RÉPUBLIQUE ALGÉRIENNE DÉMOCRATIQUE ET POPULAIRE
MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE SCIENTIFIQUE

ÉCOLE NATIONALE POLYTECHNIQUE

Département de Génie Mécanique
Laboratory of Green and Mechanical Development (LGMD)

Final Year Project Thesis

To obtain the State Engineer degree in Mechanical Engineering

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Design and Fabrication of a Femoral Prosthesis for Clinical Testing

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ZERKOUK Riadh & TOUATI Amine

Under the supervision of **Dr. BELOUADAH Zouheyr**, ENP

Presented and publicly defended on (07/07/2025)

Jury Members:

President:	M. BELKACEMI Yacine	MCA ENP
Supervisor:	M. BELOUADAH Zouheyr	MCA ENP
Examiner:	M. SEDJAL Hamid	MAA ENP

ENP 2025

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المدرســة الوطنيــة المتعددة التقنيــات
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Département de Génie Mécanique
Laboratoire de Développement Durable et Mécanique (LGMD)

Mémoire de Projet de Fin d'Études

Pour l'obtention du diplôme d'Ingénieur d'État en Génie Mécanique

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Conception et Fabrication d'une Prothèse Fémorale pour Essais Cliniques

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ZERKOUK Riadh & TOUATI Amine

Sous la direction de **Dr. BELOUADAH Zouheyr**, ENP

Présenté et soutenu publiquement le (07/07/2025)

Membres du Jury :

Président :	M. BELKACEMI Yacine	MCA ENP
Encadreur :	M. BELOUADAH Zouheyr	MCA ENP
Examinateur :	M. SEDJAL Hamid	MAA ENP

ENP 2025

الملخص: تصميم وتصنيع طرف صناعي فخذي من أجل اختبارات سريرية

تُشكّل البتر فوق الركبة (البتر الفخذي) تحديات كبيرة في مجال التأهيل باستخدام الأطراف الصناعية، لا سيما في تصميم الجُويّات (emboîtures) التي توفر الراحة والوظيفة في آن واحد. من بين المشاكل الشائعة: الألم، وسوء التوافق، وضعف التثبيت، بالإضافة إلى التوزيع غير المعروف للضغط داخل الجُويّة. غالبًا ما يتم وضع مناطق التعزيز دون بيانات موضوعية، مما قد يؤثر سلبًا على الراحة والمتانة.

يهدف هذا المشروع إلى فهم أفضل للتفاعل بين الجزء المتبقي من الطرف المبتور والجُويّة. من خلال تحديد مناطق الضغط الحرجة وتقييم سلوك الجُويّة، يسعى المشروع إلى تحسين الراحة، والتوافق، والأداء العام. الهدف النهائي هو المساهمة في تصميم أكثر كفاءة وتخصيصًا للجُويّات الخاصة بمبتوري الأطراف الفخذية.

الكلمات المفتاحية: جُويّة فخذية، أخذ القياسات، قوة الضغط، الطباعة ثلاثية الأبعاد، التوصيف الميكانيكي.

Résumé: Conception et fabrication d’une prothèse fémorale pour des essais cliniques.

L’amputation transfémorale présente d’importants défis en matière de réhabilitation prothétique, notamment dans la conception d’emboîtures à la fois confortables et fonctionnelles. Les problèmes fréquents incluent la douleur, un mauvais ajustement, un accrochage insuffisant et une répartition des pressions mal connue à l’intérieur de l’emboîture. Les zones de renfort sont souvent placées sans données objectives, ce qui peut nuire au confort et à la durabilité. Ce projet vise à mieux comprendre l’interaction entre le membre résiduel et l’emboîture. En identifiant les zones de pression critiques et en évaluant le comportement de l’emboîture, il cherche à améliorer le confort, l’ajustement et la performance globale. L’objectif final est de contribuer à une conception plus efficace et personnalisée des emboîtures pour les amputés transfémoraux.

Mots-clés: Emboîture fémorale, prise de mesures, force de pression, impression 3D, caractérisation mécanique.

Abstract: Design and Fabrication of a Femoral Prosthesis for Clinical Testing

Transfemoral amputation presents major challenges in prosthetic rehabilitation, especially in designing sockets that are both comfortable and functional. Common issues include pain, poor fit, inadequate suspension, and unclear pressure distribution inside the socket. Reinforcement zones are often placed without objective data, which can affect both comfort and durability. This project aims to better understand the interaction between the residual limb and the socket. By identifying critical pressure areas and assessing socket behavior, it seeks to improve comfort, fit, and overall performance. The ultimate goal is to contribute to more effective and personalized socket design for transfemoral amputees.

Keywords: Femoral socket, measurement acquisition, pressure force, 3D printing, mechanical characterization.

Acknowledgements

First and foremost, we would like to express our sincere gratitude to the École Nationale Polytechnique for providing a rich and challenging environment throughout our engineering studies. From the very first day in the preparatory classes to the final stages of our specialization, this institution has shaped not only our technical knowledge but also our values and mindset.

We are deeply thankful to all the professors and academic staff who guided us with dedication, shared their expertise with passion, and constantly encouraged us to go beyond our limits. Their commitment played a vital role in our academic and personal growth. We also extend our appreciation to the administrative and technical staff of ENP for their behind-the-scenes efforts, which ensured that our academic experience was smooth and well-supported.

We are particularly grateful to the Office National d'Appareillage et d'Aide à la Personne Handicapée (ONAAPH) for their collaboration and support during the clinical evaluation phase of our project. Their assistance and professionalism greatly enriched the quality and relevance of our work.

*We would especially like to thank our project supervisor, **Mr. Zouheyr Belouadah**, for his valuable guidance, constant availability, and constructive feedback throughout this work. His support and expertise were instrumental in bringing this project to completion.*

*We would like to express our sincere thanks to **Mr. Mourad Adnane** for his valuable support and guidance in the electronic part of our project. His expertise and availability were of great help to us.*

ZERKOUK Riadh and TOUATI Amine

Dedication

To my family
To my beloved ***mother, father, and older brother****:*
Thank you from the bottom of my heart for your unconditional support, your countless sacrifices, and your presence through every step of my life in both joyful and difficult times. Without your love, guidance, and encouragement, reaching this point would have been far more challenging, if not impossible.

To my friends
Twil, Abbad, Rafik, Imad, Kodus:
Thank you for sharing this long journey with me. Over these five unforgettable years, you've been more than just friends, you've been a second family. From shared laughter to late-night study sessions, from struggles to celebrations, every moment with you mattered deeply.

To my classmates and close friends from the Mechanical Engineering program
Yanis, Fouad, Samy, Hilal, Smail, Adem, Mondhir, and sns*:*
Thank you for the joy, the help, and the solidarity we experienced together over the past three years. You made every challenge more bearable and every achievement more meaningful through teamwork and friendship.

And finally —
As they say, the best is always saved for last.
To my ***binôme****, my teammate since high school:*
Thank you for walking beside me throughout this entire journey, from the baccalaureate, to preparatory classes, through national exams and this final project. We've been through both struggles and successes side by side. Thank you for your resilience, your support, and for turning this long road into an unforgettable adventure.

Amine Touati

Dedication

To my family —
*To my dear **father and mother**,*
Your unconditional love, tireless sacrifices, and constant encouragement have been the pillars of every step I've taken. Words will never suffice to express how grateful I am for your guidance and faith in me.

To my beloved siblings —
***My big sister and my two little brothers**,*
Thank you for being my strength and motivation. Your presence made the hardest moments lighter and the good ones even better.

To my friends from the earliest days in ENP —
Amine Akezouh, Abbad Raouf, Rafik Ayad, Imad Khodja, and Aloui Kodous,
This journey would not have been the same without you. From the struggles of CP to the memories we made, your support and friendship were a true gift.

To my fellow mechanical engineers —
***Yanis, Fouad, Samy, Hilal, Smail, Adem, Mondhir, and Chakib Nazim**,*
Thank you for the solidarity, teamwork, and humor that got us through these challenging years. The shared experiences and the camaraderie we built made every challenge worthwhile.

And finally —
*To my **binôme**, from the very beginning until the very end,*
We've shared more than a project; we've shared a journey that started back in high school. From exams to sleepless nights, from failures to victories, we've been through it all together. Thank you for your unwavering commitment, your patience, and for turning all the ups and downs into something truly unforgettable. This wouldn't have been possible without you.

Riadh ZERKOUK

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