POWER MACHINES N 512

(One 3-hour paper)

(With effect from September 1986)

1. Heating and expansion of gases: Units of heat; the two specific heats; the laws of perfect gases; the two laws of thermodynamics; heating of gases; work done by a gas in expanding; the general law $PV^n=C$. Isothermal and adiabatic operations. Simple energy equation.
Thermodynamics: Thermodynamics of gases and vapours; isothermal, polytropic and adiabatic expansion and compression; relation between pressure, volume and temperature of a gas expanding according to the law $PV^n = C$; entropy, general expression for the change of entropy of a perfect gas when passing from the state $P_1V_1T_1$ to $P_2V_2T_2$; temperature-entropy diagrams.

2. Steam generation: Short description of main types of boilers and their applications; methods of firing (oil firing, solid coal firing, pulverised coal firing). Calculation of enthalpy, volume and internal energy of wet, dry and superheated steam; use of steam tables; throttling of steam; measurement of dryness fraction by calorimeter. Equivalent evaporation from and at 100°C. Use of enthalpy-entropy diagram.

3. Condensers: Construction of jet and surface condensers. Dalton's law of partial pressures. Calculation of condensing water required. Calcuations for cooling surface required: logarithmic mean temperature difference.

4. Condenser pumps: Air pumps and air ejectors; extraction pumps; air-steam ratio entering air pump; condenser and vacuum efficiency; effect of air leakage.

5. Combustion:

5.1 Composition of solid, liquid and gaseous fuels.

5.2 Calorific values by chemical analysis and experiment.

5.3 Higher and lower calorific value.

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5.4 Minimum air required for complete combustion using basic chemistry and formula.

5.5 Calculation of products of combustion for minimum air and for a given percentage of excess air.

5.6 Gravimetric and volumetric analysis of flue gases by calculation.

5.7 Bomb calorimeter.

5.8 Orsat exhaust gas analysis apparatus.

6. Reciprocating air compressors - single stage only with and without clearance; volumetric effeciency.

7. Governors: Watt, Porter and Hartnell types; simple calculations taking effect of friction into account.

8. The gas turbine - principle of operation; simple calculations and velocity diagrams. Single stage only.

9. Relevant Factories regulations in respect of boilers and pressure vessels.

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POWER MACHINES N622

(One 3-hour paper)
(With effect from September 1986)

1. THERMODYNAMICS

General thermodynamics of gases and vapours. Internal and external energy, total heat and entropy. Energy charts for gases and vapours including pressure - volume, pressure-total heat, temperature - entropy and total heat - entropy charts. Enthalpy and change in enthalpy. Steady flow equation. Reversible and irreversible processes; throttling; isothermal, adiabatic and polytropic operations and their representation on the energy diagrm. The Carnot cycle and the Rankine cycle.

2. STEAM GENERATION

Roller efficiency and equivalent evaporation. Improvement of efficiency by use of economisers, superheaters and air preheaters. Heat balance sheets for boilers.

3. NOZZLES

Theory as applied to steam or gas flow, critical throat pressure; calculation of throat and discharge areas for a given flow rating; effect of reheat. Nozzle efficiency. Convergent and convergent-divergent nozzles.

Diagram of change of pressure and velocity passing through the nozzle.

4. STEAM AND GAS TURBINES

Principles of action of impulse and reaction turbines; general features of construction; velocity and pressure compounding - De Laval, Curtis, Ratteau and reaction turbines. Velocity diagrams for impulse and re-action blading, word done per kilogram of steam: diagram efficiency

The gas turbine - principle of operation: simple calculations (two stage only.) Power developed, diagram efficiency. Axial thrust of turbine.

5 INTERNAL COMBUSTION ENGINES

Air standard efficiency of Joule, Diesel and dual cycles. Relative efficiencies of these cycles. Ideal constant volume Otto cycle and practical constant volume cycle; indicated power; brake power; mechanical efficiency; indicated and brake thermal efficiencies. Heat balance sheet for I.C. Engines.

6. AIR COMPRESSORS

Two stage compression; intercooling; volumetric efficiency. Calculations of work done in multi-stage compressors; adiabatic and isothermal efficiency; power calculations. Ratio of compression for maximum efficiency.

7. REFRIGERATION

7.1 The vapour compression cycle.
7.2 Representaiton on T-S and P-H charts
7.3 Co-efficient of performance
7.4 Refrigerating effect and work done
7.5 Ideal and practical vapour compression cycle.

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KRAGMASJIENE N5(1

(EEN DRIE-UUR VRAESTEL)

1. Verhitting en uitsetting van gasse: Eenhede van warmte: Die twee spesifieke warmtes: Die wette van volmaakte gasse: Die twee wette van termodinamika: Verhitting van gasse: Arbeid verrig deur 'n gas wat uitsit: Die algemene wet $pv^n = c$: Isotermiese en adiabatiese bewerkings: Eenvoudige energie vergelykings.

   Termodinamika: Die termodinamika van gasse en dampe: Die termiese, politropiese en adiabatiese uitsetting en samedrukking: Relasie tussen druk, volume en temperatuur van 'n gas wat uitsit volgens die wet $pv^n = c$: Entropie, die algemene uitdrukking vir die verandering van entropie vir 'n perfekte gas wanneer dit vanaf $P_1 V_1 T_1$ na $P_2 V_2 T_2$ verander: Temperatuur-entropie diagramme.

2. Stoomopwekking: Kort beskrywing van vernaamste soorte stoomketels en hul toepassings: Stookmetodes (oliestokery, soliede steenkool-stokery, verpoeierde steenkool-stokery). Berekeninge van entalpie, volume en interne energie van nat, droog en oorverhitte stoom: Gebruik van stoomtafels; Smoor van stoom: Meting van droogheids-graad deur middel van 'n kaloriemeter: Ekwivalente verdamping vanaf en by 100°C: Gebruik van die entalpie-entropie diagram.

3. Kondensators: Konstruksie van straal- en oppervlaktekondensators: Dalton se wet van gedeeltelike druk: Berekeninge van kondenseerwater benodig: Berekening vir afkoel oppervlakte benodig: Logaritmiese gemiddelde temperatuur verskil.

4. Kondensator pompe: Lugpompe en lugverdrywers: Ekstraksiepompe: Lug-stoom verhouding wat lugpompe binnegaan: Kondensator en vakuum nuttigheidsgraad: Uitwerking van lug-lekkasies.

   Verbranding:
   (i) Samestelling van soliede-, vloeibare en gastipes brand-stowwe.
   (ii) Kaloriese waardes by chemiese analise en eksperimente.
   (iii) Hoër en laer kaloriese waarde.
   (iv) Minimum lug vir algehele verbranding benodig deur gebruik te maak van basiese chemie en formules.
   (v) Berekening van produkte van verbranding vir minimum lug en vir 'n gegewe persentasie van oortollige lug.
   (vi) Gravimetriese- en volumetriese analise van rookgasse deur berekeninge.
   (vii) Bomkalorimeter.
   (viii) Orsat uitlaat gas-analise apparaat.

6. Wederkerige lugkompressor - eentrapkompressor alleenlik met en sonder vry volumetriese rendement.

7. KOELING

KRAGWERKSJIENE N621

(EEN DRIE-UUR VRAESTEL)

1. TERMODINAMIKA

Algemene termodinamika van gasse en dampe. Interne en eksterne energie, Totale warmte en entropie. Energie kaarte vir gasse en dampe insluitend druk-volume, druk-totale warmte, temperatuur-entropie en totale warmte-entropie. Entalpie en verandering in entalpie. Gelykmatige (konstant) stroming vergelyking. Omkeerbaar en nie-omkeerbaar prosesse; Wurg (van stoom); Isotermies, adiabaties en politropiese operasies en hulle voorstelling op 'n energie diagram. Die Carnot-kringloop en die Ranicine-kringloop.

2. STOOM-OPWEKKING

Ketel rendement en ekwivalente verdamping. Verbetering van rendement in die gebruik van hitteverhalers, oorverhitters en lugvoorverhitters. Hittebalans tabel vir ketels.

3. SPUITSTUKKE

Teorie soos van toepassing op stoom en gas vloei, kritiese keeldruk; Berekening van keel en uitlaatareas vir 'n gegewe vloeitempo; Die effek van herverhitting; Spuitstuk rendement. Konvergent en konvergent-divergent spuitstukke.
Diagram van verandering van druk en snelheid deur 'n spuitstuk.

4. STOOM- EN GAS TURBINES

Beginsels van aksie van impuls en reaksie turbines;
Algemene kenmerke van konstruksie; Snelheid en druk kompensering - De Laval, Curtis, Ratteau en Reaksie turbines. Snelheidsdiagramme vir impuls en reaksie wieke, werkverrig per kilogram van stoom; Diagram rendement.
Die Gasturbine - beginsels van werking: Eenvoudige berekeninge - twee trappe alleenlik: Drywing ontwikkeling, diagram rendement.
Aksiale druk van 'n turbine.

5. BINNEBRANDENJIN

Ideale rendement van Joule, diesel en dubbel kringloop.
Relatiewe rendement van hierdie kringlope. Ideale konstante volume - Otto-kringloop en praktiese konstante volume kringloop.
Indikteurvermoë: Remvermoë; meganiese rendement; Indikteurs en rem termiese rendement; Hittebalans tabel vir binnebrandenjins.

6. LUGKOMPRESSORS

Tweetrapkompressor; Tussenkoeling: Volumetriese rendement; Berekening van werkverrig in meertrappige kompressors; Adiabatiese en isotermiese rendement; Drywing berekeninge; Verhouding van kompressie vir maksimum rendement.

7. Reelaars: Watt, Porter en Hartneu tipes: Eenvoudige berekeninge wat die effek van wrywing in ag neem.

8. Gasturbine: Beginsels van werking: Eenvoudige diagramme asook snelheidsdiagramme: Eentrap alleenlik.

9. Toepaslike fabriek regulasies in verband met ketels en drukhouers.

POWER MACHINES N 5 :

(One 3-hour paper)

(With effect from September 1986)

1. Heating and expansion of gases: Units of heat; the two specific heats; the laws of perfect gases; the two laws of thermodynamics; heating of gases; work done by a gas in expanding; the general law $PV^n=C$. Isothermal and adiabatic operations. Simple energy equation.
Thermodynamics: Thermodynamics of gases and vapours; isothermal, polytropic and adiabatic expansion and compression; relation between pressure, volume and temperature of a gas expanding according to the law $PV^n = C$; entropy, general expression for the change of entropy of a perfect gas when passing from the state $P_1V_1T_1$ to $P_2V_2T_2$; temperature-entropy diagrams.

2. Steam generation: Short description of main types of boilers and their applications; methods of firing (oil firing, solid coal firing, pulverised coal firing). Calculation of enthalpy, volume and internal energy of wet, dry and superheated steam; use of steam tables; throttling of steam; measurement of dryness fraction by calorimeter. Equivalent evaporation from and at 100°C. Use of enthalpy-entropy diagram.

3. Condensers: Construction of jet and surface condensers. Dalton's law of partial pressures. Calculation of condensing water required. Calcuations for cooling surface required: logarithmic mean temperature difference.

4. Condenser pumps: Air pumps and air ejectors; extraction pumps; air-steam ratio entering air pump; condenser and vacuum efficiency; effect of air leakage.

5. Combustion:

5.1 Composition of solid, liquid and gaseous fuels.

5.2 Calorific values by chemical analysis and experiment.

5.3 Higher and lower calorific value.

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5.4 Minimum air required for complete combustion using basic chemistry and formula.

5.5 Calculation of products of combustion for minimum air and for a given percentage of excess air.

5.6 Gravimetric and volumetric analysis of flue gases by calculation.

5.7 Bomb calorimeter.

5.8 Orsat exhaust gas analysis apparatus.

6. Reciprocating air compressors - single stage only with and without clearance; volumetric effeciency.

7. Governors: Watt, Porter and Hartnell types; simple calculations taking effect of friction into account.

8. The gas turbine - principle of operation; simple calculations and velocity diagrams. Single stage only.

9. Relevant Factories regulations in respect of boilers and pressure vessels.

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KRAGWASSIENE N4

(EEN DRIE-UUR VRAESTEL)

1. TERMODINAMIKA

Algemene termodinamika van gasse en dampe. Interne en eksterne energie, Totale warmte en entropie. Energie kaarte vir gasse en dampe insluitend druk-volume, druk-totale warmte, temperatuur-entropie en totale warmte-entropie. Entalpie en verandering in entalpie. Gelykmatige (konstant) stroming vergelyking. Omkeerbaar en nie-omkeerbaar prosesse; Wurg (van stoom); Isotermies, adiabaties en politropiese operasies en hulle voorstelling op 'n energie diagram. Die Carnot-kringloop en die Ranicine-kringloop.

2. STOOM-OPWEKKING

Ketel rendement en ekwivalente verdamping. Verbetering van rendement in die gebruik van hitteverhalers, oorverhitters en lugvoorverhitters. Hittebalans tabel vir ketels.

3. SPUITSTUKKE

Teorie soos van toepassing op stoom en gas vloei, kritiese keeldruk; Berekening van keel en uitlaatareas vir 'n gegewe vloeitempo; Die effek van herverhitting; Spuitstuk rendement. Konvergent en konvergent-divergent spuitstukke.
Diagram van verandering van druk en snelheid deur 'n spuitstuk.

4. STOOM- EN GAS TURBINES

Beginsels van aksie van impuls en reaksie turbines;
Algemene kenmerke van konstruksie: Snelheid en druk kompensering - De Laval, Curtis, Ratteau en Reaksie turbines. Snelheidsdiagramme vir impuls en reaksie wieke, werkverrig per kilogram van stoom; Diagram rendement.
Die Gasturbine - beginsels van werking: Eenvoudige berekeninge - twee trappe alleenlik: Drywing ontwikkeling, diagram rendement.
Aksiale druk van 'n turbine.

5. BINNEBRANDENJIN

Ideale rendement van Joule, diesel en dubbel kringloop.
Relatiewe rendement van hierdie kringlope. Ideale konstante volume - Otto-kringloop en praktiese konstante volume kringloop.
Indikteurvermoë: Remvermoë; meganiese rendement; Indikteurs en rem termiese rendement; Hittebalans tabel vir binnebrandenjins.

6. LUGKOMPRESSORS

Tweetrapkompressor; Tussenkoeling: Volumetriese rendement; Berekening van werkverrig in meertrappige kompressors; Adiabatiese en isotermiese rendement; Drywing berekeninge; Verhouding van kompressie vir maksimum rendement.

7. KOELING