REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

EDUCATION POLICY

SYLLABUS

FOR

ENGINEERING SCIENCE N4

CODE NUMBER

15070434

DATE OF IMPLEMENTATION

August 1996

DATE OF FIRST EXAMINATION

November 1996

Eksamination Instruction no. 29/96

1. AIMS FOR ENGINEERING SCIENCE N4

1.1 GENERAL AIMS

During the presentation of the modules of Engineering Science N4, care should be taken that the students understand each basic scientific principle in such a way that they will be able to incorporate this knowledge in their applied subjects.

1.2 SPECIFIC AIMS

On completion of all the modules of Engineering Science N4, the student should

* be able to apply the scientific principles mastered by him to his specific trade theory;
* be able to use the correct science terminology;
* be able to apply SI units and derived units correctly;
* be able to use acknowledged symbols, formulae and abbreviations correctly and to recognise appropriate formulae;
* be able to give and apply definitions correctly;
* have mastered the basic scientific principles in such a way that he will be able to apply them in the working situation as well as in everyday life; and
* be able to function effectively in his working environment and to make sense of the extended technology in which he is involved.

2. DURATION OF INSTRUCTIONAL OFFERING

Full-time: one trimester
Part-time: one trimester

3. EVALUATION

Candidates must be evaluated continually by conducting class tests on completion of each module.

4. EXAMINING

4.1 Reproduction, application, analysis and evaluation are important aspects in determining the degree of difficulty of this subject. The division of these aspects should be as follows:

REPRODUCTION	APPLICATION	ANALYSIS	EVALUATION
15	35	25	25

4.2 One three-hour question paper will be set at the end of each trimester. The pass mark is 40%.

4.3 Only content specified as **LEARNING OUTCOME** will be examined.

5. GENERAL INFORMATION

* In order to bring the student into contact with the practical work situation, all calculations dealt with during the instructional offering should be based on problems encountered in the engineering industry in general.

* The correct use of technical language and terminology should be stressed, especially in formulating definitions and concepts.

* Answers to calculations must at all times be given correct to three decimal numbers.

* Before a calculation is attempted, the standard formula should first be written down. Depending on the question, the formula can then be manipulated or the given values substituted. $g = 9,8\ m/s^2$ should be taken as the value for gravitational acceleration in all applicable calculations.

* Neat, labelled line sketches must be drawn of specified apparatus.

* Test and examination questions should be answered comprehensively. Answers consisting of a single word should be discouraged, except when such an answer is specified in the question.

* Didactic guidelines must be regarded as hints which can contribute to the success of the presentation.

* The weighted value (WV) indicates the time which should be spent to conclude a module as well as the approximate weight the module should carry in the examination.

* Exposition of subject matter

  The subject is preceded by the word **MODULE**, followed by a number indicating the chronological position of the subject. Decimal numbers indicate the **CONTENT** to be dealt with, and extended decimal numbers identify the expected **LEARNING OUTCOME**.

6. SUBJECT MATTER

MODULE		WEIGHT VALUE
1.	Kinematics	15
2.	Angular motion	9
3.	Dynamics	12
4.	Statics	15

5.	Hydraulics	20
6.	Stress, strain and Young's modulus	14
7.	Heat	15
	TOTAL:	(100)

7. DETAILED SYLLABUS

MODULE 1: KINEMATICS

1.1 RELATIVE VELOCITY

On completion of this topic the student should be able to:

1.1.1 Solve analytical problems relating to practical situations where two objects move horizontally at constant velocity in different directions. Determine the resultant velocity, shortest distance, time, intersection, overtaking and actual velocity.

1.2 RESULTANT VELOCITY

On completion of this topic the student should be able to:

1.2.1 Solve problems dealing with linear motion analytically where external factors such as wind and water are concerned.

DIDACTIC GUIDELINE

The number of simultaneous motions which are involved during the discussion of the topic is not limited, but a maximum of two simultaneous motions will be examined.

1.3 PROJECTILES

On completion of this topic the student should be able to:

1.3.1 Solve problems that deal with projectiles which are launched vertically or at an angle other than 90° to the horizontal analytically. The landing point must be in the same horizontal plane as the launching point.

DIDACTIC GUIDELINE

Calculations of horizontal and vertical displacements must be done. A sound knowledge of resolution into components and the parabola, with emphasis on the sketch of the projectile trajectory as a parabola, is of cardinal importance.

MODULE 2: ANGULAR MOTION

On completion of this topic the student should be able to:

2.1 Calculate angular displacement, velocity and acceleration.
2.2 Give the relationship between linear and angular motion and apply this relationship to calculations which deal with displacement, velocity and acceleration.
2.3 Calculate the torque required for acceleration or for braking. Resistance to motion and friction can be included.
2.4 Calculate the work done and the power required as in 2.3 and also calculate the efficiency of transmission if input power is given.

DIDACTIC GUIDELINE

It must be stressed that only the absolute angular measurement is valid in all of the above calculations.

MODULE 3: DYNAMICS

3.1 NEWTON'S THREE LAWS OF MOTION

On completion of this topic the student should be able to:

3.1.1 State Newton's three laws of motion

3.1.2 Calculate the total force required for motion on horizontal and inclined planes with regard to practical problems and including gravitational force, frictional force and inertia

3.1.3 Calculate the total work done over a given distance or during a given time and calculate the power at a given instant or at a given velocity.

DIDACTIC GUIDELINE

The discussion is limited to the total force required parallel to the motion only.

3.2 KINETIC AND POTENTIAL ENERGY

On completion of this topic the student should be able to:

3.2.1 Define the concepts *kinetic* and *potential energy* and state the law of conservation of energy

3.2.2 Apply the law of conservation of energy to a free-falling body and to motion on an inclined plane where no external force is applied.

MODULE 4: STATICS

4.1 BEAMS

On completion of this topic the student should be able to:

4.1.1 Calculate the reactions at the supports of beams subjected to vertical point loads and evenly distributed loads. The mass of the beam is also considered as an evenly distributed load

4.1.2 Draw shear force and bending moment diagrams for simply supported beams subjected to point loads and evenly distributed loads

4.1.3 Determine the positions of the maximum bending moments and their magnitudes.

DIDACTIC GUIDELINE

Problems are limited to a maximum of three loads excluding the mass of the beam.

4.2 CENTROIDS AND CENTRES OF GRAVITY

On completion of this topic the student should be able to:

4.2.1 Determine the centroids of laminae and centres of gravity of solid objects by choosing the turning point or moment axis himself.

DIDACTIC GUIDELINE

Calculations are limited to combinations of squares, discs, triangles and rectangles in the case of centroids and to cylinders, cones, spheres and semi-spheres in the case of centres of gravity.

MODULE 5: HYDRAULICS

5.2 HYDRAULIC PRESSES

On completion of this topic the student should be able to:

5.2.1 Analytically solve practical problems which deal with the determination of

(a) the volume of liquid required per stroke by the press (slip to be taken into account);

(b) the diameter of the ram of the press or force exerted by the ram;

(c) the pressure in the liquid to overcome a given load; and

(d) the work done by the press (efficiency to be taken into account).

5.2 HYDRAULIC PUMPS

On completion of this topic the student should be able to:

5.2.1 Analytically solve problems which have bearing on the determination of

(a) the volume of liquid delivered per stroke or in a certain time (slip to be taken into account);

(b) the pressure in the liquid, plunger diameter and force on the plunger;

(c) the rotational frequency of a pump to deliver a given volume of water; and

(d) the power required and efficiency with input power given in the case of single-, double- and three-cylinder single acting pumps.

5.3 HYDRAULIC ACCUMULATOR

On completion of this topic the student should be able to:

5.3.1 Analytically solve practical problems on the determination of

(a) the volume of liquid delivered by the accumulator per

working stroke of the machine it serves or the volume delivered in a given time;

(b) the diameter of the ram and the load required on the accumulator to keep the pressure required constant during the working stroke;

(c) the distance travelled by the accumulator ram during the working stroke;

(d) the transfer of pressure in the liquid between the accumulator and the machine; and

(e) the work done and the power with efficiency and slip taken into account.

5.3.2 Draw sketches which illustrate the working of an accumulator.

DIDACTIC GUIDELINE

The liquid is regarded as static when the pressure is calculated, i.e. no efficiency factor is taken into account. In calculations on volume however the slip is taken into account and efficiency is taken into account in calculations on work done and power.

MODULE 6: STRESS, STRAIN AND YOUNG'S MODULUS

On completion of this topic the student should be able to:

6.1 Do calculations on tensile and compressive stress, including the determination of

(a) cross-sectional areas; and

(b) load or dimensions of a member to satisfy the given conditions.

6.2 Do calculations on shear stress including the determination of

(a) cross-sectional areas; and

(b) load or dimensions of a member to satisfy the given conditions, where double shear must also be taken into account.

6.3 State Hooke's law and define Young's modules of elasticity

6.4 Do calculations and change the subject to any unknown using the following formulae:

$f = F/a$, $v = l/L$ and $E = f/v$. Problems involving combinations of these are included.

6.5 Draw stress-strain graphs (limited to the elastic limit) with clear reference to the direct proportionality between stress and strain.

MODULE 7: HEAT

7.1 EXPANSION

On completion of this topic the student should be able to:

7.1.1 Change from the Celsius to the Kelvin temperature scale and vice versa

7.1.2 Analytically solve practical problems on the expansion of solids owing to temperature changes (area and volume expansion).

7.1.3 Analytically solve practical problems on volumetric expansion of liquids as a result of a rise in temperature. (The student must also be aware of the anomaly in the expansion of water.)

7.2 THE LAWS OF BOYLE AND CHARLES

On completion of this topic the student should be able to:

7.2.1 Reproduce the laws of Boyle and Charles in the form of specified mathematical equations.

7.2.2 Do calculations which entail applications of the laws of Boyle and Charles and the combination of the two laws.

7.3 THE CHARACTERISTIC GAS EQUATION

On completion of this topic the student should be able to:

7.3.1 Do calculations with regard to applications of the characteristic gas equation.

DIDACTIC GUIDELINE

In all the calculations concerning the gas laws the use of absolute temperature must be emphasised.

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REPUBLIEK VAN SUID-AFRIKA

DEPARTEMENT VAN ONDERWYS

ONDERWYSBELEID

SILLABUS VIR

INGENIEURSWETENSKAP N4

KODENOMMER

15070434

DATUM VAN IMPLEMENTERING

Augustus 1996

EERSTE DATUM VAN EKSAMINERING

November 1996

Eksamen Instruksie nr..29/96

1. DOELSTELLINGS VIR INGENIEURSWETENSKAP N4

1.1 ALGEMENE DOELSTELLINGS

Die student moet tydens die aanbieding van die modules van Ingenieurswetenskap N4 elke basiese wetenskaplike beginsel sodanig begryp dat hy die nodige aansluiting kan vind by die toegepaste vakke wat hy bestudeer.

1.2 BESONDERE DOELSTELLINGS

Na afhandeling van al die modules van Ingenieurswetenskap N4, behoort die student

* in staat te wees om die wetenskaplike beginsels wat hy bemeester het, in sy besondere vakteorie toe te pas;
* in staat te wees om die korrekte wetenskaplike terminologie te kan gebruik;
* in staat te wees om SI-eenhede en afgeleide eenhede korrek te gebruik;
* in staat te wees om erkende simbole, formules en afkortings korrek te gebruik en formules te herken;
* in staat te wees om definisies korrek weer te gee en toe te pas;
* die basiese wetenskaplike beginsels sodanig te bemeester het dat hy dit in die werksituasie en alledaagse leefwêreld sal toepas; en
* in staat te wees om effektief in sy werksomgewing te kan funksioneer en die breë tegnologie waarby hy betrokke is, te begryp.

2. TYDSDUUR VAN ONDERRIGAANBIEDING

Voltyds: een trimester
Deeltyds: een trimester

3. EVALUERING

Kandidate word deurlopend geëvalueer deur die skryf van klastoetse na afhandeling van elke module.

4. EKSAMINERING

4.1 Reprodusering, toepassing, analise en evaluering is belangrike aspekte by die bepaling van die moeilikheidsvlakke in hierdie vak en die indeling daarvan behoort soos volg te wees:

REPRODUSERING	TOEPASSING	ANALISE	EVALUERING
15	35	25	25

4.2 Een 3-uurvraestel uit 'n totaal van 100 punte word aan die einde van elke trimester geskryf.

4.3 Slegs inhoud wat as 'n LEERUITKOMS gespesifiseer is, sal geëksamineer word.

5. ALGEMENE INLIGTING

* Om die student sover moontlik met die praktyk in aanraking te bring, behoort alle berekeninge wat gemaak word, op probleme wat in die praktyk ondervind word, gegrond te wees.

* Klem moet, veral in die formulering van definisies en beginsels, op die korrekte gebruik van vaktaal en tegniese terminologie gelê word.

* Antwoorde van alle berekeninge moet noukeurig tot drie desimale gegee word.

* In alle berekenings moet die standaardformules eers neergeskryf word voordat daar met die berekeninge begin word. Daarna moet die waardes in die formules vervang of die formule gemanipuleer word, na gelang van die betrokke vraag. $g = 9,8\ m/s^2$ moet in alle toepaslike berekeninge as waarde vir die gravitasieversnelling geneem word.

* Netjiese, benoemde lynsketse, volgens 'n redelike skaal, moet van gespesifiseerde apparatuur gemaak word.

* Vrae moet volledig beantwoord word. Daar moet gewaak word teen eenwoordantwoorde, tnesy die vraag so 'n antwoord spesifiseer.

* Didaktiese riglyne moet beskou word as wenke wat 'n bydrae kan lewer tot die sukses van die aanbieding.

* Die gewigswaarde (GW) gee 'n aanduiding van die tyd wat aan 'n bepaalde module bestee moet word, asook van die relatiewe gewig wat die module in die eksamen behoort te dra.

* Uiteensetting van leerinhoud

  Die onderwerp word voorafgegaan deur die woord **MODULE**, gevolg deur 'n nommer wat die chronologiese posisie van die module aandui. 'n Desimale getal dui vervolgens aan watter **INHOUD** behandel gaan word, waarna uitgebreide desimale getalle gebruik word om die **LEERUITKOMSTE** te identifiseer.

6. LEERINHOUD

MODULE		GEWIGSWAARDE
1.	Kinematika	15
2.	Hoekbeweging	10
3.	Dinamika	12
4.	Statika	12
5.	Hidroulika	20

6.	Spanning, vormverandering en Young se modulus	15
7.	Warmte	16
	TOTAAL:	(100)

7. GEDETAILLEERDE SILLABUS

MODULE 1: KINEMATIKA

1.1 RELATIEWE SNELHEID

Nadat die onderwerp afgehandel is, behoort die student:

1.1.1 Analitiese probleme te kan oplos wat betrekking het op praktiese situasies waar twee voorwerpe in verskillende rigtings horisontaal teen 'n konstante snelheid beweeg. Resulterende snelheid, kortste afstand, tyd, kruising, inhaal en werklike snelheid moet bepaal kan word.

1.2 RESULTERENDE SNELHEID

Nadat die onderwerp afgehandel is, behoort die student:

1.2.1 Probleme analities te kan oplos waar eksterne faktore soos wind en water op lineêre beweging ter sprake is.

DIDAKTIESE RIGLYN

Die aantal gelyktydige bewegings wat tydens die bespreking van die onderwerp behandel word, word nie beperk nie, maar hoogstens twee gelyktydige bewegings sal geëksamineer word.

1.3 PROJEKTIELE

Nadat die onderwerp afgehandel is, behoort die student:

1.3.1 Analitiese probleme te kan oplos wat betrekking het op projektiele wat vertikaal of teen 'n hoek met die horisontaal gelanseer word. Die lanseer- en landingspunt moet op dieselfde horisontale vlak wees.

DIDAKTIESE RIGLYN

Berekeninge ten opsigte van horisontale en vertikale verplasings moet gemaak kan word. Grondige kennis van ontbinding in komponente, die parabool, met nadruk op die skets van die projektielbaan as parabool, is van kardinale belang.

MODULE 2: HOEKBEWEGING

Nadat die onderwerp afgehandel is, behoort die student:

2.1 Hoekverplasing, hoeksnelheid en hoekversnelling te kan bereken

2.2 Die verwantskap tussen lineêre en hoekbeweging te kan weergee en gebruik in berekeninge wat betref verplasing, snelheid en versnelling.

2.3 Die draaimoment benodig vir versnelling of die draaimoment veroorsaak deur 'n remkrag te kan bereken. Weerstand teen beweging of wrywing kan ingesluit word

2.4 Die arbeid en drywing benodig soos in 2.3 te kan bereken asook die rendement van aandrywingsmeganismes te kan bereken as insetdrywing gegee word.

DIDAKTIESE RIGLYN

Dit moet beklemtoon word dat slegs die absolute eenheid van hoekmeting in enige van bostaande berekeninge gebruik mag word.

MODULE 3: DINAMIKA

3.1 NEWTON SE DRIE BEWEGINGSWETTE

Nadat die onderwerp afgehandel is, behoort die student:

3.1.1 Die drie bewegingswette van Newton te kan weergee

3.1.2 Die totale krag (gravitasiekrag, wrywingskrag en traagheid inbegrepe) benodig vir beweging op horisontale en skuinsvlakke te kan bereken met betrekking tot praktiese probleme.

3.1.3 Die totale arbeid verrig in 'n gegewe afstand of tydsduur en drywing op 'n gegewe tydstip of teen 'n gegewe snelheid, te kan bereken.

DIDAKTIESE RIGLYN

Die bespreking word beperk tot die totale krag benodig vir beweging slegs ewewydig aan die bewegingsrigting.

3.2 KINETIESE EN POTENSIëLE ENERGIE

Nadat die onderwerp afgehandel is, behoort die student:

3.2.1 Die begrippe *potensiële* en *kinetiese energie te kan definieer en die wet van behoud van energie te kan* weergee

3.2.2 Die wet van behoud van energie op 'n vryvallende liggaam en op beweging teen 'n skuinsvlak sonder 'n eksterne toegepaste krag te kan toepas.

MODULE 4: STATIKA

4.1 BALKE

Nadat die onderwerp afgehandel is, behoort die student:

4.1.1 Die reaksies by die steunpunte van balke wat aan vertikale puntbelastings en eenvormig verspreide belastings onderworpe is, te kan bereken. Die massa van die balk word ook as verspreide belasting beskou.

4.1.2 Skuifkrag- en buigmomentdiagramme te kan teken van eenvoudig ondersteunde balke wat aan punt- en eenvormig verspreide belastings onderworpe is.

4.1.3 Die posisie en grootte van maksimum buigmomente op die balk te kan bepaal.

DIDAKTIESE RIGLYN

Probleme word beperk tot hoogstens drie belastings, uitgesonderd die massa van die balk.

4.2 SENTROÏDES EN SWAARTEPUNTE

Nadat die onderwerp afgehandel is, behoort die student:

4.2.1 Die sentroïdes van laminas en die swaartepunte van soliede voorwerpe te kan bereken deur self die draaipunt of momentlyn te kies.

DIDAKTIESE RIGLYN

Berekeninge word beperk tot samestellings van vierkante, skywe, driehoeke en reghoeke in die geval van sentroïdes en tot silinders, kegels, sfere en halfsfere in die geval van swaartepunte.

MODULE 5: HIDROULIKA

5.1 HIDROULIESE PERSE

Nadat die onderwerp afgehandel is, behoort die student:

5.1.1 Praktiese probleme analities te kan oplos wat betrekking het op die bepaling van die

(a) volume water per werkslag benodig deur die pers (glip moet in aanmerking geneem word);

(b) diameter van die persram of krag deur ram uitgeoefen;

(c) druk in 'n vloeistof om 'n gegewe belasting te oorkom; en

(d) arbeid verrig deur die pers (rendement moet in aanmerking geneem word).

5.2 HIDROULIESE POMPE

Nadat die onderwerp afgehandel is, behoort die student:

5.2.1 Praktiese probleme analities te kan oplos wat betrekking het op die bepaling van die

(a) volume vloeistof gelewer per slag of in 'n sekere tydsduur (glip moet in aanmerking geneem word);

(b) druk in vloeistof, suierdiameter en krag in suierstang;

(c) rotasiefrekwensie van 'n pomp om 'n totale volume water wat benodig word, te lewer; en

(d) drywing benodig en rendement van aandrywing met insetdrywing gegee

in die geval van een-, twee- of drieslag enkelwerkende pompe.

5.3 HIDROULIESE AKKUMULATOR

Nadat die onderwerp afgehandel is, behoort die student:

5.3.1 Praktiese probleme analities te kan oplos wat betrekking het op die bepaling van die

(a) volume water deur akkumulator gelewer per werkslag van die masjien wat bedien word of in 'n gegewe tydsduur;

(b) diameter van die ram en die belasting benodig op die akkumulator om die druk benodig deur die masjien konstant te hou gedurende die werkslag;

(c) daling of styging van die akkumulator gedurende die werkslag van die masjien;

(d) oordrag van druk in 'n vloeistof tussen die hidrouliese akkumulator en die masjien; en

(e) arbeid verrig, met glip en rendement in berekening gebring.

5.3.2 Sketse wat die werking van 'n akkumulator illustreer, te kan maak.

DIDAKTIESE RIGLYN

Die vloeistof word as staties beskou wanneer die druk bereken word, dit wil sê geen rendementfaktor word in berekening gebring nie. By berekeninge oor volume word glip egter in berekening gebring en by arbeid en drywing word die rendement in berekening gebring.

MODULE 6: SPANNING, VORMVERANDERING EN YOUNG SE MODULUS

Nadat die onderwerp afgehandel is, behoort die student:

6.1 Berekeninge te kan doen oor druk- en trekspanning, wat insluit die bepaling van
(a) deursnee-areas
(b) belasting of afmetings van 'n onderdeel om aan gegewe vereistes te voldoen.

6.2 Berekeninge te kan doen oor afskuifspanning, wat insluit die bepaling van
(a) deursnee-areas
(b) belasting of afmetings van 'n onderdeel om aan gegewe vereistes te voldoen,
waarby dubbelafskuiwing ook in aanmerking geneem moet word.

6.3 Hooke se wet te kan weergee en Young se elastisiteits-modulus te kan definieer.

6.4 Berekeninge te kan doen deur toepassing en manipulasie na enige onbekende van die volgende formules: $f = F/a$; $v = l/L$ en $E = f/v$. Probleme wat kombinasies van hierdie formules bevat, word hierby ingesluit.

6.5 Spanning- en vormveranderinggrafieke te kan teken (beperk tot by die elastisiteitsgrens) met duidelike verwysing na die eweredigheid tussen spanning en vormverandering.

MODULE 7: WARMTE

7.1 DIE EFFEK VAN WARMTE

Nadat die onderwerp afgehandel is, behoort die student:

7.1.1 Omskakeling tussen Celsius- en Kelvintemperatuurskale te kan doen.

7.1.2 Analities praktiese probleme te kan oplos oor die uitsetting as gevolg van temperatuurstyging van vaste stowwe (oppervlakte- en volume-uitsetting).

7.1.3 Analitiese probleme te kan oplos in verband met die volume-uitsetting van vloeistowwe as gevolg van temperatuurstyging (die student moet ook kennis dra van die anomalie van die uitsetting van water).

7.2 BOYLE EN CHARLES SE WETTE

Nadat die onderwerp afgehandel is, behoort die student:

7.2.1 Die wette van Boyle en Charles te kan weergee in die vorm van 'n gespesifiseerde wiskundige vergelyking

7.2.2 Berekeninge te kan doen wat die toepassing van Boyle en Charles se wette behels, asook die kombinasie van die twee wette.

7.3 DIE KARAKTERISTIEKE GASVERGELYKING

Nadat die onderwerp afgehandel is, behoort die student:

7.3.1 Berekeninge te kan doen oor die toepassing van die karakteristieke gasvergelyking.

DIDAKTIESE RIGLYN

In al die berekeninge ten opsigte van die gaswette moet die gebruik van die absolute temperatuur beklemtoon word.