

Electrical Electronics / Applied Mechanics 3
7218



CAMEROON GENERAL CERTIFICATE OF EDUCATION BOARD

Technical and Vocational Education Examination

JUNEXXX

ADVANCED LEVEL

Specialty Name (Specialty Code)	ELECTRICAL POWER SYSTEM-EPS (F3) & ELECTRONICS-ELN (F2))
Subject Title	Electrical Electronics / Applied Mechanics
Paper No.	3
Subject Code No.	7218

Three hours

INSTRUCTIONS:

1. All the sections are compulsory
2. Illustrate your answers with neat sketches wherever necessary.
3. Preferably, write the answers in sequential order.
4. Use of non-programmable calculator is permissible
5. This paper carries 40% of the total marks.
6. Before starting, make sure that the paper is complete: 09 pages numbered from 1 to 9
7. The candidates will write the answers to the questions asked on the documents "answer sheets" pages 5/9 to 9/9. All the answer sheets documents even blanked are to be given at the end of the test.

You are reminded of the necessity for good English and orderly presentation in your answers.

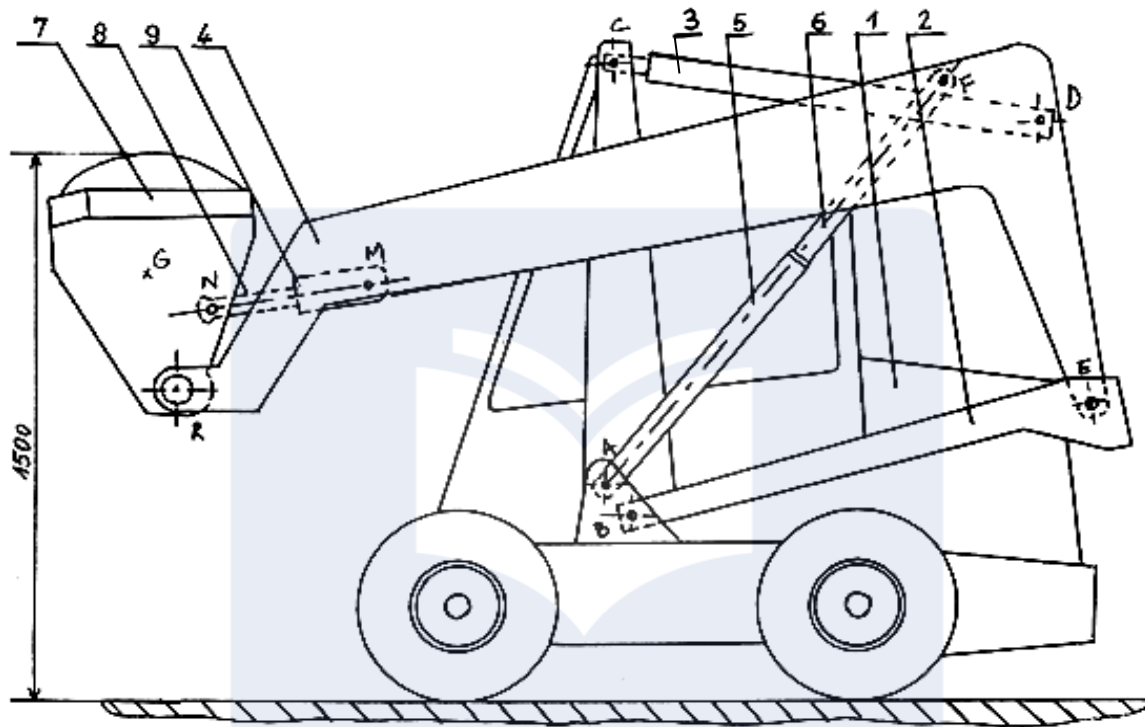
You are advised to read carefully through the question paper, before you begin your answers.

Turn Over

THEME: MINI WHEEL TRACTOR-LOADER

I- DESCRIPTION

The device represented on figure 1 below at reduced scale is a wheel tractor-loader. This model is distinguished from the conventional models by its small size and its height of lifting.



The device is made up of:

- A frame 1;
- A jib 4 (realized starting from two symmetrical arms) articulated at E and D on two pairs of arms 2 and 3;
- A bucket 7 articulated at R on the jib 4.

Arms 2 and 3 are articulated at B and C on the frame 1. The tilting of the bucket is ensured by the hydraulic actuating cylinder 8+9 (8 = piston rod, 9 = body). This jack is articulated at M on the jib and at R on the bucket.

The lifting of the jib is carried out by two hydraulic actuating cylinders 5+6 (5 = body, 6 = rod).

Each jack is articulated at A on the frame and at F on the jib.

II- WORK TO BE DONE

SECTION A: STATICS /25 marks

Aim: To determine the thrust developed by the jacks 8+9 and 5+6.

Hypotheses:

- The loader is in equilibrium in the position of figure 1;
- All the mechanical actions are contained in the symmetry plane of the device which is that of figure 1;
- All the joints are perfect;
- The linkages at **A, B, C, D, E, F, M, N** and **R**, are pivots whose centers bear the same name.
- They will note by only one reference mark the groups of two identical parts.
- The weight of the set { bucket + materials } has as magnitude $\|\vec{P}\| = 1500 \text{ daN}$
- The other weights are neglected.
- Scale of forces: $1\text{cm} \rightarrow 500\text{daN}$

QUESTIONS:

A.1 Equilibrium of arms 2 and 3 (4mks)

Isolate successively the arms 2 and 3, apply the Fundamental Principle of Statics to the equilibrium of each of them and deduce the support of the mechanical actions at **B** and **E**, then at **C** and **D**.

A.2 Equilibrium of jacks 5+6 and 8+9 (4mks)

Isolate successively the jacks 5+6 and 8+9, apply the Fundamental Principle of Statics to the equilibrium of each of them and deduce the support of the mechanical actions at **A** and **F**, then at **M** and **N**.

A.3 Equilibrium of the set {bucket + materials}

A.3.1 Isolate the set {bucket + materials} and fill the table bill of the external actions applied on it. (3mk)

A.3.2 Apply the Fundamental Principle of Statics to it equilibrium and determine analytically the actions at **N** and (5mks)

A.4 Equilibrium of the set {4+7+8+9}

A.4.1 Isolate the set {4+7+8+9} and fill the table bill of the external actions applied on it. (3mks)

A.4.2 Apply the Fundamental Principle of Statics to it equilibrium and determine graphically by using Cullman's method, the actions at **D**, **E** and **F**. (6mks)

SECTION B: KINEMATICS /15 marks**Aim:** To determine the climb speed of bucket 7**Hypotheses and Data:**

- The device occupies the position of figure 2
- Frame 1 is motionless;
- Jack 8+9 is not supplied;
- The rod 6 leaves the body 5 at the velocity of magnitude $\|\vec{V}_{F\ 6/5}\| = 5\text{ cm/s}$
- The linkages at **A, B, C, D, E, F, M, N** and **R**, are pivots whose centers bear the same name.
- Scale of velocities : $1\text{cm} \rightarrow 1\text{cm/s}$

QUESTIONS :

- B.1 Give the nature of the movement of 2 compared to 1. Determine and plot the support of $\vec{V}_{E\ 2/1}$. (2mks)
- B.2 Give the nature of the movement of 3 compared to 1. Determine and plot the support of $\vec{V}_{D\ 3/1}$. (2mks)
- B.3 Justify the equalities: $\vec{V}_{D\ 3/1} = \vec{V}_{D\ 4/1}$, $\vec{V}_{E\ 2/1} = \vec{V}_{E\ 4/1}$ and $\vec{V}_{F\ 6/1} = \vec{V}_{F\ 4/1}$ (2mks)
- B.4 Determine the instantaneous Centre of rotation of jib 4 in its movement compared to 1 (represented $I_{4/1}$). (1mk)
- B.5 Determine the line supports of the velocity vectors $\vec{V}_{F\ 4/1}$ and $\vec{V}_{R\ 4/1}$. (1mk)
- B.6 Give the nature of the movement of 6 compared to 5. Plot the vector $\vec{V}_{F\ 6/5}$. (1mk)
- B.7 Plot the support of $\vec{V}_{F\ 5/1}$ knowing that 5 makes a rotation of axis (**F, z**) compared to 1. (1mk)
- B.8 Write a relation of composition of velocities at point **F** between solids 1, 5 and 6 (1mk)
- B.9 Determine graphically the magnitude of $\vec{V}_{F\ 4/1}$. (1mk)
- B.10 Determine graphically by the equiprojectivity method applied to the jib 4, the magnitude of $\vec{V}_{R\ 4/1}$, and then deduce the climb speed of the bucket 7. (3mks)

SECTION C: DYNAMICS /10 marks**Aim:** To determine the work absorbed by the braking of the loader.

To go to discharge materials, the loader moves on a straight and horizontal route with a uniform movement at the speed of 25km/h. the loader operator sees the plate indicating the place of discharge, and slows down on a distance of 23m to stop at the height of that plate.

Hypotheses and Data:

- Loader weight $m_{\text{loader}} = 200\text{kg}$
- Weight of the set {bucket + materials} $m_b = 150\text{kg}$
- Acceleration of gravity $g = 10\text{m/s}^2$
- Speed of the loader: $V_{\text{loader}} = 25\text{km/h}$
- Breaking distance: $D = 23\text{m}$

QUESTIONS:

- C.1 Determine the deceleration acquired by the loader on the 23m. (3mks)
- C.2 Determine the breaking duration (3mks)
- C.3 Consider the loader and its contents and fill the table bill of the external forces. (2mks)
- C.4 Apply the kinetic energy theorem and determine the work absorbed by braking. (2mks)

ANSWER SHEET

SECTION A: STATICS

A.1 Equilibrium of arm 2:

F.P.S.

Line support of the actions at **B** and **E**

Equilibrium of arm 3:

F.P.S.

Line support of the actions at **C** and **D**:

A.2 Equilibrium of jack 5 + 6:

F.P.S.

Line support of the actions at **A** and **F**:

Equilibrium of jack 8 + 9:

F.P.S.

Line support of the actions at **M** and **N**:

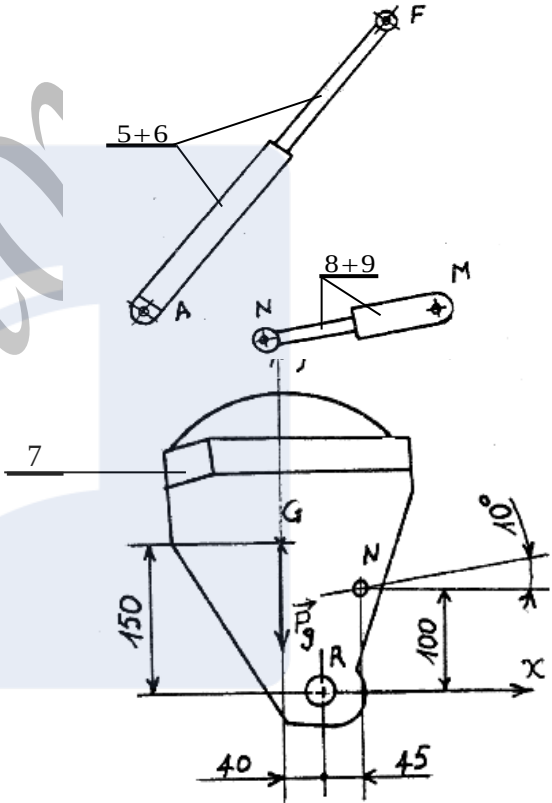
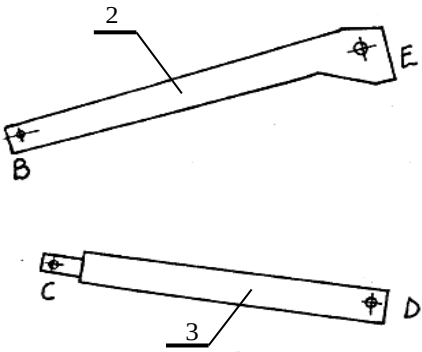
A.3 Equilibrium of the set {bucket + materials}:

A.3.1 Table bill of external forces:

Force	P.A.	Support	Direction	Magnitude

A.3.2 F.P.S:

Analytical determination of the actions at **N** and **R**:



ANSWER SHEET

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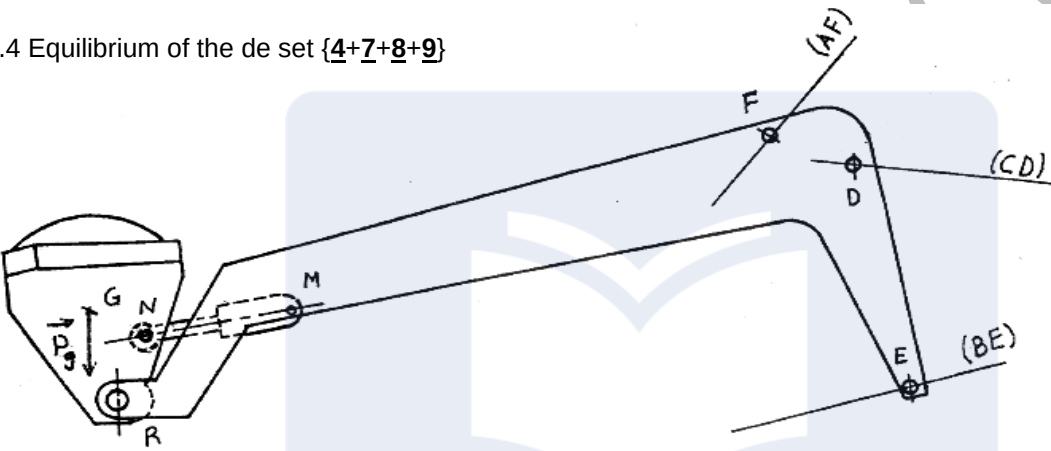
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$\|\vec{R}_{7/1}\| = \dots\dots\dots$ $\|\vec{N}_{8/7}\| = \dots\dots\dots$

A.4 Equilibrium of the de set {4+7+8+9}



A.4.1 Table bill of external forces:

Force	P.A.	Support	Direction	Magnitude

A.4.2 F.P.S.

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Graphical determination of the actions at **D**, **E** and **F**:

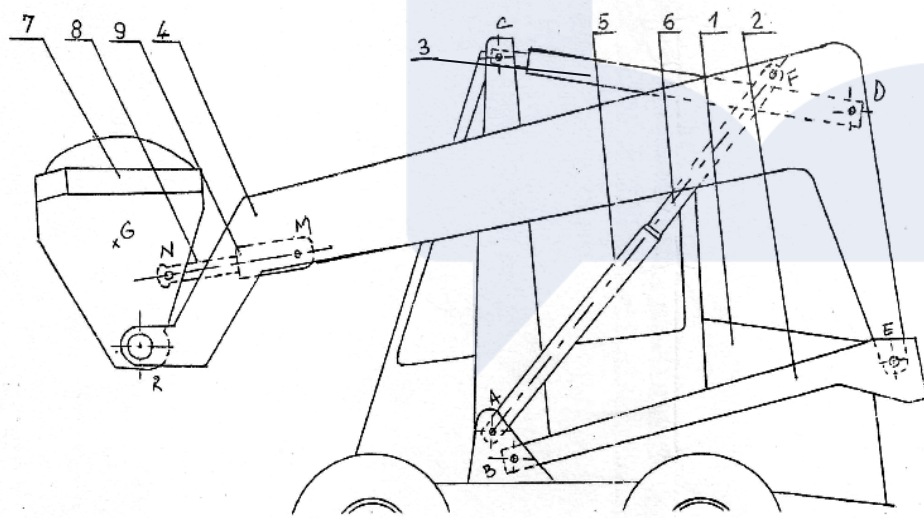
Scale of forces: 1cm → 500daN

$\|\vec{D}_{3/4}\| = \dots\dots\dots$ $\|\vec{E}_{2/4}\| = \dots\dots\dots$ $\|\vec{F}_{6/4}\| = \dots\dots\dots$

SECTION B: KINEMATICS

Line Support of $\overrightarrow{V}_{E\ 2/1}$:

Line support of $\overrightarrow{V}_{D\ 3/1}$:

$$\vec{V}_{D\,3/1} = \vec{V}_{D\,4/1},$$
$$\overrightarrow{V}_{E\,2/1} = \overrightarrow{V}_{E\,4/1}, :$$
$$\overrightarrow{V}_{F\ 6/1} = \overrightarrow{V}_{F\ 4/1}, \quad :$$


B.5 Line support of $\vec{V}_{F4/1}$:

Line support of $\overrightarrow{V}_{R\ 4/1}$:

ANSWER SHEET

B.6 Nature of the movement of 6 compared to 5:

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Plotting of the vector $\vec{V}_{F\ 6/5}$:

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B.7 Plotting of the line support of $\vec{V}_{F\ 5/1}$:

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B.8 Relation of composition of velocities at point **F** between solids 1, 5 and 6:

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B.9 Graphical determination of the magnitude of $\vec{V}_{F\ 4/1}$:

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$\|\vec{V}_{F\ 4/1}\| = \dots\dots\dots$

B.10 Graphical determination of the magnitude of $\vec{V}_{R\ 4/1}$:

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$\|\vec{V}_{R\ 4/1}\| = \dots\dots\dots$

Deduction of the climb speed of bucket **Z**: $\|\vec{V}_{7\ CLIMB}\| = \dots\dots\dots$

SECTION C: DYNAMICS

C.1 Determination of the acceleration acquired by the loader on the 23m:

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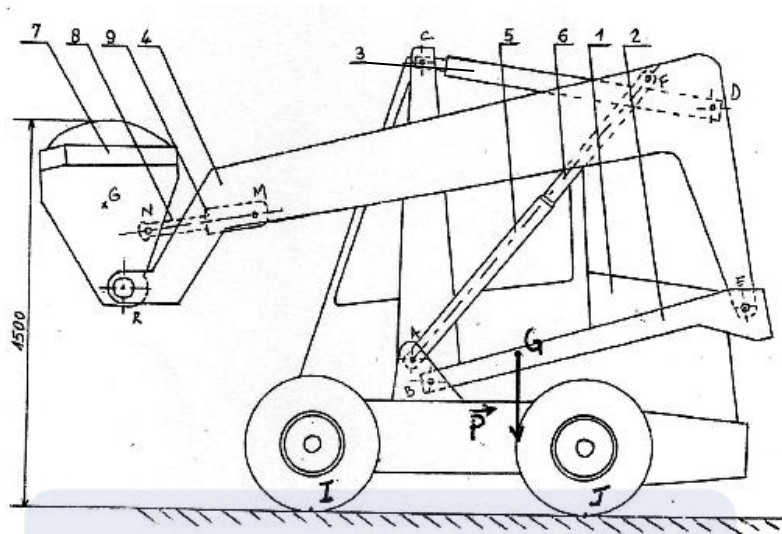
$\gamma = \dots\dots\dots$

C.2 Determination of the duration of breaking:

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$\Delta t = \dots\dots\dots$

ANSWER SHEET



C.3 Table bill of external forces:

Force	P.A.	Support	Direction	Magnitude

C.4 Determination of the work absorbed by braking:

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..... W = ...