POLYTECHNIC UNIVERSITY OF THE PHILIPPINES
College of Engineering
Computer Engineering Department

CMPE 101

Computer Engineering as a Discipline

CASE STUDY

Proponents

Name	Section
Palabay, Israfil D.	1-2
Palomo, Shane Craven L.	1-2
Punzal, Gillian R.	1-2
Quezada, Rhexyruz Erwin R.	1-2

January 12, 2025

Table of Contents

INTRODUCTION

This case study, titled "*Pathways in Computer Engineering: Insights from Senior and Professionals,*" aims to provide a comprehensive understanding of the various specializations in the field of Computer Engineering. Through in person interviews and survey with third and fourth-year senior students, as well as graduates currently working in the field, the researchers explore the essential skills, potential career opportunities, a real-world application.

The study focuses on the perspectives the senior Computer Engineering students alongside insights from graduates. This study is particularly important for first year Computer Engineering students as it helps bridge the gap between theoretical learning and the real-world applications. By gaining insights from seniors and graduates, it introduces first year students to various specializations within the field, including **Computer Networking**, **Machine Learning**, **Big Data**, **Systems Development**, and **Mechatronics** outside of class. Additionally, this case study serves as a guide for developing the necessary skills and competencies needed to succeed in the respective specializations. Moreover, this will help students make informed decisions, promoting early career planning, and academic and professional growth.

SUMMARY OF INTERVIEWS

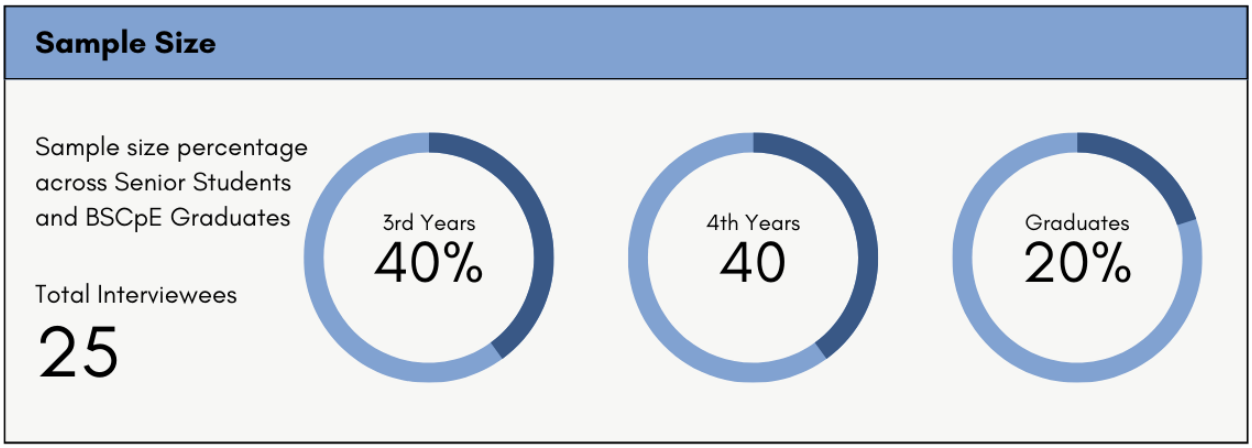

fig 1.

Profile of each Interviewee:

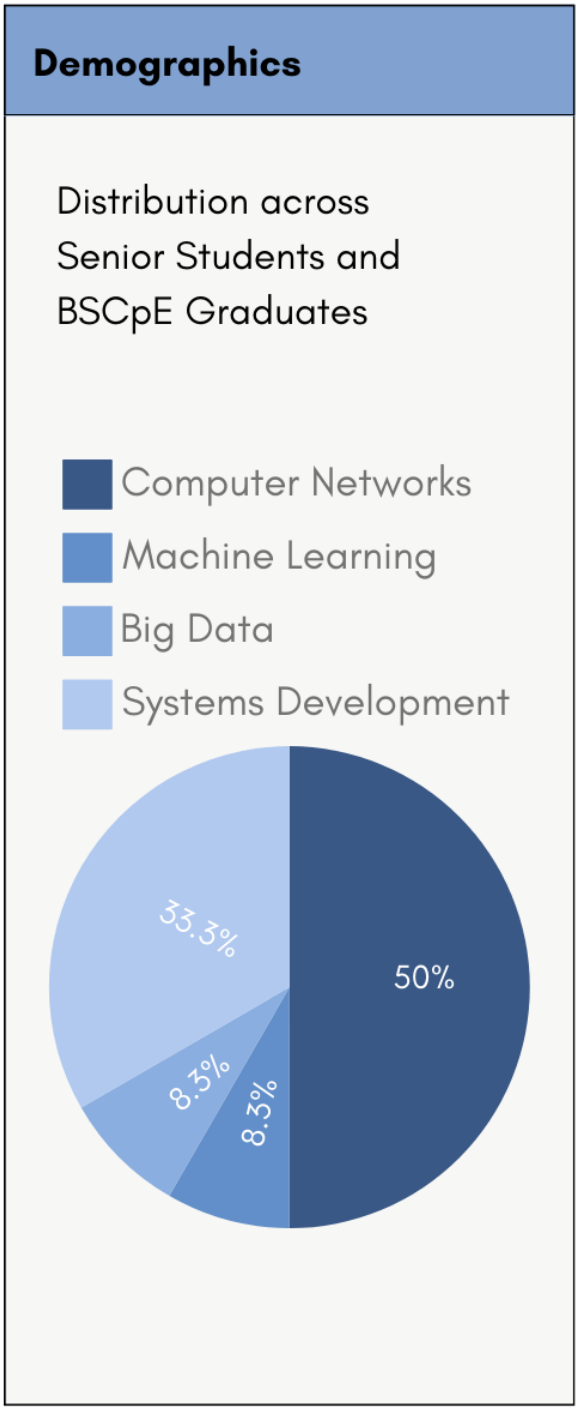

fig 3.

3rd Year Students:

Participant	Yr/Section	Specialization/Field
Interviewee 1	3-4	Computer Networking
Interviewee 2	3-5	Computer Networking
Interviewee 3	3-5	Computer Networking
Interviewee 4	3-4	Computer Networking
Interviewee 5	3-4	Computer Networking
Interviewee 6	3-2	Big Data
Interviewee 7	3-5	Machine Learning
Interviewee 8	3-4	Computer Networking
Interviewee 9	3-5	Computer Networking
Interviewee 10	3-1	Machine Learning

4th Year Students

Participant	Yr/Section	Specialization/Field
Interviewee 1	4-3	Computer Networking
Interviewee 2	4-2	Big Data
Interviewee 3	4-2P	System Development
Interviewee 4	4-2P	System Development
Interviewee 5	4-2P	System Development
Interviewee 6	4-5	System Development
Interviewee 7	4-5	System Development
Interviewee 8	4-4	Computer Networking
Interviewee 9	4-2T	System Development
Interviewee 10	4-3	Computer Networking

BSCPE Alumni Professionals

Name	Job Role/Position	Specialization/Field
Interviewee 1	Software Development Engineer	Cybersecurity and Cloud Computing
Interviewee 2	Software Development Engineer	Artificial Intelligence and Machine Learning
Interviewee 3	Project Development Engineer	System Development
Interviewee 4	Production Specialist	N/A
Interviewee 5	Software Engineer	ERP Systems

Key Insights Gathered:

Reasons for Choosing a Specialization

- **Third-Year Students:** Many chose Computer Networking due to market demand, relevance, and perceived simplicity compared to other fields. A few were influenced by trends like AI or opted for alternatives like Big Data due to unavailable slots in their preferred fields.
- **Fourth-Year Students:** System Development was a popular choice, attributed to its practicality, job flexibility, and market opportunities. A few cited prior exposure or curiosity as significant factors.
- **Graduates:** Alumni pursued diverse specializations like AI, Cybersecurity, and Cloud Computing. Their decisions were shaped by career goals, curiosity, or external influences such as industry demands.

Notable Projects/Accomplishments

- **Third-Year Students:** Focused on introductory projects like setting up networks, using topologies, and basic data analysis. Some experimented with AI tools like Braille printers or OCR-based systems.
- **Fourth-Year Students:** More advanced projects included software development, encryption, mobile apps, and optimizing systems for scheduling and inventory management.
- **Graduates:** Alumni achieved substantial milestones such as AI-driven chatbots, operating systems for embedded products, and automating business processes to enhance efficiency.

Skills and Challenges

- **Technical Skills:** Students emphasized programming, data manipulation, and system configuration (e.g., subnet masks, packet tracing). Alumni highlighted advanced skills like AI integration and automation tools.
- **Soft Skills:** Commonly mentioned skills were critical thinking, perseverance, teamwork, and adaptability.
- **Challenges Faced:**
    - **Students:** Troubleshooting, debugging, managing academic workloads, and mastering syntax.
    - **Graduates:** Alumni dealt with complex system optimization and adapting to rapid technological advancements.
    - Overcoming strategies included self-study, collaboration, discipline, and leveraging online resources.

Advice for Beginners

- Build foundational knowledge and develop essential skills like programming and problem-solving.
- Stay curious, disciplined, and initiative-taking in learning.
- Balance academics with personal growth, avoid procrastination, and seek firsthand practice.
- Choose a specialization based on interest and market relevance and establish professional connections.

Shaped Perceptions About Computer Engineering

- Computer Engineering is seen as a dynamic field that requires technical skills and adaptability.
- Understanding modern technologies, having both technical and soft skills, and aligning career goals are key.
- Perseverance and initiative are essential to overcome challenges and seize opportunities.

ANALYSIS AND REFLECTION

This section of the paper provides analysis and reflection to compare the perspectives of different Computer Engineering students and graduates. The objective of this comparison is to explain their ideas, inspirations, and experiences throughout the year on the path to success as Computer Engineers. Lastly, by using the obtained information, the researchers will try to provide insights and discuss the potential specializations and professions that they might pick in the future.

Differences and Commonalities

Key Points	3rd Year Students	4th Year Students	Graduates
Field of Specialization	Majority are in Computer Networking, but some also chose Big Data and Machine Learning.	Concentrate on System Development, however, some individuals picked Computer Networking and Big Data.	Some specialize in Machine Learning and System Development, the majority work in advanced fields like Cybersecurity, Cloud Computing, and Artificial Intelligence.
Projects	Setting up networks, on the job trainings, and basic data analysis	Software development, encryption, analyzing big data sets, and setting up networks	System optimization, AI-driven chatbot, developing operating systems, and automation of business processes.
Inspirations	Greatly affected by the influence of others and external factors such as high salaries and current trends in	Share the same opinions as the third-year students, but they also attribute this to	Motivated by their long-term professional and

	the market, but some individuals are not in favor of what their specializations are.	their extensive practical experience.	personal objectives and goals.
Difficulties	Troubleshooting, debugging, working with circuits, adjusting to demands of professors, academic workloads, and managing time.	Debugging, managing syntax, organizing and optimizing large data sets, procrastination, and academic workloads.	Practical issues such as debugging, optimizing systems, adjusting to industry demands, and many more.
Skills	Technical skills such as programming, network configuration, knowledge about specific tools like Cisco Systems, RJ45 connections, and data handling techniques. Soft skills such as mindfulness, patience, teamwork, and perseverance.	Technical skills such as programming, data manipulation, and system optimization. Soft skills such as time management, perseverance, critical thinking, teamwork, and adaptability.	Technical skills such as programming and familiarity with automation tools. Soft skills such as adaptability critical thinking, perseverance, and teamwork.

Advice	Study diligently while having perseverance, patience, focus on foundational knowledge, sharpen practical skills, and choose specialization wisely.	Continuously learn new skills, balance academic life and social life, discipline, and build good connections with other students and professionals.	Choose specialization carefully, engage in internships, build wide connections, and master foundational skills.

Comparative Analysis: Specialization Motivations, Essential Skills, and Challenges

Motivations for Specialization

- **3rd-Year Students:** Chose specializations for their relevance, ease of learning, or high salaries. Some were influenced by limited options.
- **4th-Year Students:** Focused on job demand, flexibility, and skills gained through hands-on activities in earlier years.
- **Graduates:** Valued adaptability and soft skills, highlighting the importance of combining technical knowledge with practical experience.

Challenges Faced

- **3rd-Year Students:** Struggled with understanding difficult topics and managing workloads. Patience and persistence helped them.
- **4th-Year Students:** Faced procrastination and technical tool issues. They overcame these by staying disciplined and practicing regularly.

- **Graduates:** Found it challenging to apply theory to real-world problems. They relied on adaptability and new tools like AI to succeed.

Overall

- **3rd-Year Students**: Focus on basic skills and foundational learning, with influences heavily shaped by various factors such as finance, market trends, and personal interests.
- **4th-Year Students:** Experience a transition phase, where practical experience shapes their focus and career path.
- **Graduates:** Showcase maturity and alignment with industry trends, driven by their long-term goals and real-world experiences.

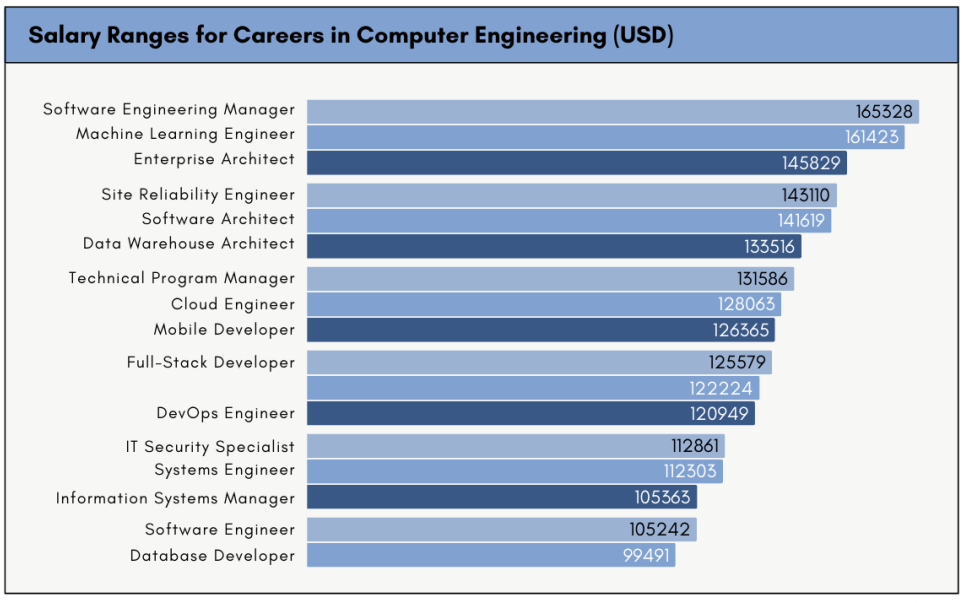

fig 3.

How These Perspectives Influence Our Understanding

Computer Engineering combines technical skills with creativity to solve real-world problems. It teaches the importance of practical experience, managing workloads, and staying adaptable. Students and graduates have shown hands-on learning, and soft skills are just as important as technical knowledge. According to Lamo et al. (2022), online courses during the

pandemic showed the value of hands-on learning, while Andaya et al. (2024) found that skills adaptable to change improve employability. Emphasizing patience, discipline, and regular practice for success in this field.

Choosing a program often leads to a question, “What inspired us?” and “What factors did we consider?”. Career specialization and pathways in this field are influenced by various internal and external factors, such as peers, salaries, and industry trends. Wang et al. (2024) observed that families, instructors, and peers play a significant role in shaping motivation, which directly impacts academic and career decisions. Similarly, Kampala International University (n.d.) highlighted the importance of competitive salaries in enhancing job satisfaction and retention. The respondents recommend that we remain determined, explore opportunities, and balance academics with practical experiences. These strategies not only help in navigating what we genuinely want but also in setting our goals for personal and professional growth.

However, it is undeniable that not everyone has the same privilege. While many are guided by major factors, others face constraints that limit their options. One of the experiences of our respondent, they shared that they did not have an option because they came from a ladderized section. Which highlights how some individuals do not have the same opportunity, and they must accept what is available to them rather than pursuing their ideal path. With this scenario, it shows the importance of acknowledging diverse situations for us to visualize and accept what may happen.

With the help of these insights, we realize that both internal and external factors play a critical role in shaping our career decisions. Recognizing these influences allows us to make more informed choices and approach our future paths with greater clarity and purpose. Moreover, it reminds us of the need to create education systems that offer equitable opportunities, ensuring everyone has the chance to pursue what they want.

Being a Computer Engineer involves various challenges, which begin in the early stage. The transition period of learning is a struggle that everyone faces. According to Valero (2022), a

fundamental challenge in engineering education is transitioning from theoretical knowledge to developing students' practical skills. The first-year courses are mostly based on theory, unlike the last few years which focus on practical applications. In the third year, it includes practical work such as troubleshooting, debugging, and dealing with circuits, and after a year, the practical work becomes more complex, such as optimizing huge data sets, packet tracing, and developing software and mobile applications. When someone becomes a professional Computer Engineer, the problems become more practical, such as adapting to the expectations of the industry.

Even though there are various external challenges, there is also a conflict within us. Based on some of our respondents, they said, “Procrastination is one of the main challenges.”, “it was mostly a matter of time.”, and “it’s difficult to analyze…” Hearing it from them reminds us that overcoming internal conflicts is just as important as sharpening our technical skills.

Overcoming challenges is not as easy as it looks. One simple way to help ourselves is by using technology. For example, Sagbas and Koc (2021) pointed out that many students use YouTube to go over tough topics or prepare for exams in a way that works best for them. Also, building connections with mentors and classmates is just as important. Felten and Lambert (2020) explained that these relationships not only open doors to new opportunities but also provide support and motivation.

Everything they said is true, but we believe that the most important thing for us to overcome challenges is to discipline ourselves. Just like one respondent shared, “When it comes to studying, any course is really challenging, but if you add hard work, perseverance, and consistent practice, you will manage.” We can say that while using the internet and building connections can really help us, self-discipline and determination are what truly make a significant difference, it makes challenges become valuable stepping stones and it paves the way for us to become successful in the field.

To summarize, with the help of this study, we gained more in-depth knowledge about the program that we are currently taking, and it became an eye-opener on the near future. We gained

an understanding about different things in Computer Engineering such as what are the possible paths for us, what are the challenges that we might face in the future, what are the things we should improve, and how can we come up with the challenges that we may encounter in the future.

Potential Specialization and Career Paths

Based on our group's discussion, we are particularly interested in fields such as Embedded Systems, Artificial Intelligence (AI), Machine Learning, and Software Development, which correspond to some of the most promising specializations in Computer Engineering. Based on our research, these disciplines are currently at the top of the industry, and they play a significant part in how technology solves issues in the modern world. We believe that exploring these areas will help us stay up to date on technological developments such as automation, application development, and data science, all of which play a significant role in modern society.

Embedded systems use hardware and software together to create devices that solve real-world problems. Adding 3D printing allows engineers to design and assess these systems, making it easier to improve and create innovative solutions. This combination is used in areas like robotics and automation. This supports the innovation through applications in 3D printing, prototyping, and artificial intelligence. As Engin (2016) showed how a firefighting robot used embedded systems and creative designs to solve practical challenges.

As per Indeed (2024) that Embedded systems, IoT, robotics, and 3D printing offer exciting career opportunities with competitive salaries. In embedded systems, roles like embedded software engineers earn about $90,000 annually, focusing on creating smart devices using tools like Arduino and Raspberry Pi. IoT professionals can work as IoT architects or data analysts, with salaries ranging from $80,000 to $120,000, depending on expertise and location. Robotics engineers develop automated systems and earn an average of $100,000 per year, with applications in fields like healthcare and manufacturing. According to Vasconcellos (2023) in 3D printing, designers and technicians earn between $50,000 and $80,000, contributing to areas like prototyping and

product design. This field offers opportunities to develop advanced technologies like smart devices and custom hardware, making it an important part of modern engineering.

Based on the report of Glover (2024), "Artificial intelligence (AI) is a computer science field focused on creating machines that can mimic human intelligence. This includes abilities like learning, solving problems, making decisions, and understanding information. AI is used in various applications, such as speech and image recognition, content creation, personalized recommendations, and autonomous vehicles." It is also used to find new links in genetic codes, powering surgery-assisting robots, automating administrative tasks like documentation, transcription, claims processing, appointment scheduling and patient communication. The potential of AI is limitless and to work on AI one must be knowledgeable in Machine learning.

Additionally, it was mentioned in the report that Machine learning (ML) is the primary method for developing AI systems. In ML, computers learn from massive datasets by identifying patterns and relationships within the data. ML algorithms use statistical techniques to improve their performance on a task without explicit programming. They leverage historical data to predict future outcomes. Machine learning encompasses two primary approaches: supervised learning, where the desired output is known due to labeled datasets, and unsupervised learning, where the expected outcomes are uncertain as the data is unlabeled.

The top candidates for machine learning engineer positions have a background that blends software engineering, data science, and applied research. Strong mathematical abilities, familiarity with machine learning, deep learning, neural networks, and cloud applications, as well as programming knowledge in Java, Python, and Scala, are required for AI positions. Knowing how to use software development IDEs like Eclipse and IntelliJ is also beneficial. A bachelor's degree in Computer Engineering, computer science or a similar discipline is most likely required.

According to Gupta (2024), in the United States, a machine learning engineer typically makes $130,000. Companies such as Apple, Facebook, Twitter, and others pay far more, with average salaries ranging from $170,000 to $200,000.

According to Indeed (2024), software development focuses on building software systems, and managing applications, and company networks. They are the ones who write code for software to conduct specific functions and to update it. In addition, the professionals who chose this area commonly have a good foundation of understanding the software development lifecycle and other relevant methodologies.

Software development currently offers a high demand for skilled professionals, and it has a diverse range of jobs. When an individual graduates as a Computer Engineer and chooses software development, there are a large amount of job opportunities that are waiting for them. Some of the popular jobs in software development are web developer, database administrator, full-stack developer, and software architect. Also, the salary in software development is high compared to others. According to Indeed (2024), the salary of a software developer ranges from $105,242 (software engineer) to $141,619 (software architect) per year, which can already be considered a high-paying job.

This list of specialization and potential career paths enables the group to possibly solve different real-world challenges in different sectors. AI and machine learning enable the development of creative solutions to healthcare problems, such as predictive healthcare systems that can assist patients. In embedded systems, they develop robots for monitoring and regulating industrial processes. Software development services include the development of systems and apps. For example, in the business sector, it assists in enhancing procedures and the creation of new income sources for different types of business. These examples demonstrate the undeniable significance of Computer Engineering, not just today, but also in its continuous growth.

Lifelong learning is important in Computer Engineering due to rapid technological advancements. Staying updated ensures professionals remain skilled and relevant. Fields like AI, embedded systems, and software development can address global challenges, such as promoting sustainability, improving accessibility for people with disabilities, and increasing industry efficiency. By embracing continuous learning, engineers can help create a better and more innovative future.

CONCLUSION

Computer Engineering as a program may be daunting at firsthand when looking at the vast field that it covers and the difficulties that it entails. That is why this case study was conducted to help the 1st year students of this program and other aspiring Computer Engineers to understand the realities of this field and gain a deeper understanding of Computer Engineering and its specializations. In the end of the day, Computer Engineering is just like any other programs. It's filled with hardships and challenges in different levels. Whether you are only starting or already experienced in the field. You are going to face these difficulties and to succeed; Dedication, perseverance, adaptability, passion, resourcefulness and braveness, still holds true as the key to success.

This study reveals a nuanced understanding of the Computer Engineering landscape. 3rd-year students primarily focused on foundational learning, driven by factors like perceived ease and potential earnings. 4th-year students, with more practical experience, prioritized career demand and flexibility. Graduates emphasized the crucial role of adaptability and soft skills alongside technical expertise. Throughout the case study, building a solid foundation, creating good connections, broadening your horizons, developing practical experience through internships and projects and to be daring to take actions, was the main advice and focus of the respondents. Determining your goals and passion will help you decide which specializations to take, various external factors such as market demands and salaries will also affect it. The study highlights the importance of continuous learning, practical experience, and a holistic approach that encompasses both technical proficiency and professional development for success in this dynamic field.

REFERENCES

Alam, Tanweer. (2021). Blockchain cities: the futuristic cities driven by Blockchain, big data and internet of things. GeoJournal. 87. 1-30. 10.1007/s10708-021-10508-0.

Alejo, M., Bagara, M., Nalunat, J., & Apduhan, J. (n.d.). *Employability tracer study of the Computer Engineering graduates from a private university in the Philippines*. https://national-u.edu.ph/wp-content/uploads/2022/04/2.-JSTAR7-1-COE-p.3-16.pdf

Andaya, M., Pedro, J. R. S., So, C. L., & Tanyag, B. (2024). Employability of Computing Students in the Age of Disruption: A Graduate Tracer study. European Journal of Education and Pedagogy, 5(1), 82–87. https://doi.org/10.24018/ejedu.2024.5.1.793

BasuMallick, C. (2023, October 31). Mechatronics Engineering Jobs, skills, and salary | Spiceworks. Spiceworks Inc. https://www.spiceworks.com/tech/it-careers-skills/articles/what-is-mechatronics-engineering/

Career Pathways and companies for Computer Engineering Graduates | Engineering & Technology | University of Washington Tacoma. (n.d.). University of Washington Tacoma. https://www.tacoma.uw.edu/set/job-opportunities-CENGR-graduates

Computer Engineering: Machine Learning and Data Science, BS < University of Wisconsin-Madison. (n.d.). https://guide.wisc.edu/undergraduate/engineering/electrical-computer-engineering/computer-engineering-bs/computer-engineering-machine-learning-data-science-bs/

Daley, S. (2025, January 6). *AI in Healthcare: Uses, Examples and Benefits*. Built In. https://builtin.com/artificial-intelligence/artificial-intelligence-healthcare

Felices, M. L. P., Costa, J. L. C., & Morenilla, A. J. (2010). Personal and emotional skill profiles in the professional development of the Computer Engineer. International Journal of Engineering Education, 26(1), 218–226. https://dialnet.unirioja.es/servlet/articulo?codigo=7395014

Felten, P., & Lambert, L. M. (2020). *Relationship-rich education: How human connections drive success in college*. Johns Hopkins University Press.

Gonzalez, D., & Jimenez, M. (2023). Academic performance of Computer Engineering students on the K-12 implementation. *Journal for Educators, Teachers and Trainers*, *14*(1). https://doi.org/10.47750/jett.2023.14.01.002

Glover, E. (2024, December 3). *What is artificial intelligence (AI)?* Built In. https://builtin.com/artificial-intelligence#:~:text=The%20primary%20approach%20to%20building,use%20of%20unlabeled%20data%20sets).

Grigoras, C. C., Zichil, V., Ciubotariu, V. A., & Cosa, S. M. (2024). Machine Learning, Mechatronics, and Stretch Forming: A History of Innovation in Manufacturing Engineering. Machines, 12(3), 180. https://doi.org/10.3390/machines12030180

Gupta, S. (2024, February 26). High-Paying AI Jobs & Careers to Pursue in 2024. *Springboard*. Retrieved January 11, 2025, from https://www.springboard.com/blog/data-science/careers-in-ai/

GUERRERO, C., & JAUME-I-CAPÓ, A. (2024). Use of Social Networks to Motivate Computer-Engineering Students to Participate in Self-assessment Activities. *Studies in Informatics and Control*, *23*(2). https://doi.org/10.24846/v23i2y201408

Indeed. (2024a, February 24). *11 Computer Engineering specializations you can pursue*. *Indeed.com*. Retrieved January 8, 2025, from https://www.indeed.com/career-advice/career-development/computer-engineering-specialization

Indeed. (2024b). *15 careers in robotics: Types and tips for exploring them*. *Indeed Career Guide*. Retrieved January 10, 2025, from https://www.indeed.com/career-advice/finding-a-job/careers-in-robotics

Indeed. (2024c). *18 highest paying coding jobs: Salaries and responsibilities*. Indeed. https://www.indeed.com/career-advice/pay-salary/highest-paying-software-jobs

Kampala International University. (n.d.). The role of salary in employee motivation and retention. Retrieved January 9, 2025, from https://ir.kiu.ac.ug/items/32565cc8-9861-4626-849c-0fbdffe8303d

Klavon, L. (2023, February 6). *Consider an Exciting Career in Computer Engineering - UNCF*. UNCF. https://uncf.org/the-latest/remake-the-future-stay-on-the-cutting-edge-of-technology-through-computer-engineering?utm_source=chatgpt.com&fbclid=IwY2xjawHraONleHRuA2FlbQIxMAABHeRNUpsqTJBpTtFa23j8WqM0XnvGWT5Y-YTHDZy3FRCvFwVpxmqrqNJqmg_aem_BqgrcqzC9xUpyu1U_c6fkA

Lamo, P., Perales, M., & De-La-Fuente-Valentín, L. (2022). Case of Study in Online Course of Computer Engineering during COVID-19 Pandemic. Electronics, 11(4), 578. https://doi.org/10.3390/electronics11040578

Lara-Bercial, P. J., María Cruz Gaya-López, Juan-Miguel Martínez-Orozco, & Lavado-Anguera, S. (2024). PBL Impact on Learning Outcomes in Computer Engineering: A 12-Year Analysis. *Education Sciences, 14*(6), 653–653. https://doi.org/10.3390/educsci14060653

Malykhin, O., Aristova, N., Dichek, N., & Dyka, N. (2021). FORMATION OF TOP JOB SKILLS OF TOMORROW AMONG COMPUTER ENGINEERING AND INFORMATION TECHNOLOGIES UNDERGRADUATE STUDENTS IN THE PROCESS OF LEARNING ENGLISH. Environment Technology Resources Proceedings of the International Scientific and Practical Conference, 2, 249–254. https://doi.org/10.17770/etr2021vol2.6642

Malykhin, O., Aristova, N., & Melikova, S. (2021). SOFT SKILLS DEVELOPMENT STRATEGIES FOR COMPUTER ENGINEERING AND INFORMATION TECHNOLOGIES UNDERGRADUATE STUDENTS DEVISED IN THE PROCESS OF

LEARNING ENGLISH. Environment Technology Resources Proceedings of the International Scientific and Practical Conference, 2, 255–260. https://doi.org/10.17770/etr2021vol2.6602

M. Engin, "Embedded and real time system design: A case study fire fighting robot," 2016 5th Mediterranean Conference on Embedded Computing (MECO), Bar, Montenegro, 2016, pp. 18-21, doi: 10.1109/MECO.2016.7525712.

Nguyen, H., Nawara, D., & Kashef, R. (2024). Connecting the indispensable roles of IoT and artificial intelligence in smart cities: A survey. Journal of Innovation and Integrated Systems Design. https://doi.org/10.1016/j.jiixd.2024.01.003

Sagbas, O. F., & Koc, M. (2021). *Computer Engineering Students' Views on Educational Use of YouTube Videos.* International Society for Technology, Education, and Science; International Society for Technology, Education, and Science. 944 Maysey Drive, San Antonio, TX 78227. Tel: 515-294-1075; Fax: 515-294-1003; email: istesoffice@gmail.com; Web site: http://www.istes.org. https://eric.ed.gov/?q=computer+AND+engineering&pg=3&id=ED623169&fbclid=IwY2xjawHrZUpleHRuA2FlbQIxMAABHVZccCEbkpP1PLUmmwrUPB-SasLe9x6_nZ1xvgTC1NugOmA5DHE6MJ397Q_aem_xYiPh1SDTdmmu7OVovraCw

Salokannel, P. (2024, July 1). *The Impact of AI: How Artificial Intelligence is Transforming Society — 3DBear*. 3DBear. https://www.3dbear.io/blog/the-impact-of-ai-how-artificial-intelligence-is-transforming-society

Santelices, R. (2024). *Performance in on-the-job training (OJT) of Computer Engineering students from host training establishments (HTES), summer 2022*. SSRN. https://doi.org/10.2139/ssrn.4887749

Solution, M.-. C. I. (2024, June 21). Emerging trends in computer hardware for 2024. https://www.linkedin.com/pulse/emerging-trends-computer-hardware-2024-the-complete-it-solution-vemnc/

Valero, M. (2022). *Challenges, difficulties and barriers for engineering higher education*. *International Journal of Engineering Pedagogy (iJEP), 12*(1), 66-80. https://doi.org/10.3991/ijep.v12i1.21527

Vasconcellos, E. (2023, December 20). *9 Cool 3D printing jobs*. Business News Daily. https://www.businessnewsdaily.com/5125-3d-printing-jobs.html

Wang, X., Dai, M., & Short, K. M. (2024). One size doesn't fit all: how different types of learning motivations influence engineering undergraduate students' success outcomes. *International Journal of STEM Education, 11*(1). https://doi.org/10.1186/s40594-024-00502-6

Xu, W., Ouyang, F. The application of AI technologies in STEM education: a systematic review from 2011 to 2021. IJ STEM Ed 9, 59 (2022). https://doi.org/10.1186/s40594-022-00377-5

Zhang, Dan & Pee, L. G. & Pan, Shan L & Cui, Lili. (2021). Big data analytics, resource orchestration, and digital sustainability: A case study of smart city development. Government Information Quarterly. 39. 101626. 10.1016/j.giq.2021.101626.

Zhuang, Y., Cenci, J., & Zhang, J. (2024). Review of Big Data Implementation and Expectations in Smart Cities. Buildings, 14(12), 3717. https://doi.org/10.3390/buildings14123717