_T)^2\, dx$ where a and b are the x-coordinates of the intersections between the two curves • $V_y = \pi \int_c^d (x_R^2 - x_L^2)\ dy$ where c and d are the y-coordinates of the intersections between the two curves

Previous curriculum (1996)	New curriculum (2023)
	8.5.2.2 Shell method c) Calculate the volume between a curve and one of the reference axes • $V_x = 2\pi\int_a^b xy\ dx$ where $a \le x \le b$ • $V_y = 2\pi\int_c^d yx\ dy$ where $c \le y \le d$ d) Calculate the volume between two curves • $V_x = 2\pi\int_a^b x(y_B - y_T)\ dx$ where a and b are the x-coordinates of the intersections between the two curves • $V_y = 2\pi\int_c^d y(x_R - x_L)\ dy$ where c and d are the y-coordinates of the intersections between the two curves
Module 5: Application of the definite integral (continued)	**Module 6: Centroids and centre of gravity**
7.5 MODULE 5: APPLICATIONS OF THE DEFINITE INTEGRAL • ALL THE APPLICATIONS IN THIS MODULE MUST BE DONE AS FOLLOWS:	
• DRAW A NEAT SKETCH OF THE RELEVANT CURVES AND CLEARLY INDICATE THE RELEVANT POINTS OF INTERSECTION AFTER SUITABLE CALCULATIONS	• Sketch a function on a given interval • Calculate and sketch the points of intersection of areas and volumes under two functions • Calculate the areas and volumes of a given function or two functions using a definite integral.
• INDICATE THE REPRESENTATIVE STRIP AND THE RELEVANT LIMITS, AS WELL AS THE DISTANCE TO THE REFERENCE AXIS WHEN MOMENTS ARE TO BE DETERMINED	

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Previous curriculum (1996)	New curriculum (2023)
• GIVE THE EQUATION FOR THE VOLUME, CENTROID, MOMENT, ETC. OF THE REPRESENTATIVE STRIP • APPLY THE OPERATION FOR SUMMATION (DETERMINE THE CORRECT DEFINITE INTEGRAL) NB: ONLY CURVES PRESCRIBED IN THE N1 TO THE N6 SYLLABI WILL BE EXAMINED.	
7.5.2 Centroids On completion of this topic, the student should be able to calculate the distance from any of the reference axes to the centroid of the area between a given curve and an axis, or between two given curves.	8.6.1 **Centroids** Calculate the distance from any of the reference axes to the centroid of the area between a given curve and an axis, or between two given curves.
7.5.3 Centres of gravity On completion of this topic, the student should be able to calculate the distance from a reference axis to the centre of gravity of a solid of revolution generated when the area between two given curves or a given curve and an axis is rotated about a reference axis.	8.6.2 **Centre of gravity** Calculate the distance from a reference axis to the centre of gravity of a solid of revolution generated when the area between two given curves or a given curve and an axis is rotated about a reference axis.
Module 5: Application of the definite integral (continued)	**Module 7: Second moment of area, moment of inertia and centre of fluid pressure**
7.5.4 Second moment of area On completion of this topic, the student should be able to calculate the second moment of area of an area enclosed between two given curves, or a given curve and an axis, with respect to a reference axis.	8.7.1 **Second moment of area** Calculate the second moment of area of an area enclosed between two given curves, or a given curve and an axis, with respect to a reference axis.

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Previous curriculum (1996)	New curriculum (2023)
7.5.5 Moments of inertia On completion of this topic, the student should be able to calculate the moment of inertia of a solid of revolution generated when the area between two given curves or a given curve and an axis is rotated about an axis. If the mass of the solid is not given, the answer must be given in terms of m.	8.7.2 **Moments of inertia** Calculate the moment of inertia of a solid of revolution generated when the area between two given curves or a given curve and an axis is rotated about an axis. If the mass of the solid is not given, the answer must be given in terms of the mass m.
7.5.6 Centres of fluid pressure On completion of this topic, the student should be able to calculate the depth of the centre of fluid pressure on a vertical plane submerged in the fluid with respect to the surface of the fluid.	8.7.3 **Centre of fluid pressure** Calculate the depth of the centre of fluid pressure on a vertical plane submerged in the fluid with respect to the surface of the fluid.
Module 6: Applications where differentiation and integration techniques are combined	**Module 8: Combinations of differentiation and integration**
7.6.1 Length of curves On completion of this topic, the student should be able to calculate the arc length of a given curve between two points, by applying differentiation and integration as indicated in the following two formulae. a) $S = \int_a^b \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$ when $y = f(x)$ b) $S = \int_a^b \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2}\, d\theta$ for parametric equations	8.8.1 **Lengths of curves** Lengths of curves using the arc length of a given curve between two given points followed by applying differentiation and integration formulae as indicated below a) $S = \int_a^b \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$ when $y = f(x)$ b) $S = \int_a^b \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{dx}\right)^2}\, dx$ for parametric equations

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Previous curriculum (1996)	New curriculum (2023)
7.6.2 Surfaces of revolution On completion of this topic, the student should be able to calculate the surface area generated when the arc of a curve, between two points, revolves through a full revolution about an axis, by applying the following formulae: a) $A = \int_a^b 2\pi y \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$ when $y = f(x)$ b) $A = \int_a^b \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2}\, d\theta$ for parametric equations	8.8.2 **Surfaces of revolution** Surfaces of revolution of the surface area generated when the arc of a curve, between two points, revolves through a full revolution about an axis, using: a) $A = \int_a^b 2\pi y \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$ when $y = f(x)$ b) $A = \int_a^b 2\pi y \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2}\, dx$ for parametric equations

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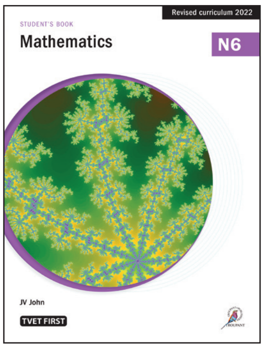

***Mathematics* (S A Chuturgoon and J V John)**

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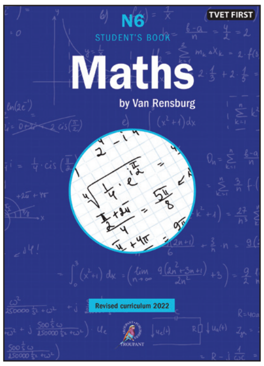

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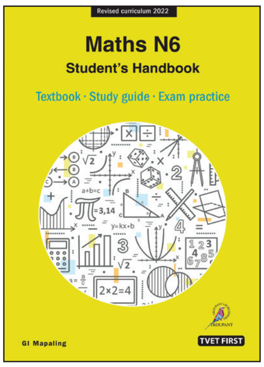
- Students who want to consolidate their knowledge of the basics of mathematics quickly and easily
- Stronger students looking for extension and enrichment activities
- Lecturers who like to work with alternative methods to cater for different learning styles
- Lecturers who have enjoyed a previous edition of Maths by Van Rensburg and know that it works for them.



Maths Student's Handbook (G I Mapaling)

Get straight to the point with this practical, hands-on approach. This essential series provides a targeted approach to understanding mathematics problems with step-by-step explanations and guidance in applying knowledge. Students can gain vital insights into where they make mistakes by checking their work using the full solutions at the back of each book.

The books aim to help students to:

- analyse the question
- select the method and tools needed to solve the question
- apply the method.

The Maths Student's Handbook is ideal for the following:

- Students who study mostly on their own and need everything in one comprehensive, hands-on guide
- Students who use another core textbook, but need more practical application and help with their technique
- Students who want a significant improvement in their results, whether from a 'fail' to a 'pass' or from 'very good' to 'excellent'
- Lecturers who want to help students take responsibility for their learning.

SUPPORTING LECTURERS
NATED 2023
CURRICULUM IMPLEMENTATION

Strength of Materials and Structures N6

This document contains important information about the revised curriculum for Strength of Materials and Structures N6 for implementation in January 2023.

Overview of main curriculum changes

- The syllabus for Strength of Materials and Structures N6 has been fully reworked and updated.
- It has been restructured and reordered and is now divided into eight weighted modules with learning content and detailed learning outcomes.
- Both the learning content and the learning outcomes have been completely reworded, and much more detail has been provided for all sections.
- All the modules relating to concrete (Module 7: Beams, slabs and columns; Module 8: Retaining walls; and Module 9: Foundations) have been removed.
- Module 10 (Estimating) has also been removed.
- Module 4 (Theory of bending) is covered in the new syllabus in Module 4 (Bending and deflection of beams) and Module 5 (Combined direct and bending stress).
- The following new content has been added:
  - Module 6: Shear stress in beams
  - Module 7: Close-coiled helical springs
  - Module 8: Transformation of stress
- The old Module 5 (The strength and the testing of ropes, chains and attachments used in lifting gear) is no longer covered explicitly.
- The aim of the new syllabus is for students to understand each basic scientific principle that it covers in a way that will allow them to integrate and use this knowledge in their applied trade theory subjects.

Structure and weighting changes

Previous syllabus (1981)

Old curriculum modules (No weighting given)
1. Pin jointed frames structures
2. Thick cylinders
3. Bending and twisting of shafts
4. Theory of bending
5. The strength and the testing of ropes, chains and attachments used in lifting gear
6. Sag and tension in wire ropes and chains supported from horizontal points
7. Beams, slabs and columns
8. Retaining walls
9. Foundations
10. Organisation, inspection and estimates of quantities on construction work

Strength of Materials and Structures N6

New syllabus (2023)

New curriculum modules	Weighting
1. Thick cylinders	12
2. Tension in cables	10
3. Combined bending and twisting of shafts	11
4. Bending and deflection of beams	12
5. Combined direct and bending stress	11
6. Shear stress in beams	11
7. Close-coiled helical springs	10
8. Transformation of stress	11
9. Forces in three-dimensional frameworks	12
Hot rolled structural steel section tables (Appendix)	
Total	**100**

Detailed curriculum changes

Previous curriculum (1981)	New curriculum (2023)
Module 2: Thick cylinders ● Stresses in thick cylinders under internal and external pressures ● Application of Lame's formulae ● Force and shrink fits	**Module 1: Thick cylinders** On completion of this module, the students should be familiar with solving problems related to single and compound cylinders. 1.1 **Single cylinders** ● Calculate longitudinal stress. ● Apply Lame's theory to calculate radial and hoop stresses for internal pressure. ● Apply Lame's theory to calculate radial and hoop stresses for external pressure. ● Apply Lame's theory to calculate radial and hoop stresses for combined internal and external pressures. ● Sketch a stress distribution graph to indicate the values of radial and hoop stresses through the cylinder wall.

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Previous curriculum (1981)	New curriculum (2023)
	• Calculate the strain at inner and outer diameters. • Calculate the change in diameter at inner and outer diameters. • Calculate the resultant thickness of the cylinder wall.
	1.2 **Compound cylinders**
	• Apply Lame's theory to calculate radial and hoop stresses if a sleeve is shrunk onto a solid shaft. • Sketch a stress distribution graph to indicate the values of radial and hoop stresses in the shaft and sleeve. • Calculate the change in diameters of the shaft and sleeve. • Calculate the shrinkage allowance between the shaft and sleeve. • Calculate the force required to push the sleeve off the shaft and the torque it can transmit without slipping. • Apply Lame's theory to calculate radial and hoop stresses if a sleeve is shrunk onto a hollow shaft. • Sketch a stress distribution graph to indicate the values of radial and hoop stresses in the shaft and sleeve. • Calculate the change in diameters of the shaft and sleeve. • Calculate the shrinkage allowance between the shaft and sleeve. • Apply Lame's theory to calculate radial and hoop stresses in compound cylinders due to shrinkage. • Sketch a stress distribution graph to indicate the values of radial and hoop stresses in both cylinders. • Calculate the change in diameters and wall thickness of the cylinders. • Calculate the shrinkage allowance between the cylinders.

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Previous curriculum (1981)	New curriculum (2023)
	• Apply Lame's theory to calculate the resultant radial and hoop stresses in compound cylinders subjected to internal pressure and shrinkage. • Sketch a stress distribution diagram of the resultant radial and hoop stresses in both cylinders. • Calculate the change in diameters and wall thickness of the cylinders. • Calculate the shrinkage allowance between the cylinders.
Module 6: Sag and tension in wire ropes and chains Sag and tension in wire ropes and chains supported from horizontal points	**Module 2: Tension in cables** On completion of this module, the student should be able to do calculations on simple catenary cable supporting its own weight, as well as parabolic cables for suspension bridges. 2.1 **Introduction to simple catenary cables** 2.1.1 Supports on same level: • Calculate minimum and maximum tension in cable. • Calculate the tension at a certain point in the cable. • Calculate position in the cable when tension is known. • Calculate the slope of the cable. • Calculate the length of the cable. • Calculate diameter of cable for a given stress limit. • Calculate the stress in each material for a compound cable. 2.1.2 Supports on different levels: • Calculate minimum tension in cable and tensions at each support. • Calculate the tension at a certain point in the cable. • Calculate position in the cable when tension is known. • Calculate the slope of the cable at both supports. • Calculate the length of the cable.

Strength of Materials and Structures N6

Previous curriculum (1981)	New curriculum (2023)
	• Calculate diameter of cable for a given stress limit. • Calculate the stress in each material for a compound cable.
	2.2 **Parabolic catenary**
	2.2.1 Supports on same level: • Calculate maximum and minimum tension in cable. • Calculate the tension at a certain point in the cable. • Calculate position in the cable when tension is known. • Calculate the slope of the cable. • Calculate the length of the cable. • Calculate diameter of cable for a given stress limit. • Calculate the tension in the anchor cables when cable is supported by frictionless pulley or frictionless rollers. • Calculate the vertical and horizontal reactions at the supports when cable is supported by frictionless pulley or frictionless rollers. • Calculate bending moment on the support.
	2.2.2 Supports on different levels: • Calculate the position of the turning point of the cable. • Calculate minimum tension in cable and tension at both supports. • Calculate the tension at a certain point in the cable. • Calculate position in the cable when tension is known. • Calculate the slope of the cable. • Calculate the length of the cable. • Calculate diameter of cable for a given stress limit. • Calculate the tension in the anchor cables when cable is supported by frictionless pulley or frictionless rollers.

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Previous curriculum (1981)	New curriculum (2023)
	• Calculate the vertical and horizontal reactions at the supports when cable is supported by frictionless pulley or frictionless rollers. • Calculate bending moment on the support.
Module 3: Combined bending and twisting shafts • Combined bending and twisting as applied to solid and hollow shafts • Diameters and power transmitted	**Module 3: Combined bending and twisting of shafts** On completion of this module, the student should be able to calculate maximum shear stress and principal stress when a shaft is subjected to both bending and twisting. 3.1 **Maximum torque** • Calculate maximum torque transmitted by a motor by using the power formulae, including the percentage increase due to the starting torque. • Calculate the maximum torque transmitted by a belt drive with belt tensions given. • Calculate maximum allowable torque that can be transmitted by the solid or hollow shaft by considering both bending and twisting. • Calculate actual shear stress in the solid or hollow shaft. • Calculate dimensions of hollow or solid shaft. • Calculate weight of the pulley that is eccentrically loaded on the shaft when it is simply supported. 3.2 **Maximum bending moment** • Calculate the maximum bending moment carried by a shaft by using the standard formulae used for cantilever and simply supported beams. Loads can include self-weight, flywheels and belt drives.

Strength of Materials and Structures N6

Previous curriculum (1981)	New curriculum (2023)
	• Calculate the maximum bending moment carried by a shaft by drawing a shear force diagram to determine the position of the maximum bending moment. 3.3 **Equivalent torque and equivalent bending moment** • Calculate equivalent torque using Guest's formula when shear stress limit is known. • Calculate equivalent bending moment using Rankine's formula when principal stress limit is known. • Calculate the dimensions of solid and hollow shafts to satisfy both stress limits. • Calculate the percentage saving in weight if a solid shaft is replaced by a hollow shaft for the same stress limits. • Calculate the maximum torque and bending moment the shaft can transmit to satisfy both stress limits. • Calculate the actual shear stress and principal stress in the shaft.
Module 4: Theory of bending • Revision of bending moment and shear force • Second moment of sections and section moduli • Properties of sections and use of standard tables of section properties. • More difficult problems on moment of inertia • Eccentric loads on short columns • Deflection of: (i) cantilevers with uniformly distributed load and a concentrated load	**Module 4: Deflection of beams** On completion of this module, the student should be able to calculate maximum deflection and slope for cantilevers and simply supported beams subjected to uniformly distributed loads as well as concentrated loads. 4.1 **Bending of beams** • Calculate the bending moment for standard cantilever and simply supported beams. • Calculate the position and value of the maximum bending moment for an eccentric lateral load on a simply supported beam.

Strength of Materials and Structures N6

Previous curriculum (1981)	New curriculum (2023)
(ii) simply supported beams with uniformly distributed load and a central concentrated load. The advantages of built in and continuous beams as compared to the simply supported beam (descriptive only.)	• Do calculations on second moment of area for standard beams and built-up beams consisting of not more than two profiles. • Understand and apply simple bending equations. • Select profiles according to the profile modulus from the steel tables if the bending stress limit is known.
	4.2 Deflection and slope • Understand and apply deflection and slope equations. • Calculate max slope and max deflection for a simply supported beam carrying a UDL over the full length. • Calculate max slope and max deflection for a simply supported beam carrying a concentrated load at mid-span. • Calculate max slope and max deflection for a simply supported beam carrying a UDL over the full length as well as a concentrated load at mid-span. • Calculate the force in a prop placed at the mid-span to prevent all or some of the deflection. • Calculate max slope and max deflection for a cantilever carrying a concentrated load at the free end. • Calculate max slope and max deflection for a cantilever carrying a concentrated load not at the free end. • Calculate max slope and max deflection for a cantilever carrying a UDL over the full length. • Calculate max slope and max deflection for a cantilever carrying a UDL from the fixed point, but not for the full length.

Strength of Materials and Structures N6

<table>
<tr><th>Previous curriculum (1981)</th><th>New curriculum (2023)</th></tr>
<tr><td></td><td>

Calculate max slope and max deflection for a cantilever carrying a UDL from the free end, but not all the way to the fixed point.
Calculate the force in a prop placed at the free end to prevent all or some of the deflection.
Select profiles according to the second moment of area from the steel tables if the deflection limit is known.

4.3 Combined bending and deflection

Select profiles from the steel tables if bending stress limit and deflection limit are both known.
Calculate the actual stress and deflection of the selected beam.
Calculate the maximum allowed length of the beam if bending stress limit and deflection limit are both known.
Calculate the maximum allowed load that the beam may carry if bending stress limit and deflection limit are both known.

</td></tr>
<tr><td>Module 4: Theory of bending

Revision of bending moment and shear force
Second moment of sections and section moduli
Properties of sections and use of standard tables of section properties
More difficult problems on moment of inertia.
Eccentric loads on short columns
Deflection of:
(i) cantilevers with uniformly distributed load and a concentrated load

</td><td>Module 5: Combined direct and bending stress
On completion of this module, the student should be able to calculate maximum, minimum and resultant stresses in different columns.
5.1 Introduction to direct and bending stresses

Calculate direct stress in a column supporting a force.
Sketch a stress distribution diagram.
Calculate maximum and minimum bending stress of beams with symmetrical and unsymmetrical profiles.
Sketch a stress distribution diagram to show position of neutral axis.

</td></tr>
</table>

Strength of Materials and Structures N6

Previous curriculum (1981)	New curriculum (2023)
(ii) simply supported beams with uniformly distributed load and a central concentrated load. The advantages of built in and continuous beams as compared to the simply supported beam (descriptive only)	5.2 **Combined direct and bending** ● Calculate the direct stress, bending stress and resultant stresses of a beam supporting a lateral load as well as a horizontal concentric load. ● Calculate the position of the neutral axis. ● Sketch a resultant stress distribution diagram to show position of neutral axis. ● Calculate the direct stress, bending stress and resultant stresses of a column supporting its own weight as well as a horizontal force due to wind. ● Calculate the position of the neutral axis. ● Sketch a resultant stress distribution diagram to show position of neutral axis. ● Calculate the direct stress, bending stress and resultant stresses of a column supporting a load that is eccentric from either the XX or YY axis. ● Calculate the position of the neutral axis. ● Sketch a resultant tress distribution diagram to show position of neutral axis. ● Calculate the direct stress, bending stress and resultant stresses of a column supporting a load that is eccentric from both the XX and YY axis. ● Calculate the position of the neutral axis. ● Sketch a resultant stress distribution diagram to show position of neutral axis. ● Calculate the eccentricity of the force if the resultant stress limit is known. ● Calculate magnitude of the force if resultant stress is known.

Strength of Materials and Structures N6

Previous curriculum (1981)	New curriculum (2023)
No corresponding module in old syllabus	**Module 6: Close-coiled helical springs (NEW)** On completion of this module, the student should be able to do calculations on single closecoiled helical springs as well as compound springs. 6.1 **Single springs** • Understand the assumptions made in the design of close-coiled helical springs. • Calculate the maximum shear stress in the spring. • Calculate the deflection of the spring. • Calculate the strain energy stored in the spring. • Calculate the stiffness of the spring. • Calculate the wire diameter. • Calculate mean coil diameter. • Calculate number of coils. • Calculate the work done on the spring. 6.2 **Compound springs** • Apply the same calculations of single springs to springs joined in series. • Apply the same calculations of single springs to springs joined in parallel.
No corresponding module in old syllabus	**Module 7: Shear stress in beams (NEW)** On completion of this module, students should be able to calculate the horizontal shear stress in a beam at different levels and draw a shear stress diagram. 7.1 **General shear stress formula** • Understand the general formula for horizontal shear stress in a beam. • Calculate the maximum shear stress in a beam with a rectangular cross-section. • Calculate the maximum shear stress in a beam with a circular cross-section.

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Previous curriculum (1981)	New curriculum (2023)
	• Calculate the shear force per unit length of a beam. • Calculate the pitch of bolts required to fasten different layers of a beam. 7.2 **Shear stress diagram** • Calculate the shear stress in rectangular beams at various distances from the centroid. • Sketch the distribution of the shear stress across the beam section and show values at key points. • Calculate the shear stress in Isection beams at various distances from the centroid. • Sketch the distribution of the shear stress across the beam section and show values at key points. • Calculate the percentage of shear force carried by the web.
No corresponding module in old syllabus	**Module 8: Transformation of stress (NEW)** On completion of this module, the student should be able to calculate stresses at any oblique plain in a material. The module is limited to plane stress conditions only. 8.1 **Introduction to plane stresses** • Sketch an element to indicate the normal and shear stresses acting on a point in the material. • Calculate the resultant stress at any oblique plane if the normal and shear stresses are known. • Calculate the angle where the normal stresses will be maximum and minimum (principal stresses). • Calculate the values of the principal stresses. • Calculate the value of the maximum shear stress.

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Previous curriculum (1981)	New curriculum (2023)
	8.2 **Mohr's circle for plane stresses** • Sketch Mohr's circle to scale from given element with normal and shear stresses. • Determine the resultant stress at any oblique plane using Mohr's circle. • Determine the principal stresses and the angle where that will be using Mohr's circle. • Determine the value of the maximum shear stress using Mohr's circle.
Module 1: Pin jointed frame structures • Loads in various members of pin jointed and simple framed structures such as shear legs, jibs and travelling cranes	**Module 9: Forces in structural frameworks** 9.1 **Introduction to sheerlegs and tripods** • Draw top and side view of a sheerleg or tripod according to appropriate scale. • Draw separate vector diagrams to graphically determine the forces in all members when a load is lifted by the sheerleg or tripod. • Set up a table to indicate the magnitude of all members and if a member is a strut or tie. 9.2 **Derrick crane** • Use a suitable scale to draw the top view and side view of the crane. • Draw separate vector diagrams to graphically determine the forces in all members when a load is lifted by the crane. • Set up a table to indicate the magnitude of all members (including the reactions) and if a member is a strut or tie.
	Appendix: Hot rolled structural steel section tables (NEW)

Strength of Materials and Structures N6

Previous curriculum (1981)	New curriculum (2023)
Module 5 (Not in new syllabus) ● The strength and the testing of ropes, chains and attachments used in lifting gear	
Module 7: Concrete beams and columns (Not in new syllabus) ● The mixing and placing of both mass and reinforced concrete ● The general design features of rectangular and T beams, slabs and columns and the purpose of reinforcement ● Details of construction and use of timber and steel for forms and shuttering ● Theoretical treatment of reinforced concrete beams of rectangular section with tension reinforcement, reinforced concrete slabs treated as beams	
Module 8: Retaining walls (Not in new syllabus) ● The details and construction of brick, concrete and masonry structures, including storage bins and their supports and retaining walls subjected to earth or water pressure	
Module 9: Foundations (Not in new syllabus) ● The types of foundations and their application and construction in various types of ground ● A knowledge of bearing pressures and methods of testing ground. Foundations should include grillage foundations, illustrations, descriptions and calculations. Only a basic knowledge of soil mechanics and testing is required.	

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Previous curriculum (1981)	New curriculum (2023)
Module 10: Estimating (Not in new syllabus) • Organisation, inspection and estimates of quantities on construction work. Costing, estimating and quantity surveying should be done at a basic level, as applicable to sections 7, 8 and 9 above.	

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P du Toit

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Implementation dates 2023

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