BUILDING RESPONSIBLE COMPUTER SCIENCE ECOSYSTEM IN KENYA

Mozilla Foundation

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1. Introduction

The Kenyan technology ecosystem has occasionally been referred to as the "Silicon Savannah". According to a report released by AfricArena where Nigeria and Kenya are the hotspots for African venture capital investment with $307 million and $305 million raised in 2022, respectively[1]. It is the home to the world's largest mobile money platform, M-Pesa, a hub of hundreds of tech start-ups and has lately attracted huge investments from global technology giants to be the host for the engineering offices for Microsoft (Africa Development Center), IBM (IBM Research-Africa Lab), Google (Product Development Center), VISA (Innovation Studio) and AWS (Local Zone). This robust Kenyan tech ecosystem employs thousands of computer science engineers in designing, creating, deploying and supporting software products. Over the last few years, as the Kenyan tech ecosystem continue to grow, the number of offenses relating to computer systems misuse have also increased. The Kenya government have tried to address this rise in computer systems misuse by enacting the Computer Misuse and Cybercrimes Act, 2018 and the Kenya Data Protection Act, 2019. Therefore, this analysis is to reflect on the current training of computer education and the engagement of its stakeholders in addressing the ethical and social challenges arising at the interface of technology and human values..

Over the last twenty years, there have been a huge growth in academic and vendor specific trainings in computing and use of the internet beyond the fundamental digital literacy skills among the Kenyan training institutions as the demand for computer science and information technology professionals continue to surge. This has seen the introduction of diplomas, bachelors and masters academic programmes in computer science, data science, information systems, information technology, software engineering, informatics and computer engineering. These academic programmes are usually coupled with training on vendor specific certification from software developers and hardware manufacturers such Oracle, IBM, CISCO, Huawei and Microsoft. Computing products' certification trainings are also offered by vendor-neutral organizations such as Comptia, ISACA and EC-Council. There are also learning-accelerators who provide tech-based learning programmes for market-aligned skills such as a six-month programme training on a specific programming language such as Python. However, most academic and vender certification courses have minimal or no training on computing code of ethics, professional practices or responsible use of information and communication technologies.

Kenya is also a home to many innovation and incubation centers. These centers of excellence in computing, innovation and development are hosted by institutions of higher learning, or funding agencies. Their main objective is to incubate, build, nature and assist in launching scalable startups and ensuring persistent innovation. They help individuals to leverage computing technologies in building market-relevant solutions through mentorship, collaboration and access to requisite resources. However, there is minimal or no training on computing code of ethics and professional

[1] https://www.statista.com/chart/24911/vc-investment-by-country-in-africa/

practice, but there are courses on innovation, knowledge sharing, technology commercialization, and entrepreneurship.

The importance of responsible computing has been acknowledged by all the innovation and incubation hubs participating in the landscape analysis. This is particularly true during the current Kenyan election season. With misinformation and disinformation flying all over the country and has the potential to cause postelection violence. Most hubs agree that rules around AI ethics are essential, and actors must educate players about moral considerations.

1.1. Objectives

The main objective of this study is Conduct a thorough landscape analysis of the computing ecosystem in Kenya, to recalibrate the implementation of the ethical framework and strengthen the supporting infrastructure for responsible computer science (RCS) in Kenya. We identified the following to enhance the growth of RCS in Kenya:

i. Built and foster collaborative, respective connections with relevant stakeholders in the training programmes and technology hubs,
ii. Identify promising approaches for engaging with the local tech sector,
iii. To give recommendations on how to design the RCS Challenge in Kenya,
iv. Develop a methodological rubric to inform future landscape analysis in diverse geographies.

This landscape analysis highlights the current computing ecosystem in Kenya. The analysis was conducted as part of the Mozilla Foundation's global Project on Responsible Computer Science. The landscape analysis examines training, employment trends, and digital inequality in Kenya, as well as possible collaborative ways in which Mozilla Foundation could engage relevant stakeholders in the Kenyan tech sector, to conduct RCS challenge and to prepare for any future landscape analysis in diverse geographies. The analysis has the following sections: Section 1 introduces the landscape analysis and its objectives Section 3 provides the current status of the tech ecosystem; ; Section 3 presents the methodology employed for the analysis; Section 4 presents discussion and analysis Section 5 presents the recommendations on how to design the RCS Challenge for Kenya; while Section 6 reflects on the success of the analysis, its conclusion and directions for future analysis.

2. Computing Ecosystem in Kenya: Current Status

The Kenyan computing ecosystem has experienced rapid technological development, and digitalization, creating novel opportunities for information and communications technologies innovations, entrepreneurship and new business models. For this robust digital ecosystem to continue growing, it must be supported by the right digital skills development programmes and opportunities, strong employment growth, above-average salaries and an enabling business environment.

2.1. Computing Training in Kenya

To have the right digital and soft skills, most of the formal training in the Kenyan tech industry is conducted through undergraduate academic programmes, vendor certification courses and learning-accelerators trainings and mentorship programmes.

Computing training in the Kenyan Universities

In the Kenyan Universities, there are a number of diverse yet similar academic computing courses. These include BSc. Computer Science, BSc. Applied Computer Technology, BSc. Information systems, BSc. Data Science, BSc Mathematics & Computer Science, BSc. Software Engineering, Bachelor of information Technology, Bachelor of Business information Technology and other derivatives of these computing programmes. Some of the programmes have similar content but uses different naming nomenclatures due to nature of the university itself. Example, Technical University of Kenya uses Bachelor of Technology in Information Technology instead of BSc. Information Technology or Bachelor of Information Technology. A list of the accredited computing programmes in the Kenyan universities is provided as appendix 11 and a summary presented below in figure 3.1. These computing programs are taught and managed with the aim of providing the students with the requisite knowledge, skills and attitudes for professional excellence and competencies in theories and practice to develop innovative solutions to complex global problems. The graduates of these programs have core knowledge in computing areas such as theoretical foundations of computing, data structures, networks, operating systems, industry-standard programming languages, problem solving with databases, computer ethics, Web and mobile application development, artificial intelligence, data mining, and software engineering.

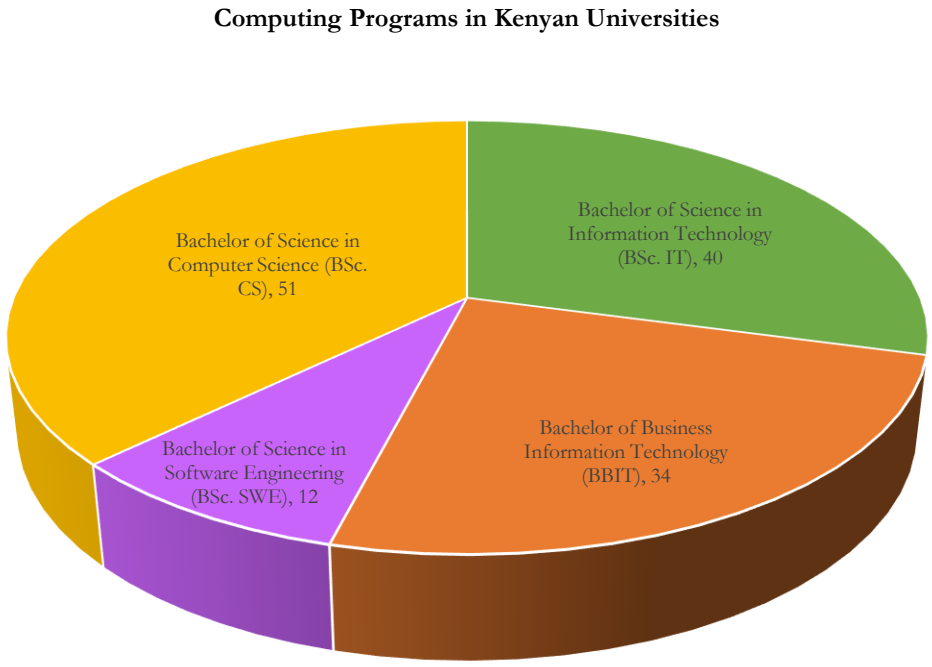

Figure 2.1: Number of Computing programmes in Kenyan Universities.

Clubs and Apprenticeship

Outside classrooms, computing training and mentorship in the Kenyan Universities also take place in the computing clubs. Most universities have clubs to equip students with skills in tech to bridge the gap between class work and workplace. The club welcome students with diverse backgrounds interested in new technologies while fostering a friendly and collaborative learning community environment. The clubs organize training bootcamps, mentorship meetups, hackathons and competitions such as the Capture the Flag (CTF). The clubs have an advantage in that they can quickly adapt students' trainings and mentorship to respond changes in the local and global technological advancement while university departments may take months or even years to propose and complete curriculum improvements.

Skills Development in the Learning-Accelerators

Learning-accelerators are institutions seeking to close the computing skills gap in Kenya by providing job-ready skills to their trainees through market-aligned curriculum, project-based learning and practical on-the-job-experience simulations. The institutions also assist their trainees to building network and relationships in the local and international technology ecosystems. Based on the type of funding, learning accelerators could be categorized in two groups namely (1) Donor funded or supported, and (2) For-Profit.

Donor funded learning accelerators offer training and mentorship to their mentees without requiring any payments from them. Some of the learning accelerators which are dependent of donor funding, grants and well-wishers include KamiLimu, Cyber Shujaa, Akirachix and Pwani Teknowgalz. Some of the For-Profit learning accelerators include Moringa, Zindua and Jenga. Some learning accelerators such as the Ubunifu College also do incubation services where they seek to have their students develop complete software products within a given timeline and to launch their own startups.

Skills Development in the Innovations and Incubation Centers

Even though most of the innovations and incubation centers are based in Nairobi, many more are housed in the rural areas and second tire towns of Kenya. Those innovations centers outside Nairobi are members of the Association of Countrywide Innovation Hubs[2]. Computing based innovation and incubation centers offer access to incubation, mentorship and access to funding while no tech related hubs offer training and mentorship programs in adoption of modern organic farming techniques, use of green energy technologies and environmental conservation. The focus of this report is limited to the tech related innovations and incubation hubs. Most trainers have a minimum of a bachelor's degree. However, trainers are selected based on the nature of trainings and the level of trainees. The innovations and incubation offer pre-incubation and incubation training programs. These training include marketing, design thinking, company planning, and entrepreneurship.

Some of the innovations and incubation centers have informal rather than official arrangements with educational institutions, which permit them to take part in the universities' activities. The innovations and incubation centers offer mentorship to the students from partner institutions and let them use the hubs' resources and laboratories. On the other side, many academic-focused incubation centers have official arrangements. Some researchers and innovators hosted by the innovations and incubation centers are supported by the universities and are working on projects that benefit both faculty and students of the partner institutions.

Constituency Innovation Hubs

The government proposed to setup two hundred and ninety constituency innovation hubs to provide free internet, training and workspaces to enable the public access to online jobs and information for decision making. As technology centers, the constituency innovation hubs are expected to empower the youth by giving them an opportunity to earn decent wages from online work. They offer ICT capacity building, online jobs, data management and entry (transcribing court proceeding) and digital marketing and e-commerce. Five constituency innovation hubs were visited. Four of the constituency innovation hubs were active while one is yet to be operationalized. The constituency innovation hubs' trainees are usually taken through digital literacy training for one week followed by a two-week mentorship programme. The training and mentorship are meant to help the youths in building online work careers, hence improving their livelihoods.

[2] https://countrywidehubs.org/

2.2. Funding Innovation Hubs and Participation

There are thirty-eight active incubation and innovation hubs. Many more other hubs have failed to survive beyond their initial funding or the first two years of their operations. From an interview with a founding member of the Association of Countrywide Innovation Hubs, the number of innovation hubs had increased from the fifteen founding organizations in 2019 to more than forty members in 2022. The Association of Countrywide Innovation Hubs was formed to promote activities and programs of hubs outside the city of Nairobi. However, several hubs have wound-up or scaled down due to high operational costs and lack of adequate funding and access to capital. To ensure sustainability of the innovations and incubation hubs, huge financial investment is required to finance business growth and to pay for the day-to-day operations.

Kenyan innovation and incubation hubs are either funded by the government, universities, private organizations or depend on donations as shown in figure 3.2. Other hubs also host and mentor individuals who pay a membership fee. The membership fees range between Kenya shillings one thousand five hundred per month to fifteen thousand. A sample of two such hosting plans are shown in figure 3.3. However, the government funded hubs offer opportunities for financial support, office facilities, technical support, advisory services, access to market, networking opportunities and access to incubation and accelerator facilities at no cost.

The innovation and incubation hubs have a sizable participation base including student interns, entrepreneurs and start-up businesses who take part in acceleration programs. The fifteen selected hubs have launched a total of one hundred and seventy-eight startups from their incubation programs, graduated three hundred and eighty-two software developers and supported two hundred and twenty-six entrepreneurs in the last two years. The hubs have full-time employees who provide training and mentorship in different programs. Upon training some hubs provide certificates while others do not.

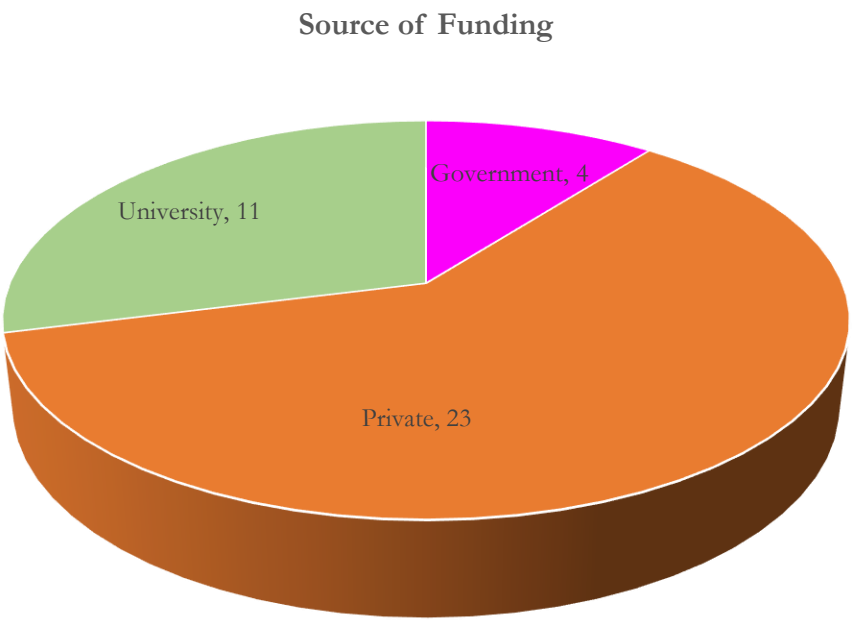

Figure 2.2: Innovation and Incubation Hubs Source of Funding.

The Kenya National Innovation Agency organizes the annual Kenya Innovation Week to showcase the innovativeness of Kenyans, fulfill its mandate of coordinating, nurturing and promoting the National Innovation System and in strengthening research and commercialization practices for greater socio-economic impact and addressing Government priorities and needs.

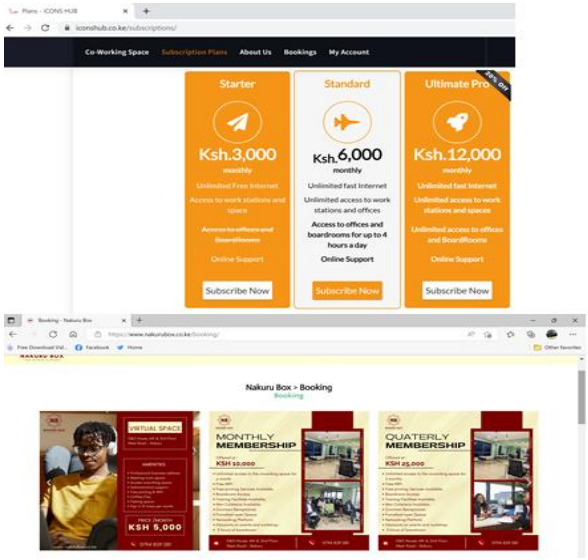

Figure 2.3: Innovation and Incubation Hubs hosting Costs

2.3. Employment for Computing Programs Graduates

Most computing graduates join employment through internship programs, career fairs and hackathons. Other students get their jobs through online job-seeking platforms which aggregate job seeker profiles, job positions, and employers in a database. Graduates also get their employment from organizations which advertise jobs on their websites.

Recruitment

Traditionally, organizations publicly advertise for vacant positions. The categories of organizations that were selected for data collection are listed in table 4.1. From the fifty-eight organizations where the interviews were done, only thirteen had placed job advertisement on the print and electronic media in the last one year and they did so only to meet the legal requirements. These twelve of these organizations were government agencies. It is mandatory for all government agencies to advertise their latest job vacancies through print and electronic media. The government agencies also recruit employees through the Presidential Digital Talent Program.

Over the years, most undergraduate students had to complement their undergraduate degree trainings with vendor specific certifications as the computing curriculum was more theoretical in nature. Most employers would require a student to come when already having completed the CISCO, IBM, Oracle, Huawei or Microsoft certification. However, Over the years, universities have now established labs so that there is hands-on training to teach students.

No.	Category of Organization	Number of organizations where data was Collected
1	Government Agencies	12
2	ICT Departments of non-ICT Organizations	18
3	Technology Intermediaries	2
4	International Technology Companies	2
5	Software Development Houses	13
6	Tech Startups	8
7	Telecommunication Companies	3
	Total	**58**

Table 2.1: Categories of Organizations that were selected for data collection

Tech startups, technology intermediaries and software development houses work together with the universities, learning accelerators and innovation and incubation hubs as employer partners. Through the employer partner programs, these organizations are given the opportunities to market,

promote and recruit directly from the training institutions. The organizations are also allowed to recruit during university career fairs, pitch competition and hackathons.

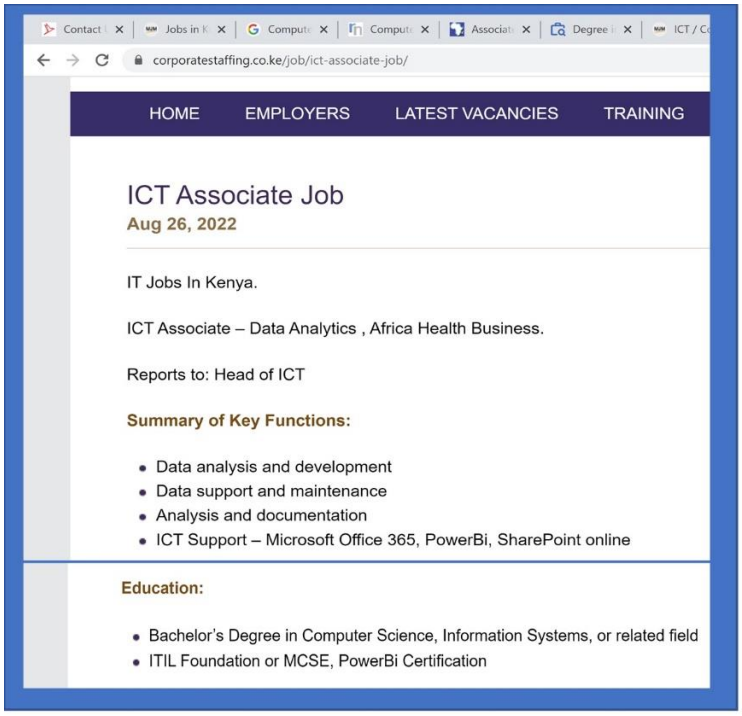

***Figure 2.4: Computing Job Advert*[3]**

Technology intermediaries, international technology companies and ICT Departments of non-ICT Organizations mostly use recruitment agencies in Kenya to find highly skilled employees. These agencies run print and electronic media advertisements on behalf of their client organization. A Sample job advert is shown on figure 4.1.

Most international technology companies hire graduates who have core computer science skills. These include data structures and algorithms and system designs. This makes them the number one employers of computing graduates. For technology intermediaries, startups and ICT Departments of non-ICT, they mostly employ learning accelerators and computing graduates who can create an API, consume an API and are good in one programming language.

AJIRA Digital Program

The AJIRA Digital Program[4], an initiative by the government of Kenya through the Ministry of ICT, Innovation and Youth Affairs to enable one Million youth to earn a decent wage from digital and digitally enabled jobs online by providing them with the right tools, training and mentorship.

[3] https://www.corporatestaffing.co.ke/job/ict-associate-job/
[4] https://ajiradigital.go.ke/#/index

The Ajira Program training is usually conducted in various designated centers in each county. The centers are normally meant for use by the citizens to access the e-government services.

2.4. Digital inequality

Over the years, many community-based organizations have tried to address the matter of rural urban digital divide, gender digital divide and the urban digital divide. The government has not been able to reduce the rural-urban and urban digital divides as most of the ICT services are provided by private organization and whose main objective is profit. That is why it is we still have many people using cybercafé services in rural areas as well as the urban slum areas and non-in the affluent suburban areas. Internet is also still expensive for most of the Kenyans and even a good device to access the internet is not affordable many people. In some places the support infrastructures such as electricity, mobile phone network and digital skills are not there. This problem was aggravated due to the failure of the national digital literacy skills program which was launched in 2013 when there was the introduction of computer for schools' program. While most people in areas use internet as a source of news and information, people in rural areas mostly get their news from vernacular radio stations. This means that most people do not get information in time.

Poor working conditions in most of the Business process outsourcing (BPO) is also a huge challenge with employees complaining of unsafe and unfair working conditions. Only last month that Sama[5], the Facebook content moderators' subcontractors were taken to court for violating their employees' rights by keeping them in unsafe and degrading environment which was posing a health risk to the workers. Similarly, the commission percentage paid by the Uber drivers makes the drivers to use multiple apps so that they can keep on driving when on app is blocked for working more than predefine number of hours and to allow the driver to take rest. Uber getting 25% of the fare is exploitative as fuel prices are too high and the base fare does not compensate well enough. Many people are also exploited when working on the online writing jobs through poor rates and delayed payment by the local middlemen.

There is an urgent need to create laws to prevent e-waste dumping by multinational corporations in Kenya. The National Environment Management Authority6 describes e-waste as "discarded electrical or electronic devices or appliances that have ceased to be of any value to their owners". Even though there was a directive to stop importation of second-hand electronic devices in January 2020, hundreds of such devices come to the country every month as evidence by the available stocks in most of the computer resellers shops in Nairobi.

[5] https://www.sama.com/our-story/
[6] https://www.nema.go.ke/

3. Research Methodology

To address the research objectives, qualitative data collection methods were used. These included face-to-face semi-structured in-depth interviews supported by observations, document analysis, an expert panel group discussion and a survey among computer science interns.

3.1. Data collection methods

Interviews

The semi-structured interview approach was adopted to allow further prodding and seeking physical evidence in case of any available innovations, community related activities or labs. On skills development, the study sought to interview Deans, Chairs of departments, Programme Leaders and Coordinators of computing schools and departments among Kenyan universities, innovation and incubation centers and the learning accelerators. These face-to-face interviews lasted between fifty minutes and two hours. Semi-structured interview guides were used to facilitate the dialogue between the researcher and participants. The interview guides are attached as appendix 1 (Universities), appendix 2 (innovation hubs), and appendix 3 (learning accelerators). Pertaining to employment, human resource managers and line managers of purposely selected software development houses and tech intermediation firms were interviewed. The interview guide is attached as appendix 4.

Expert Panel Discussion Group

A panel of experts was specifically selected to evaluate the existing efforts in the Kenyan universities to teach social, ethical and political dimensions of computing. Twelve of the participants were faculty members from Kenyan Universities while the other three members were corporate executives. The faculty members comprised of Deans, Chairs of departments or their appointed representatives. A list of the participants is provided and attached as appendix 5.

During the group discussion session, the members were presented with the results from the semi-structured interviews and were asked to give their personal observations in regard to teaching ethics in the undergraduate computing programmes as well on how their schools or departments were improving people's lives using technologies. The moderator’s guide to the panel discussions is attached as appendix 6.

Internship Survey

The Internship Survey was developed to collect data from the computing students taking their industrial attachment on their experience in regard to social, ethical, and political dimensions of computing during their university studies as well as during the internship period. The survey questionnaire is attached as appendix 7.

3.2. Sampling

Data was collected from randomly selected participants among the Kenyan universities, learning accelerators, employers, computing interns and the innovation and incubation centers.

Universities

Currently, Kenya has seventy-two universities. These include thirty-five public universities and four public universities constituent colleges, hence, thirty-nine government funded degree programmes offering institutions. The National Defense University-Kenya which offers courses in areas related to defense and security and the Pan African University Institute for Basic Sciences, Technology and Innovation (PAUSTI), housed at Jomo Kenyatta University of Agriculture and Technology (JKUAT) and which has a focus on postgraduate degrees only are the other two public degree offering institutions in Kenya. There are thirty-one private universities and two private universities constituent colleges while five foreign universities have been granted authority to collaborate and offer degree programmes in Kenya. Among the five existing collaborations, only one, the University of Hertfordshire in United Kingdom is offering a computing related undergraduate degree programme.

Private universities fund their operations through student tuition fees, donations, and endowments. However, from the year 2015, most of the private universities have been admitting government-sponsored students. A list of the universities in Kenya is attached as appendix 8. Out of the seventy-two universities, only sixty-three institutions are currently offering computing related degree programmes. Seven private and two public universities do not offer any computing related degree programmes. Data was collected from thirty randomly selected universities which included thirteen private and seventeen public universities. A list of the universities from which data was collected is attached as appendix 12. To regulate and assure quality among the Kenyan universities, supervision and monitoring is done by the Commission for University Education[7]. The commission also approves the degree programs offered by these universities.

Expert Panel Group Discussion Participants

Key stakeholders were identified to participate in an expert panel discussion on the existing efforts in the Kenyan universities to teach social, ethical and political dimensions of computing. The participants were selected from the academia and the information technology industry. The academia participants were selected randomly from the thirty study universities. They included, one Dean of school, seven Chairs of Departments and four faculty members who were representing their department chairs. Five participants were from public universities while seven were from private universities. The group discussions also had three corporate executives who included an Information Security Manager at a public liability company[8], a Business Continuity and Resilience

[7] https://www.cue.or.ke/
[8] https://kplc.co.ke/

Solutions Practice Lead in an information technology services company[9] and a cloud security advocate at a multinational technology corporation[10]. A list of the participants is provided and attached as appendix 5.

Learning Accelerators

Even though there are many Information Technology training centers in Kenya, most of them offer vendor authorized instructor led training and certifications using vendor official curriculum, course materials and certified instructors. These training institutions pride themselves as "authorized training and testing centers". A sample course listing from one of the training centers is shown in figure 2.1. These centers are expected to seek accreditation from the Technical and Vocational Education and Training Authority (TVETA[11]). While these Information Technology training centers offer generic technical training for the business ecosystem, the Learning Accelerators focus on helping the learners to build their skillsets through real-time project-based learning. This is meant to provide the students with marketable, industry driven skills designed to meet current and future tech industry demands. The courses offered by the learning accelerators are in Data Science, Software Development, and Blockchain Development. There are thirteen prolific leaning accelerators and upskilling programs and three Coding Programmes for kids as listed in appendix 9. Data was collected from eight randomly selected leaning accelerators.

Figure 3.1: An Information Technology Training Center Courses

Innovation and Incubation Hubs

Innovation and incubation centers are usually co-working spaces where ideas thrive to achieve potential of becoming great companies or get support to scale and grow their social and

[9] https://www.dimensiondata.com/
[10] https://www.microsoft.com/en-us/madc
[11] https://www.tveta.go.ke/

commercial impact. The centers provide infrastructure (office, equipment, marketing), mentorship, training, access to finances, investor pitching and linkages. They provide dedicated physical and virtual incubator facilities. Selected ideas are normally incubated for a six to twelve months period to ensure their successful scale and launch as startup centers. There are thirty-eight prolific innovations and incubation centers. Four are government owned while eleven and twenty-three are under universities and for-profit businesses respectively. The lists of the thirty-eight innovation and incubation centers is attached as appendix 10. Data was collected from fifteen randomly selected innovation and incubation centers.

Employers

Due to the academic diversity and inter-disciplinary nature of computing programmes taught in the Kenyan universities, the graduates are usually employed in the public and private spheres locally and internationally as systems analysts and designers, system developers, researchers, network administrators, database developers and administrators, cybersecurity and project managers. Data was collected from fifty-eight randomly selected organizations.

Computing Interns

1 Undergraduate Students Internships

All of the computing bachelor degree programmes in the Kenyan Universities have integrated some form of industry internship in their curriculum requiring the students to undertake three months industrial attachment before they graduate as part of their meeting their graduation requirements. A student is required to complete at least 400 hours of work over the course of the industrial attachment. Most students are usually engaged in the industrial attachments as unpaid internships. A survey questionnaire was emailed to forty-five Applied Computer Technology programme students taking their industry internship during the summer 2022 semester.

2 Presidential Digital Talent Program

Presidential Digital Talent Program is a government managed twelve-month internship program in both the public and private sector organizations which started in 2016 with one-hundred interns. "The objective of the program is to prepare young talents with skills on ICT operations, gain work-place experience, refine career goals and build professional networks in the areas of Network and Infrastructure, Applications development, Information Security, Research and Innovation and Project Management to enhance employability and self-reliance in the ICT sector"[12]. The program also aims to build ICT technical capacity in government for effective and efficient services delivery leveraging on ICT.

[12] https://digitalent.go.ke/

4. Results and Discussion

Teaching of ethics in computing will ensure that the graduates being released in the market are not only technical proficient but are moral in their practices, ethics should be integrated in the computing education. Decision makers in government and private sectors are already exploring ethics as part of their work and society, hence we need to equip our student with ethical principles in our training.

4.1. Ethical courses in the Kenyan Universities

Views from Deans, Chairs and Program Leaders

Data from the semi-structured interviews showed that most of the computing academic programs in the Kenyan Universities have minimal or no training on computing code of ethics, professional practices, or even responsible use of Information and Communication Technologies. For several universities, one or two generic courses on ethics are usually taught during the fourth year. Table 5.1 shows some of the ethics taught courses taught in the Kenyan Universities. The sample course outlines for these courses are attached as appendix 13. Most of the universities are teaching same courses as they borrowed them from their mother universities.

A focus group discussion was conducted on 6th July 2022 to explore teaching Social and Ethical dimensions of Computing in Kenya universities. To this effect participants from both public and private universities in Kenya teaching computing were identified and invited to participate in this activity. The panel had twelve faculty members from Kenyan Universities, three corporate executives, the moderator and a rapporteur. The data from the semi-structured interviews phase was presented to the participants and used as the background information on teaching ethics in the Kenyan universities. The moderator used the panel group discussion guide to lead the meeting proceedings. A photograph of some of the participants is shown below.

From the discussion on teaching the ethics course is taught by most of the universities at a higher level, 4th Year, the main emerging theme was that of "harnessing the power and knowledge the student possesses". The assumption that a student in fourth year "Knows the Power they have through the knowledge acquired and need to learn how to harness it". There was consensus among the participants that by virtual of the students being fourth years, high chances are that at some point during their studies, the student is likely to have encountered an ethical dilemma.

No.	Ethics Related Course	University	Year of study
1	COSF125: Computer, Law, Ethics and Society	Kabarak University	1st Year
2	ACS401: Computer Ethics and Social Values	Daystar University	4th Year
3	ACSC371: Professional Computing Ethics, Law and Marketing	Chuka University	3rd Year
4	BAC2104: Professional Issues in IT	KCA University	3rd Year
5	BIT2222: ICT and Society	Multimedia University	3rd Year
6	CCS4204: Professional Issues and Ethics in ICT	Dedan Kimathi University of Technology	4th Year
7	CIT3451: Professional and Ethical Issues in Computing	Meru University	3rd Year
8	CIT4205: Social Impact of ICT	Dedan Kimathi University of Technology	4th Year
9	COMP420: Professional Ethics and Information Law	Kabarak University	4th Year
10	CSC422: Legal and Ethical Issues in Computing	Kibabii University	4th Year
11	LBIT2202: Ethics in Information System	Lukenya University	2nd Year
12	SCO 402: Legal and Ethical Issues in Computing	Machakos University	4th Year
13	SCO402: Legal and Ethical Issues in Computing	Chuka University	4th Year
14	SCS409: IT and Society	Jaramogi Oginga Odinga University of Science and Technology	4th Year
15	SCS427: Social and Professional Issues in Computing	Jaramogi Oginga Odinga University of Science and Technology	4th Year
16	SIT405: Professional Practice and Ethics	Murang'a University of Technology	4th Year

Table 4.1: Categories of Organizations that were selected for data collection

Figure 4.1: Expert Panel Participants

From the expert discussion group, it was clear that there are efforts geared towards teaching of social, ethical and political dimensions in computing programs. However, this is not done in all institutions. Participants from religious based institutions which are private, have ethics courses in their curriculum. Nevertheless, some institutions had ethic topics in computing courses and

not necessarily as a standalone ethics course. In some public institutions teaching of ethics is not necessarily in computing courses but also in other degree programs. In one university there is no teaching of ethics in any of the four computing degree programs. It was equally observed that there was a general assumption that religious institutions were generally expected to graduate ethical students. When comparing the behavior of computing graduates from panelist universities, the industry experts indicated that even if one of the universities is renowned for producing highly skilled computer scientists, the graduates have high degree of behaving unethically which undermines their competitive strength.

The panel explored whether the participants are aware of the Association for Computing Machinery (ACM) code of ethics and if they have used it in their classes. A few of the participating institutions were not familiar with the ACM Code of Ethics and Professional Conduct document. Therefore, they had not used it in their teaching. However, one faculty from a public university confirmed that they were familiar with the document and had used it while teaching one of the

courses that had ethical components. Nevertheless, there is no evidence that other faculty in their institution are using it in their teaching.

Students view of the Social, Ethical and Political Dimensions of Computing Education

A survey on social, ethical, and political dimensions of computing was conducted to determine the responsibility of computing professionals. We received nineteen (19) responses, majority of who attend USIU and study Applied Computing Technology. Many chiefly enjoy the Forensics course and other courses including Security Data and Science, Cyber Security, Algorithms, Web Development and Database Management and Artificial Intelligence. Though the respondents enjoyed these courses, they wished Ethical Hacking, Project Management, Blockchain Technology and Robotics were included in the Computing Program.

More than half of the respondents noted that they did not have a course that deals with responsible or ethical computing. In contrast, one person noted that every course has an aspect to ethical discussion. Others also identified that Ethical Hacking, Forensics, Criminal Investigation, and Introduction to Security Systems dealt with responsible or ethical computing.

After the program, most of the respondents' plan to work. Others plan to develop a start-up and a few plans to study. Interestingly, many have not participated in any Computer related Social Project, however the ones that have, participated in projects aimed at a car leasing app, an online store for wholesale products to retailers and monitoring water attributes in real time. For work or study, about seventy percent (70%) prefer the West (USA or Europe) to Kenya. About ninety-four percent (94%) will be interested in a course or lecture on ethics as well as a workshop or lecture on application of computing for social good.

4.2. Integrating Ethics in Computing Programs

How can universities implement computing ethics in their curriculum?

The expert panel group discussion did explore how to teach ethics in a program that does not have any ethics components either as a standalone course or in its program learning outcome. The team chose to use Applied Computer Technology program from the USIU-Africa. The program brochure is attached as appendix 14. The experts explored two options of either having a standalone ethics course or embedding of ethics in multiple courses throughout the curriculum.

Introducing a standalone ethics course

The USIU-Africa BSc. APT Program does not have any ethics course and could benefit greatly by having a course on ethics. However, the experts felt that a standalone course does may not be enough as today's applications and algorithms build for a Cloud First, Mobile First world do have profound social implications on peoples live. One faculty who teaches "Computer Ethics and Social Values" indicated that a single course may not be sufficient in today's world ethical issues permeate almost all areas of computing and over the internet communication can all lead to unintended and harmful consequences. The team then proposed to explore which courses from

the current curriculum would be appropriate as ethics intensive courses and agreed on the following:

- APT2055: Hardware and Software Practicum
- APT3010: Introduction to Artificial Intelligence – Trial done
- APT3025: Applied Machine Learning
- IST3015: Business Data Analytics
- IST3050: Introduction to Security Systems
- IST4078: IT Innovation and Entrepreneurship

Introducing Computing Ethics Intensive Courses

Computer and data scientists today wield tremendous power. The code they write and models they build may be engaged with by billions of people and influence everything from what news stories we read to what personal data companies collect to who gets loans and who does not. Algorithms are structuring, influencing, constraining, and controlling growing aspects of human behavior. Gaining skills in responsible computing helps the student to always reflect upon the wider impacts of their work and to act responsibly. A course that is designated as Computing Ethics Intensive should engage student in the acquisition of knowledge on privacy, security, dangerous consequences their work and in supporting the public good by considering ethics as a design feature from the outset of their careers.

Such a course should display the following characteristics:

1. Provide opportunity for every student to learn what constitutes appropriate and inappropriate behavior as a successful computing professional.
2. Provide opportunity for students to demonstrate an understanding of the legal, ethical, and societal implications of computing.

Curriculum changes at the universities

To have these changes effected in the curriculum, all participants agreed that institutions will need to do program reviews to have this effected. Both introduction of new courses and incorporating social, ethical and political aspects in existing course will be dependent on the internal university processes. However, the faculty felt there is an urgent need to incorporate these aspects in teaching of their courses as they await the review processes. They were all in agreement that any new responsible computing courses should be introduced and made mandatory for all students taking computing programmes. This is because ideally, computing students should not only be equipped with theories of philosophy and ethics pertinent but have knowledge on how to practice ethically.

Most private universities are continuously improving their curriculum as the Commission for University Educations conducts regular monitoring and evaluation to ensure compliance with legal requirements and conformance to set standards. The commission allows changing at most 30% of a program without necessary requiring new approvals. This gives the universities a chance to either

choose to have a new standalone course or implement the suggested computing ethics intensive courses. The new changes should take effect in the new academic year.

Financial implications and for curriculum changes in the universities

The panel participants unanimously agreed there could be some form of financial implications. For institutions introducing new courses there will be financial implications if the students will have to take this as an extra class. However, if it is substituting an existing course with a new one, the financial costs would be minimal. For those introducing intensive courses, the financial cost would involve faculty training and mentorship. This will be the same situation for institutions reviewing existing courses to incorporate ethic social and political aspects. Participants concurred that funding for curriculum changes would be necessary to ensure that there are no huddles in introducing the new courses. This will ensure that the graduates being released into the market are well equipped and have ethical values inculcated in them.

Curriculum changes for the learning accelerators

Learning accelerators have a shorter and very strict training schedule. They also have very specific trainings as they are geared toward producing a market ready graduate within the shortest time possible and with market ready skills. This may not allow the luxury of extending the training durations by introducing computing ethics without having negative financial implications to the learners and the institution. Most Learning accelerators would not continue the project beyond the funding period. This may negatively impact the desire the Mozilla Foundation has of transforming computing training by infusing responsible computer science in the training programs for the current and future talent pipeline flowing into the tech ecosystem.

Curriculum changes for the innovation and incubation centers

There is an increasing need to have curriculum changes introducing instruction in new technology ethics, safeguarding inventions, and combating malicious users and uses. All the innovations and incubation hubs agree that any funding for training would be beneficial. Most of them have in the past received funding for starting or operating as technological enterprises. Most of the managers suggested that if the funding was made available to train on responsible computing, a training need assessment will be carried out to determine what training will be conducted, who should get it, and how. This data will be used to create a curriculum and carry out the trainings. The final step will be to evaluate and monitor the program.

4.3. Staff preparedness on computing ethics issues

There was general concern raised by participating organizations on issues to do with new employee orientation and specifically on ethics. In most organizations, orientation is done by the human resources department and this component of ethics is always over-looked. Therefore, there is need to ensure that while on-boarding new employees that they commit to ethical practices and failure to do so should have dire consequences. Participants also indicated that there is need to have strict punishment for offenders besides being laid off. This will ensure that culprits do not end up being hired by other firms and hence exposing other institutions to the same risks. There was a general

observation, that financial gains have been the key motivator for learners and employees to engage in unethical practices. In some institutions those employed to oversee ethical practices have also been compromised.

Some organizations indicated that in-house training relating to computing ethical issues have been carried out but not in a consistent manner. This is due to lack of finances. The trainings mostly have been organized by the human resources department and provided by external trainers. However, there are institutions which do not do any form of training. Members believe ethics training should not be conducting in a cross-disciplinary setup since it will not have impact as intended. The issue was that computing ethics highly affects those in IT practice more than those in the other departments. Nevertheless, training and interactions with industry experts is crucial.

Respondents agreed that the place of industry in preparing graduates was lacking. The industry being the consumer of the university products, there is need to involve them in delivery of ethical aspects in the learning process. During internships, feedback from the industry should capture social and ethical components and not just the technical proficiency. The internship should also be done not necessarily as the last course in the student's program so that corrections and feedback can be affected to the students concerned while still in progress. Besides graduating students with tech knowledge, there is need to have them take certification courses and enroll with certified professional bodies. There is need to have regular industrial surveys conducted and the report shared amongst learning institutions to ensure the graduates released are fit for use. Institutions can introduce ethical champions who can enlighten their peers on importance of being ethical. There is need to get feedback from industry to ensure training is geared to the market needs. Teaching workload should be fairly distributed on the syllabus to ensure the social, ethical and political aspects are well taught and practical evaluations are administered.

4.4. Employers and Computing Ethics

For most of the organizations participating in the landscape analysis, it was observed that they were not only concerned about computing ethics but have office and employees tasked to dealing with ethics. Nonetheless, the issue of ethics in most organizations is not restricted to computing ethics but to all departments.

To ensure that computing is done in ethical manner participating firms have set up departments which ensure that any ethical computing issues raised are addressed appropriately. In some organizations, there are full functional department which handles any ethical issues. The department plans and schedule regular meetings to ensure that all employees are aware of the existence of an ethical code of conduct or policy and how it affects each employee. Despite all these, 88% of the participating organizations had experienced some form of computer misuse. This includes incidents where employees and interns have used organizational information for personal gains. There has also been massive hacking into organizations' information systems which causes massive losses and, in most instances, this is always attributed to the insider

misuse. In most incidents, the information systems misuse has arisen from the most proficient employees. This has led to institutions developing policies that will ensure that institutional data is not tampered with or is not shared out. These malpractices have resulted to firms losing some of the best performing employees.

Some organizations have employed ethical officers to ensure ethical practices are adhered to. However, the rapid changes in technology have posed challenges in keeping the ethical officer on tab with the many new eventualities. The qualifications of those working in the ethics department varies since in most organizations ethics is multifaceted. This requires organizations to have their ethical officers to undertake interdisciplinary training and regular refresher courses.

4.5. Computer Science for Social Good Projects

Most institutions have engagements with communities around them. This include training of STEM courses to girls' schools in the neighborhood, running innovation hubs which are used by students and outsiders as well as offering free internet access to the marginalized communities living in the slums. There are institutions that are currently training businesses on digital literacy skills, creating their online presence by developing and hosting websites for them at no costs. There are digital hubs where data is secured and retrieved on need basis for different projects in the community for free. It was observed that funding for social computing activities will ensure that institutions will relate well with their stakeholders as well as the communities in the locality. Most institutions indicated that they have many activities that they can engage in but due to financial constraints they have not been able to do so. One institution indicated that they support use of technology by Civil Society Organizations (CSO) in their daily operations through at their innovation center to create social change. CSOs in Kenya are active, and their innovations have impacted the world. Some of the innovations offering social solutions to Kenyan communities are Nuru, Sabasi, and Ushahidi. Providing internet at reasonable prices and facilitating easy access has opened doors for community-based organizations to work with incubation centers to grow their social ideas.

5. Recommendation

To make an informed recommendation for the RCS challenge it is imperative to ensure an inclusive participation of the design of the RCS challenge, offering an opportunity to adopt, implement and sustain the outcome of the RCS challenge.

5.1. Structure of the AI Challenge

Entry Point

Universities are he most feasible entry of the Responsible computer science challenge, although it can take about 36 months to change an entire curriculum, they also have the flexibility of adjusting their current curriculum to about 30% which can take effect immediately. Universities also have a lot of collaborations with the private sector and society either through research, recruitment or joint projects. The universities access to the private sector and society will enable an inclusive approach to the RCS challenge, thereby driving discussions around the responsible development and deployment of emerging digital technologies.

The Computing clubs in universities can also be an avenue in integrating ethics in computing programs. Except two of these universities visited, the other twenty-eight universities have an active computing student led club. Some of the universities also have the Google Developer Students Club which is run by the students and local Google communities. The clubs organize hackathons, workshops, poster presentation, technical talks, panel discussions, annual symposiums both in person or online. The student led clubs attract funding from many corporates to support their initiatives as well as receiving some funding from the universities. By hosting meetups, workshops and competitions, the student led clubs could be an ideal place to assist the university environment in successful implementation of the responsible computing curriculum and supportive activities. The advantage of the club is its diversity (different faculties) and can quickly adapt and respond to changes with less bureaucracy.

Moreover, Thanks to the landscape analysis we have been able to form a RCS Working-Group, majority of the group member are from academia and they all realise the need to train student on responsible computing. They also realised the impact of training their students on the responsible development and deployment of technology. For this reason, the members affiliated institution are very interested in the challenge and are looking forward to being part.

Customizing and Localizing Content

The RSC Challenge is to help improve computing educational content at low-cost whiles developing local values and principles for computing that prioritize inclusion, ethics and transparency. This can be done by leveraging the existing curriculum or collaborating with the newly established RCS working group to create content. The capacity of the working group can drive this agenda, develop locally appropriate solutions that are effective in their local institutional context.

Understanding of how to sustain and scale the RCS challenge.
Maintaining the quality and equity of benefits when diffusing a new concept may differ from the proof of concept. We may also have to research on the process of scaling the RCS to expand to new locations or extending the benefits. This will require and understanding on why the RCS may work well a particular context and why it may require some altering to succeed in a new environment. A lot of publication can be generated for this challenge to make an impact and serve as a motivation for academia to participate.

Having a diverse participation of the challenge, we could also be observing to better understand what context of the challenge works or do not work and for whom. We must also explore the impacts differential on the various participants (Industry, location, gender etc). This approach will increase efficiency to have a broader social effect.

Social Good Projects.
To have real time impact and generate actionable findings that will facilitate the implementation of the outcome of the RCS challenge, the challenge should be structured to support participants to develop, deploy and using computing technologies to positively impact education, health and food security and whiles ensuring these applications are ethical and inclusive. Whiles it is important for the RCS challenge to be driven by the locals, we can draw inspiration from the past RCS challenge around the globe.

5.2. Support for the Challenge

The duty of identifying the innovative topics for potential financing among the university faculty, innovation and incubation centers and the learning accelerators would be interesting and very competitive. Based on grant conditions, the funding is usually easy to manage through the university finance departments just like the National Research Funds[13] are disbursed.

We recommend adopting the grants offered by most university for curriculum development which ranges from 500,000 Kenya Shilling to about 1,000,000 Kenya Shillings ($10,000 to $15,000), which can then be staged for a larger grant after proof of concept. The duty of identifying innovative topics and creating plans for potential financing will be given to research teams after the call.

The challenge participant can leverage Mozilla Responsible Computer Science Challenge resources for inspiration, example the Global Community of Practice where they can get support towards integrating social responsibility and ethics into computing curriculum. Moreover, Teaching Responsible Computing Playbook can also serve as a starting point for the locals to adapt it to their region and institution. The participant/ research teams can access Mozilla foundation network to discuss and build joint projects and extend to projects outside the challenge.

[13] https://researchfund.go.ke/

5.3. Outreach

The project should have a strategy built on promoting and mediating responsible innovation partnerships between Mozilla, locals and international research networks. The challenge should have a mandate that channels research capacity and information/ technology access to the locals whiles ensuring the partnership fostered are focused on digital revolution being equitable and respects the dignity, perspectives, and rights of all.

The uptake of the RCS challenge will be dependent on the structure of the call and its duration and the target audience. Deans, Chairs and departments heads we interviewed (30) have all shown interest in applying for the call, this could be due to limited funding opportunities in Kenya. Many university faculty members will apply as they seek to meet the promotion criteria set by the Commission for the University Education. The rules stipulated by the commission for appointment and promotion requires the faculty MUST have attracted research or development funds during the tenure in their current position. The call could also attract competition from Postgraduate students and university clubs who could be seeking research funding for their research.

We have been able to generate contacts made up Deans, Department Head, CEOs, Managers, Co-founders, Government officials because of the Landscape analysis and we have the consent to send them an email when the call for participation is scheduled. Therefore, a personalised information friendly and easy to understand email or posters will be sent to these potential participants of the challenge and follow-up if rate of response is below what was anticipated.

To maximize our outreach, we could plan to have joint events like application workshop, speaker series, etc with the Organisations of the RCS Working-groups, Responsible AI Network Africa (RAIN_Africa), coding conferences like PyCon Kenya, incubators like Adanian Labs, KENET, and pan-African groups like African AI Ethics. These Organisations can share these events on the social media platforms thereby raising awareness of the challenge.

6. Conclusion

Most of the hiring in the Kenyan tech ecosystem can be categorized int two. The International technology companies employ students who have core computer science skills including data structures and algorithms, user experience design and system design. The startups, Technology Intermediaries and some software development houses often look for just enough hands-on skills including creating and consuming an API and goo coding skills in one programming language.

The teaching of computing ethics is very limited and would greatly benefit from curriculum changes and mentorship to enhance skill development in responsible computing. The training of the undergraduate students should also be based on market-aligned curriculum and a learning approach that simulates practical on-the-job-experience. Universities should also enhance their relationships with the industry partners to enhance for student mentorship, internship and improving their curriculum,

Even though the learning accelerators and incubation centers play a huge role in the development and growth of the Kenyan tech ecosystem, the best option to implement the RCS would be the universities. The learning accelerators and innovation hubs will drop the proposed curriculum changes the moment the funding is exhausted. However, the universities would have to continue with the adopted curriculum changes for a minimum of three years new curriculum review cycle. And as the proposed curriculum changes are universally acceptable as well as futuristic too, the proposed changes may exist in perpetuity.

Appendix

1) Interview Guide Universities – Computing Department (Dean, Chair or Program Leader)

Objective 1: Explore how computer science contribute to social good through development of innovative solutions to solve the society's most pressing problems.
Objective 2: Explore the extent of teaching ethics in the current computer science curriculum among the Kenyan Institutions of Higher Learning.
University Name: _____

· University Category

o Public University
o Public University Constituent College
o Chartered Private University
o Private University Constituent College
o Universities with Letter of Interim Authority

· Department

o How many undergraduate computing programs do you have?
o How many students do you have in these programs?

Teaching Ethics

- Do you teach Ethics in Computer Science and at what level?
- Why is the Ethics course placed at that level?
- Do you have in your computing programs courses which covers topics such as "The Kenya Data Protection Act, 2019", "The Computer Misuse and Cybercrimes Act, 2018", "The role of Cambridge Analytica in Kenya's chaotic 2017 elections", "How mobile phone companies work with police to track persons of interest hence facilitating extrajudicial killings", "misinformation, disinformation and disclosure of nature intelligence by the Kenyan bloggers on the Kenyan social media", or other matters on offences relating to computer systems?
- Does the department have qualified faculty who could teach such topics?
- What would be the requirements to have such curriculum changes?
- What would be the financial implications and requirements for such curriculum changes?
- How would funding for curriculum changes to have ethics and related topics taught across the curriculum (Multiple courses) work for your department?
- How long would it take to have the curriculum changes implemented?

Community Engagements (Computer Science for social good)

Objective: Explore use of Computer Science for Social Good through social innovation projects.
What are the department's key research areas?

- Does the department have any computer science related engagements (activities) with the community?
- Would funding for such engagement likely to incentivize department members to engage in computer science for social good related activities among the communities?
- What activities or projects would the department consider engaging with the community around the university?

Collaboration with other Universities and Institutes

Objective: To explore how universities are/can work collaboratively and in multidisciplinary teams to offer computer science-based solutions to address problems that affect us all.

- Does the department have any research collaborations with other universities?
- Does the department have any collaborations with community-based organizations?
- Does the department have an innovation and Incubation Center or any affiliations to an existing innovation hub?
- Would the department be willing to collaborate with other universities in devising a comprehensive ethics and other offences relating to use of computer systems curriculum?
- Would the department be willing to participate in a funded collaborative research in computer science for social good with other universities?

IT Club

- Does the department have a students' IT Club?
- What activities does the IT Club engage in?
- How regular are these activities?
- Does the IT club have any Computer Science for social good engagements with the community?
- Would funding for such engagements likely to incentivize IT club to engage in computer science for social good related activities among the communities?
- Do the students participate in the interuniversity academic events such as hackathons and CTF competitions, career development seminars and workshops?
- Are such travels facilitated by the university?
- Would the department be willing to support the IT Club to participate in a computer science for social good innovation challenge?

Postgraduate Students in Computer Science

- How many postgraduate computing programs do you have?
- How many students do you have in these programs?
- Where do the postgraduates students get their research funding?
- Would the department be willing to support the postgraduate students to participate in a computer science for social-good funded research?

2) Interview Guide Innovations and Incubation Hubs – Founders and CTOs

1. Is your Innovation Hub public or privately funded?
2. How many participants are there in your hub?
3. How important is analysis about social and political impact of the innovations developed in your innovation hub?
4. Do you think there are unique aspects to social computing in Kenya?
5. Do you think it is necessary to make participants in your hub aware of concerns around topics such as the Ethics in Artificial Intelligence and other emerging digital technologies?
6. Do you think it is necessary to make participants in your hub aware of the possible harm done by transnational companies who commit 'ethics dumping' in Kenya?
7. Do you have any agreements with departments of Computer Science at universities or colleges? What do these agreements entail?
8. What kind of training do participants in your hub usually have? Do they have a diploma, Bachelor degree, (post)graduate degree, or another form of training?
9. Are there certificate programs or other training available in your hub itself?
10. Would funding for training in responsible computing be welcome in your hub and how would it work?

3) Interview Learning Accelerators – (CEO, Lead Technical Mentor, Director Admissions)

Objective: Explore the extent of teaching ethics in the current academic and mentorship programs among the
Kenyan Learning Accelerators.

About the Learning Accelerator

Accelerator Name: _____

· How old is your institution?
· What type of training and mentorship programs do you offer in your institution and what are their durations?
· What are the qualifications of the trainees admitted to the institution's programs?
· On average, how many trainees are there in your institution every year?

Teaching Ethics

· Do you teach Computing Ethics in your training programs?
· Do you think it is necessary to make your trainees aware of concerns around topics such as the Ethics in

Artificial Intelligence and other emerging digital technologies?
· Do you have in your training programs topics covering issues on “The Kenya Data Protection Act, 2019”,
“The Computer Misuse and Cybercrimes Act, 2018”, “The role of Cambridge Analytica in Kenya's chaotic
2017 elections”, “How mobile phone companies work with police to track persons of interest hence facilitating
extrajudicial killings”, “misinformation, disinformation and disclosure of nature intelligence by the Kenyan
bloggers on the Kenyan social media”, or other matters on offences relating to computer systems?
o Does the institution have qualified faculty who could teach such topics?
· What would be the requirements to have curriculum changes to introduce computing ethics and responsible
computer science?
· What would be the financial implications and requirements for such curriculum changes?
· Would funding help in preparing and introducing curriculum changes to have computing ethics and related
topics included in your curriculum?
o How long would it take to have the curriculum changes implemented?
o How much funding would be required to facilitate these changes?

Community Engagements (Computer Science for social good)

· Does the Institution have any computer science related engagements (activities) with the community?
· Would funding for such engagement likely to incentivize the institution to engage in computer science for social
good related activities among the communities?

Collaboration with other Organizations

· Does the Institution have any collaborations with other organizations (Innovation and Incubation Centers,
Corporates and Universities)?

4) Interviews Employers – HR and ICT Managers

Computer and data scientists today wield tremendous power. The code they write and models they build may be engaged with by billions of people and influence everything from what news we read to what personal data companies collect to who gets loans and who does not. Algorithms are also structuring, influencing, constraining, and controlling growing aspects of human behaviour. How are organizations prepared in matters responsible computing?

1. Name of your organization
2. Do you have an ethics officer in your organization?

a. What are their qualifications
3. Is your organization concerned about computer ethics?
4. How important is awareness of responsible computing for the success of your organization?
5. Have you had challenges in regard to computer misuse?
6. Are your members of staff aware and prepared on how to handle matters pertaining to ethics and responsible computing?
7. Do you offer any in-house training relating to responsible computing or computing ethics?
a. If yes, what do you offer and to whom, and by whom is the training offered?
8. What recommendation would you give for curriculum changes to ensure that the people joining your organization are aware of responsible computing.
9. Do you think training on social and political issues in computing at universities could have positive impact on the employability of a member of a tech team or any other team in your business?
10. Do you typically employ students with vendor certifications (Microsoft, Oracle, IBM, etc.), diploma, bachelor or higher degree?

5) Expert group participant table attached below

6) Expert Panel Group Discussion on teaching Social and Ethical dimensions of Computing

Computer and data scientists today wield tremendous power. The code they write and models they build may be engaged with by billions of people and influence everything from what news stories we read to what personal data companies collect to who gets loans and who does not. Algorithms are structuring, influencing, constraining, and controlling growing aspects of human behaviour.

Discussion Questions

1. Are there existing efforts in our institutions to teach the social, ethical and political dimensions of computing?
2. How does the existing coursework in our institutions deal with topics such as bias in machine learning, algorithmic ranking on social media, social or political manipulation based on automated predictions, or digital surveillance?
3. Do we have in our computing programs courses which covers topics such as “The Kenya Data Protection Act, 2019”, “The Computer Misuse and Cybercrimes Act, 2018”, “The role of Cambridge Analytica in Kenya's chaotic 2017 elections”, “How mobile phone companies work with police to track persons of interest hence facilitating extrajudicial killings”, “misinformation, disinformation and disclosure of nature intelligence by the

Kenyan bloggers on the Kenyan social media", or other matters on offences relating to computer systems?
4. Are we familiar with the ACM Code of Ethics and Professional Conduct?
a. Have we used/or referenced it while teaching computing courses
5. What would be the requirements to have curriculum changes in our programs to allow us to include social, ethical and political dimensions of computing?
a. What would be the financial implications and requirements for such curriculum changes?
b. How would funding curriculum changes to have ethics and related topics taught across the curriculum (multiple courses) work for your department?
c. How long would it take to have the curriculum changes implemented?

Questions Specific to the Industry experts

1. Are your organizations concerned about computer ethics?
2. How important is awareness of responsible computing for the success of your organization?

3. Have you had challenges in regard to computer misuse?
4. 4. Do you have an ethics officer in your organizations?
5. a. What are their qualifications
6. 5. Are you satisfied with the preparedness of new members of staff in terms of dealing with
7. AI ethics and responsible computing concerns? Why, or why not?
8. 6. Do you offer any in-house training relating to responsible computing or computing
9. ethics?
10. a. If yes, what do you offer and to whom, and by whom is the training offered?
11. 7. What recommendation would you give for curriculum changes to ensure that the people
12. joining your organizations are aware of responsible computing.
13. a. Do you think cross-disciplinary training would be important for the ethics
14. officers? Why, or why not?
15. b. Do you think training on social and political issues in our universities could have
16. positive impact on the employability of a member of a tech team or any other
17. team in your business?
18. **Using the USIU-Africa BSc. APT Program to explore how to integrate ethics in computing**
19. **programs**
20. · The USIU-Africa BSc. APT Program does not have any ethics courses
21. · Possible courses to include ethics component
22. o APT2055: Hardware and Software Practicum
23. o APT3010: Introduction to Artificial Intelligence - **Done**
24. o IST3015: Business Data Analytics

25. o IST3050: Introduction to Security Systems
26. o APT3025: Applied Machine Learning
27. o IST4078: IT Innovation and Entrepreneurship
28. o Introduce a standalone Ethics course
29. **Computer Science for Social Good**
30. · What are the key research areas in our departments?
31. · Are there any computer science related engagements (activities) with the communities
32. living around the universities?
33. · Would funding for computer science for social good related

7) Survey Questions for Students

Social, Ethical and Political dimensions of computing

Objective: Computing professionals today wield tremendous power. The code they write and models they build may be engaged with by billions of people and influence everything. Algorithms are structuring, influencing, constraining, and controlling growing aspects of human behaviour. When that power is not coupled with responsibility, the results can have damaging and even dangerous consequences for users' privacy, security, or wellbeing, including discrimination, exclusion, harassment, or worse.

1. Name of Institution

2. What Computing program do you study?

3. Name two (2) courses you enjoy.

4. Name any course you will wish to be included in the Computing program

5. Do you have a course that deals with responsible/ethical computing?

6. If YES in question 5, name the course.

7. What do you plan to do after your program?

8. Is there any Computing related social project you participate(d) in?

9. If YES in question 8, what is/was the project and the aim of the project?

10. Assuming you have to choose between Kenya and the West (USA or Europe) in terms of study and work. Where will you prefer?

11. Will you be interested in a course or lecture on ethics?

12. Will you want to participate in a workshop or lecture on the application of computing for social good?

Expert Panel Group Participants

No.	Name	Gender	Position	University	University Category			Total Persons Present	17	
1	Lawrence Nderu	Male	Chair, Computer Science	Jomo Kenyatta University of Agriculture and Technology	Public			Participants	15	
2	George Musumba	Male	Dean, Computing and Informatics	Dedan Kimathi University of Technology	Public					
3	Aaron Oirere	Male	Chair, Computer Science	Murang'a University of Technology	Public			Industry Representation Representation		
4	Richard Otieno Omollo	Male	Computer Science and Software Engineering	Jaramogi Oginga Odinga University of Science and Technology	Public			Category	Count	Percent
5	Petronilla Muriithi	Female	Faculty, Computer Science	Jomo Kenyatta University of Agriculture and Technology	Public			Private Industry	2	67%
6	Benson Kioni	Male	Manager, Information Security	Kenya Power and Lighting Company	Public			Government Parastatal	1	33%
7	Zipporah Mbenge	Female	Chair, Applied Computer Science	Daystar University	Private					
8	Kibuku R. Njeri	Female	Chair, Software Development & Information Systems	KCA University	Private			Universities Representation		
9	Sheila Mirenja	Female	Chair, Computing and Informatics	Pan Africa Christian University	Private			Category	Count	Percent
10	Leah Mutanu	Female	Faculty, Software Engineering	USIU-Africa	Private			Private Universities	7	58%
11	Daniel Njeru	Male	Chair, Computer Science	ZETECH University	Private			Public Universities	5	42%
12	Julius Sirma	Male	Chair, Computer science and ICT	Kiriri Women University of Science and Technology	Private					
13	Tabitha Muthoni Kihara	Female	Faculty, Computer Science	St Paul's University	Private			Gender Representation		
14	Joylynn Kirui	Female	Senior Cloud Security Advocate	Microsoft	Private			Category	Count	Percent
15	Edwin Kariuki	Male	Country Manager	Continuity East Africa	Private			Male	8	53%
16	Patrick Wamuyu	Male	Chair, Computing			Moderator		Female	7	47%
17	Susan Nyambura	Female	Administrative Assistant	USIU-Africa		Rapporteur				

Public and Private Universities in Kenya

No.	University	Shortname	Category
1	AFRICA INTERNATIONAL UNIVERSITY	AIU	Private
2	AFRICA NAZARENE UNIVERSITY	ANU	Private
3	AMREF INTERNATIONAL UNIVERSITY	AMIU	Private
4	CATHOLIC UNIVERSITY OF EAST AFRICA	CUEA	Private
5	DAYSTAR UNIVERSITY	DAYSTAR	Private
6	GRETSA UNIVERSITY	GRETSA	Private
7	INTERNATIONAL LEADERSHIP UNIVERSITY	ILU	Private
8	KABARAK UNIVERSITY	KABU	Private
9	KCA UNIVERSITY	KCA	Private
10	KENYA ASSEMBLIES OF GOD EAST UNIVERSITY	KAGEU	Private
11	KENYA HIGHLANDS EVANGELICAL UNIVERSITY	KHEU	Private
12	KENYA METHODIST UNIVERSITY	KEMU	Private
13	KIRIRI WOMENS UNIVERSITY OF SCIENCE AND TECHNOLOGY	KWUST	Private
14	LUKENYA UNIVERSITY	LUKENYA	Private
15	MANAGEMENT UNIVERSITY OF AFRICA	MUA	Private
16	MARIST INTERNATIONAL UNIVERSITY COLLEGE	MARIST	Private
17	MOUNT KENYA UNIVERSITY	MKU	Private
18	PAN AFRICA CHRISTIAN UNIVERSITY	PAC	Private
19	PIONEER INTERNATIONAL UNIVERSITY	PIU	Private
20	PRESBYTERIAN UNIVERSITY OF EAST AFRICA	PUEA	Private
21	RAF INTERNATIONAL UNIVERSITY	RIU	Private
22	RIARA UNIVERSITY	RU	Private
23	SCOTT CHRISTIAN UNIVERSITY	SCU	Private
24	ST PAULS UNIVERSITY	SPU	Private
25	TANGAZA UNIVERSITY COLLEGE	TUC	Private
26	THE EAST AFRICAN UNIVERSITY	TEAU	Private
27	UMMA UNIVERSITY	UMMA	Private
28	UNIVERSITY OF EASTERN AFRICA, BARATON	BARA	Private
29	UZIMA UNIVERSITY	UZIMA	Private
30	ZETECH UNIVERSITY	ZETECH	Private
31	GREAT LAKES UNIVERSITY OF KISUMU	GLUK	Private
32	STRATHMORE UNIVERSITY	SU	Private
33	UNITED STATES INTERNATIONAL UNIVERSITY-AFRICA	USIU-AFRICA	Private

34	ALUPE UNIVERSITY	AUC	Public
35	BOMET UNIVERSITY COLLEGE	BUC	Public
36	CHUKA UNIVERSITY	CU	Public
37	CO-OPERATIVE UNIVERSITY OF KENYA	COPUK	Public
38	DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY	DKUT	Public
39	EGERTON UNIVERSITY	EU	Public
40	GARISSA UNIVERSITY	GU	Public
41	JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY	JOOUST	Public
42	JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY	JKUAT	Public
43	KAIMOSI FRIENDS UNIVERSITY	KAFUCO	Public
44	KARATINA UNIVERSITY	KARU	Public
45	KENYATTA UNIVERSITY	KU	Public
46	KIBABII UNIVERSITY	KBBU	Public
47	KIRINYAGA UNIVERSITY	KYU	Public
48	KISII UNIVERSITY	KSU	Public
49	KOITALEEL SAMOEI UNIVERSITY COLLEGE	KSUC	Public
50	LAIKIPIA UNIVERSITY	LU	Public
51	MAASAI MARA UNIVERSITY	MMARAU	Public
52	MACHAKOS UNIVERSITY	MCKU	Public
53	MAMA NGINA UNIVERSITY COLLEGE	MNUC	Public
54	MASENO UNIVERSITY	MSU	Public
55	MASINDE MULIRO UNIVERSITY OF SCIENCE & TECHNOLOGY	MMUST	Public
56	MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY	MUST	Public
57	MOI UNIVERSITY	MU	Public
58	MULTIMEDIA UNIVERSITY OF KENYA	MMU	Public
59	MURANGA UNIVERSITY OF TECHNOLOGY	MUT	Public
60	PWANI UNIVERSITY	PU	Public
61	RONGO UNIVERSITY	RNU	Public
62	SOUTH EASTERN KENYA UNIVERSITY	SEKU	Public
63	TAITA TAVETA UNIVERSITY	TTU	Public
64	TECHNICAL UNIVERSITY OF KENYA	TUK	Public
65	TECHNICAL UNIVERSITY OF MOMBASA	TUM	Public
66	THARAKA UNIVERSITY	THRKU	Public
67	TOM MBOYA UNIVERSITY	TMU	Public
68	TURKANA UNIVERSITY COLLEGE	TRUC	Public

69	UNIVERSITY OF ELDORET	UOE	Public
70	UNIVERSITY OF EMBU	UOEM	Public
71	UNIVERSITY OF KABIANGA	UOK	Public
72	UNIVERSITY OF NAIROBI	UON	Public

Dedicated Universities			
No.	**University**	**Shortname**	**Category**
1	Pan African University Institute for Basic Sciences, Technology and Innovation	PAUSTI	African Union - Hosted by JKUAT
2	National Defence University-Kenya	NDU-K	Public

Foreign universities with Grant of Authority to collaborate in offering academic programmes in Kenya			
No.	**Foreign University**	**Local Institution**	**Programme offered under collaboration**
1	California Miramar University, USA	The East Africa University, Kitengela, Kenya	Master of Business Administration (MBA), Doctor of Business Administration (DBA)
2	University of Northampton, United Kingdom (UK)	Edulink International College, Nairobi, Kenya	Bachelor of Business Administration (BBA)
3	University of Greenwich, United Kingdom(UK)	Oshwal College, Nairobi, Kenya	Bachelor of Science (Hons) Computing`
4	University of Hertfordshire, United Kingdom (UK)	Oshwal College, Nairobi, Kenya	Bachelor of Arts(Hons) Business Administration
5	Beulah Heights University	Daystar University, Athi River, Kenya	Bachelor of Arts (Hons) Business Administration

Learning Accelerators

1. AkiraChix https://akirachix.com/
2. ALXAfrica https://www.alxafrica.com/
3. Cyber Shujaa https://cybershujaa.ml/
4. eMobilis https://www.emobilis.ac.ke/
5. Eujim Academy https://academy.eujimsolutions.co.ke/
6. Jenga School https://jengaschool.com/
7. Moringa School https://moringaschool.com/
8. Pwani Teknowgalz https://pwaniteknowgalz.org/
9. Tech Camp https://www.techcamp.co.ke/
10. Ubunifu College https://ubunifucollege.com/
11. Zindua School https://zinduaschool.com/
12. MODCOM https://www.modcom.co.ke/index.html

Mentorship Programs

1. Kamilimu https://www.kamilimu.org/

Coding programs for kids

1. Digikids https://digikids.co.ke/
2. Discovery Centre https://www.thediscoverycentre.co.ke/
3. YoungSavvy https://www.youngsavvycentre.org/

No.	Name	Website	Funding
1	Huduma Whitebox	https://whitebox.go.ke/	Government
2	Kenya Industrial Research and Development Institute (KIRDI)	https://www.kirdi.go.ke/index.php/industrial-research/technology-transfer-extension-services/business-incubation-services	Government
3	Kenya National Innovation Agency	http://www.innovationagency.go.ke/	Government
4	Makueni Tech and Innovation Hub	https://innovations.makueni.go.ke/	Government
5	Adanian Labs and Ada Labs	https://www.adanianlabs.io/ and https://adalabsafrica.com/	Private
6	Border Hub	https://theborderhub.org/	Private
7	Circular Innovation Hub	https://circularinnovationhub.com/	Private
8	e.KRAAL	https://e-kraal.com/	Private
9	EldoHub	https://eldohub.co.ke/	Private
10	EmpServe Kenya	https://empserve.org/	Private
11	Fie_Labs	https://fielabs.com/	Private
12	Growth Africa	https://growthafrica.com/	Private
13	Iconshub	http://iconshub.co.ke/	Private
14	iHub	https://ihub.co.ke/	Private
15	Kikao64	https://kikao64.ke/	Private
16	LakeHub	https://lakehub.co.ke/	Private
17	Magharibi Innovation Hub	https://mih.co.ke	Private
18	Mt Kenya Hub	https://mtkenyahub.com/ea/	Private
19	Nailab	https://nailab.co/	Private
20	Nakuru Box	https://www.nakurubox.co.ke/	Private
21	Rift Valley Innovation Center (RVIC)	http://rvic.co.ke/	Private
22	Sote Hub	https://sotehub.com/	Private
23	Startup Lions	https://startuplions.org	Private
24	StartUpAfrica	https://startupafrica.org/	Private
25	Swahilipot Hub	https://www.swahilipothub.co.ke/	Private
26	TechBridge Invest	https://www.techbridgeinvest.com/	Private

27	Villgro	https://villgroafrica.org/	Private
28	Blue Economy Innovation Hub (BEI Hub)	https://www.beihub.co.ke/	Univeristy
29	C4DLab	https://c4dlab.ac.ke/	Univeristy
30	Centre for Entrepreneurship Innovation and Technology Transfer	http://kpuc.tukenya.ac.ke/index.php?option=com_content&view=article&id=183&Itemid=223	Univeristy
31	Chandaria Business Innovation and Incubation Centre	http://www.ku.ac.ke/iiuil/chandaria-business-innovation-incubation-centre/	Univeristy
32	CUEA Innovation Hub	https://www.cuea.edu/?page_id=11549	Univeristy
33	DeHUB	https://dehub.dkut.ac.ke/	Univeristy
34	iBizAfrica	http://www.ibizafrica.co.ke/	Univeristy
35	iLabAfrica	http://www.ilabafrica.ac.ke/	Univeristy
36	Incubation and Innovation Center (I2C)	https://www.usiu.ac.ke/128/innovation-incubation-center/	Univeristy
37	iZET hub	https://izet.zetech.ac.ke/index.php/about-izet	Univeristy
38	MKU Incubation Centre	https://cgsr.mku.ac.ke/innovation-hub/	Univeristy

No.	University	Shortname	Category	BIT	BBIT	SOFTWARE ENGINEERING	COMPUTER SCIENCE
1	AFRICA INTERNATIONAL UNIVERSITY	AIU	Private	✓			
2	AFRICA NAZARENE UNIVERSITY	ANU	Private				✓
3	AMREF INTERNATIONAL UNIVERSITY	AMIU	Private				
4	CATHOLIC UNIVERSITY OF EAST AFRICA	CUEA	Private				✓
5	DAYSTAR UNIVERSITY	DAYSTAR	Private				✓
6	GRETSA UNIVERSITY	GRETSA	Private				✓
7	INTERNATIONAL LEADERSHIP UNIVERSITY	ILU	Private				
8	KABARAK UNIVERSITY	KABU	Private	✓	✓		✓
9	KCA UNIVERSITY	KCA	Private	✓	✓	✓	✓
10	KENYA ASSEMBLIES OF GOD EAST UNIVERSITY	KAGEU	Private				
11	KENYA HIGHLANDS EVANGELICAL UNIVERSITY	KHEU	Private	✓			✓
12	KENYA METHODIST UNIVERSITY	KEMU	Private		✓		✓
13	KIRIRI WOMENS UNIVERSITY OF SCIENCE AND TECHNOLOGY	KWUST	Private		✓		✓
14	LUKENYA UNIVERSITY	LUKENYA	Private		✓		
15	MANAGEMENT UNIVERSITY OF AFRICA	MUA	Private				
16	MARIST INTERNATIONAL UNIVERSITY COLLEGE	MARIST	Private				
17	MOUNT KENYA UNIVERSITY	MKU	Private	✓	✓		
18	PAN AFRICA CHRISTIAN UNIVERSITY	PAC	Private		✓		
19	PIONEER INTERNATIONAL UNIVERSITY	PIU	Private	✓			
20	PRESBYTERIAN UNIVERSITY OF EAST AFRICA	PUEA	Private				✓
21	RAF INTERNATIONAL UNIVERSITY	RIU	Private				
22	RIARA UNIVERSITY	RU	Private		✓		✓
23	SCOTT CHRISTIAN UNIVERSITY	SCU	Private	✓	✓		
24	ST PAULS UNIVERSITY	SPU	Private		✓		✓
25	TANGAZA UNIVERSITY COLLEGE	TUC	Private				
26	THE EAST AFRICAN UNIVERSITY	TEAU	Private				✓
27	UMMA UNIVERSITY	UMMA	Private	✓	✓		✓
28	UNIVERSITY OF EASTERN AFRICA, BARATON	BARA	Private		✓	✓	✓
29	UZIMA UNIVERSITY	UZIMA	Private				
30	ZETECH UNIVERSITY	ZETECH	Private	✓	✓	✓	✓
31	GREAT LAKES UNIVERSITY OF KISUMU	GLUK	Private	✓			
32	STRATHMORE UNIVERSITY	SU	Private		✓		✓
33	UNITED STATES INTERNATIONAL UNIVERSITY-AFRICA	USIU-AFRICA	Private		✓		✓
34	ALUPE UNIVERSITY	AUC	Public		✓		✓
35	BOMET UNIVERSITY COLLEGE	BUC	Public		✓		✓
36	CHUKA UNIVERSITY	CU	Public				✓
37	CO-OPERATIVE UNIVERSITY OF KENYA	COPUK	Public	✓	✓	✓	✓
38	DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY	DKUT	Public	✓	✓		✓
39	EGERTON UNIVERSITY	EU	Public			✓	✓
40	GARISSA UNIVERSITY	GU	Public	✓			✓
41	JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY	JOOUST	Public	✓			✓
42	JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY	JKUAT	Public	✓	✓	✓	✓
43	KAIMOSI FRIENDS UNIVERSITY	KAFUCO	Public	✓			✓
44	KARATINA UNIVERSITY	KARU	Public	✓	✓		✓
45	KENYATTA UNIVERSITY	KU	Public	✓			✓
46	KIBABII UNIVERSITY	KBBU	Public	✓			✓

47	KIRINYAGA UNIVERSITY	KYU	Public	✓			✓
48	KISII UNIVERSITY	KSU	Public	✓	✓	✓	✓
49	KOITALEEL SAMOEI UNIVERSITY COLLEGE	KSUC	Public				
50	LAIKIPIA UNIVERSITY	LU	Public	✓			✓
51	MAASAI MARA UNIVERSITY	MMARAU	Public	✓	✓		✓
52	MACHAKOS UNIVERSITY	MCKU	Public	✓			✓
53	MAMA NGINA UNIVERSITY COLLEGE	MNUC	Public	✓			✓
54	MASENO UNIVERSITY	MSU	Public	✓	✓		
55	MASINDE MULIRO UNIVERSITY OF SCIENCE & TECHNOLOGY	MMUST	Public	✓			✓
56	MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY	MUST	Public	✓	✓	✓	
57	MOI UNIVERSITY	MU	Public		✓		✓
58	MULTIMEDIA UNIVERSITY OF KENYA	MMU	Public	✓	✓	✓	✓
59	MURANGA UNIVERSITY OF TECHNOLOGY	MUT	Public	✓	✓	✓	
60	PWANI UNIVERSITY	PU	Public	✓		✓	✓
61	RONGO UNIVERSITY	RNU	Public	✓	✓		✓
62	SOUTH EASTERN KENYA UNIVERSITY	SEKU	Public	✓		✓	✓
63	TAITA TAVETA UNIVERSITY	TTU	Public	✓	✓		
64	TECHNICAL UNIVERSITY OF KENYA	TUK	Public	✓			✓
65	TECHNICAL UNIVERSITY OF MOMBASA	TUM	Public	✓	✓		✓
66	THARAKA UNIVERSITY	THRKU	Public				✓
67	TOM MBOYA UNIVERSITY	TMU	Public	✓			✓
68	TURKANA UNIVERSITY COLLEGE	TRUC	Public				
69	UNIVERSITY OF ELDORET	UOE	Public	✓	✓		✓
70	UNIVERSITY OF EMBU	UOEM	Public	✓			✓
71	UNIVERSITY OF KABIANGA	UOK	Public	✓	✓		✓
72	UNIVERSITY OF NAIROBI	UON	Public		✓		✓

Foreign universities with Grant of Authority to collaborate in offering academic programmes in Kenya

No.	Foreign University	Local Institution	Programme offered under collaboration
1	California Miramar University, USA	The East Africa University, Kitengela, Kenya	Master of Business Administration (MBA), Doctor of Business Administration (DBA)
2	University of Northampton, United Kingdom (UK)	Edulink International College, Nairobi, Kenya	Bachelor of Business Administration (BBA)
3	University of Greenwich, United Kingdom(UK)	Oshwal College, Nairobi, Kenya	Bachelor of Science (Hons) Computing`
4	University of Hertfordshire, United Kingdom (UK)	Oshwal College, Nairobi, Kenya	Bachelor of Arts(Hons) Business Administration
5	Beulah Heights University	Daystar University, Athi River, Kenya	Bachelor of Arts (Hons) Business Administration

INSTITUTIONS	BIT	BBIT	S.E	C.S
PUBLIC UNIVERSITIES	30	19	9	33
PRIVATE UNIVERSITIES	10	15	3	18

INSTITUTIONS	TOTAL

PUBLIC UNIVERSITIES WITHOUT COMPUTING COURSES	2
PRIVATE UNIVERSITIES WITHOUT COMPUTING COURSES	7

INSTITUTIONS	**TOTAL**
PUBLIC UNIVERSITIES	39
PRIVATE UNIVERSITIES	33
TOTAL	**72**

Universities where Data was Collected		
No.	**University**	**University Category**
1	Chuka University	Public
2	Co-operative University of Kenya	Public
3	Dedan Kimathi University of Technology	Public
4	Embu University	Public
5	Garisa University	Public
6	Jaramogi Oginga Odinga University of Science and Technology	Public
7	Jomo Kenyatta University of Agriculture and Technology	Public
8	Karatina University	Public
9	Kibabii University	Public
10	Kirinyaga Universuty	Public
11	Kisii University	Public
12	Machakos University	Public
13	Maseno University	Public
14	Meru University	Public
15	Multimedia University of Kenya	Public
16	Murang'a University of Technology	Public
17	Technical University of Kenya	Public
18	Africa International University	Private
19	Daystar University	Private
20	Kabarak University	Private
21	KCA University	Private
22	KEMU	Private
23	Kiriri Women University of Science and Technology	Private
24	Lukenya University	Private
25	Mount Kenya University	Private
26	Pan Africa Christian University	Private
27	Riara University	Private
28	St Paul's University	Private
29	USIU-Africa	Private
30	ZETECH University	Private

BIT2222: ICT and Society
MULTIMEDIA UNIVERSITY

1.0 Course Objectives

Upon completion of this course the student should be able to:

1.1 Purpose The purpose of this course is to study the influences of computing technology, and examine questions that must be answered by computing professionals, policy makers, and members of the public, in relation to the potential uses and abuses of computing technology.

1.2 Objectives At the end of the course, the student should be able to:

1. Be aware of a variety of views of computing, including: historical; professional; social; political and cultural.
2. Identify areas of society where information technology has had a substantial impact and where its effects may be of concern.
3. Appreciate how different perspectives can contribute to making choices about the development and use of computing technology.
4. Appreciate the legal and social issues associated with the use of computers in organizations and computer crime.
5. Critically assess the concepts, theories and issues in recent public debates about technology and society and develop a personal position.

Overview of Concepts

i. Introduction to the concept of computers and Information Systems, management information systems, components of information systems, information technology concepts
ii. Computers in the society Investigating the relationship, range of issues and perspectives to be studied, brief history of computers and computing from one orientation, definition of society,
iii. Social Structure Social structure, social activities, social boundaries and their interdependences, the good society, ethics and morality, values and lifestyles, technology and tradeoffs in societal issues

iv. The information of the traditional society, the information age society, communities, organizations, the information economy, society.

v. Computers and the Workplace Supporting role of computers in the office, effects of computers in the office, telecommuting, advantages of telecommuting, different fields and their application of computers

vi. ICT Capabilities and limitations of computers, social impact of ICT, dependence on IT, information and professionalism, Ethics and professional codes, the need for code of conduct, elements of a code of code of conduct, a CASE illustration (IMIS code of conduct)

vii. ICT and Development The concept of development, social vs economic development, ICT as an enabler of growth, ICT for national and international integration, ICT and drivers of growth

viii. Computers and Law Ethics and law, data protection laws, confidentiality, due process, privacy and accessibility, legal issues associated with public access to information; issues of control; intellectual property rights; software ownership; copyright patents.

ix. ICT and Security concerns, privacy issues, software piracy, e-mail security, sniffers and smart card fraud, cybercrime, child pornography, network intrusion and other crimes, computers and forensics

x. ICT and selected Fields ICT and education, pedagogy, ICT and health, ICT and governance

xi. ICT and selected Fields ICT and tourism, ICT and research and development, ICT and the political process, ICT and leisure, ICT and consumers, ICT and employees

xii. ICT and selected Fields Group Presentations on the selected areas above, case studies and discussions on ethical and societal issues in ICT

Course text and recommended reading:

a) Sara Baase's, A Gift of Fire: Social, Legal and Ethical Issues in Computing, (2nd Ed). Prentice Hall, 2003.

b) Paparella, M.S. and Simko, E.S.: Current Topics in Technology. Thomson Learning, 2006.

c) Stair, R.M. and Baldauf, K.: Succeeding with Technology: 2nd Edition. Thomson Learning, 2006.

d) Morley, D. and Parker, C.S.: Computers and Technology in a Changing Society: 2nd Edition. Thomson Learning, 2004.

CSC422: Legal and Ethical Issues in Computing

KIBABII UNIVERSITY

Legal and Ethical Issues in Computing

Purpose/Aim:

The aim of the course is to provide the students with tools to enable them to build information systems to appropriate ethical, legal and professional standards.

Course Objective (Indicative Learning Outcomes)

i. Understanding the general issues of ethics,
ii. Develop ethical thinking skills,
iii. Understand and analyse an ethical problem,
iv. Construct and present a rational argument, awareness of discussions and literature on ethical issues within the field of information systems,
v. Awareness of professional responsibility in the field, and the impact of information systems on society.
vi. Differentiate between laws and ethics vii. Identify major national laws that affect the practice of information security
vii. Explain the role of culture as it applies to ethics in information security ix. Understand and apply the basics of ethics for the field of computing.
viii. Become familiar with professional and ethical responsibilities.
ix. Become aware of ethical issues related to privacy, security, intellectual property, gender.
x. Become able to involve in a managerial and decision-making with regards to computer ethical issues.
xi. Able to use some of the ethical theories to analyse ethical cases.
xii. Able to analyse ethical situations and suggest technological organisational and societal solutions.

Course Content

1) History of Computing. Legal, Moral and Ethical theories

2) Introduction to Ethics Subjective relativism, Cultural relativism, Divine command theory, Kantianism, Act utilitarianism, Rule utilitarianism, Social contract theory Comparing workable ethical theories, Moralit6y of breaking the law
3) Law in Information Technology Organizational Liability and the Need for Counsel, Policy versus Law, Types of Law, International Laws and Legal Bodies, Kenya's ICT policy, legal and This study source was downloaded by 100000847649430 from CourseHero.com on 05-27-2022 01:14:02 GMT -05:00 https://www.coursehero.com/file/107417686/CSC-422-Course-Outline-EHTICAL-ISSUES-pdf/ regulatory setting
4) Contract and Tort Law for Computer Scientists Elements of a Contract, Elements of a Compensable Breach of Contract Definition and Purpose of Tort Law, the Role of Insurance
5) Intellectual Property Intellectual property rights, protecting intellectual property, Fair use Peer-to-peer networks, Protections for software, Open-source software Legitimacy of intellectual property protection for software
6) Professional Ethics Is software engineering a profession? Software engineering code of ethics Analysis of the code, Case studies, Whistle blowing
7) Work and Wealth Automation and unemployment, Workplace changes, Globalization The digital divide, the "winner-take-all society"

a) Recommended Reading:

Ethical, Legal and Professional Issues in Computing, Duqueenoy, P, Jones, S, and Biundell, B Pearson (2008)

b) Additional Reading:

Ethics in The Information Age, Quinn, M Addison Wesley (2013) Ethics and Information Technology (e-journals) Information, Communication, Ethics and Society (www.emeraldinsight.com/info/journals/jices/jices.jsp)

c) Other Support Material:

A variety of multimedia systems and electronic information resources Various application manuals and journals

COMP 420: PROFESSIONAL ETHICS AND INFORMATION LAW: (30 Lecturer Hours: 30 Practical Hours: C.F 3.0)

Purpose:

To develop an understanding of the relationship between computer science, technological change, society and the law; to emphasize the powerful role that computers and computer professionals play in a technological society;

Course Objectives:

1. be able to describe the impact of technological change, particularly that due to the introduction of computer and software systems, upon society
2. understand the current legal framework within which computer and software systems are developed, applied and regulated
3. be able to assess the effect of the legal framework upon the design of, and professional liability for, computer and software systems

Course Content:

Introduction to Legal Concepts

Introduction to legal system in Kenya,historical perspective; the system of courts; important legal concepts; European law.

Intellectual property, copyright and patents

Introduction to copyright, patents and law of confidence; the law of designs, trade marks and passing-off; Copyright Designs and Patents Act 1998; Copyright (Computer Programs) Regulations 1992; reverse engineering, look and feel, expert systems; patentability of computer software; infringement, defences and remedies; the law of confidence.

Contracts

Contracts for bespoke software; licence agreements for off-the-shelf software; shrink-wrap licensing contracts between software authors and publishers.

Liability

Liability for losses caused by defective software; exclusion clauses; the consumer protection act; negligence; liability for defective advice from expert systems.

Introduction to ethics: Definitions

Western ethical thought ethical problem solving

Professional ethics for computer scientists

ACM and BCS professional codes; arguments for and against professional codes; moral philosophy.

Privacy and the freedom of information

Privacy in the computer age, transborder date flows; the Data Protection Act 1998; the Regulation of Investigatory Powers Act 2000.

Computer misuse and computer crime

Report of the Scottish Law Commission; Computer Misuse Act 1990, example cases.

IT and the quality, quantity and organisation of work

IT and unemployment; telecommuting; deskilling; information management.
Overview of Kenya ICT Policy and the Communication Bill 2008,Kenya ICT Policy 2006,Kenya Communication Bill 2008

Learning and Teaching Methodology

Lectures, Presentations by members of the class, Case discussions, Tutorials, Assignments,

Continuous assessment tests, manual/notes, Practicals

Instructional Materials:

Text books, handouts, chalk/white board, computers, projectors, software

Assessment Strategy:

Class Test 1	10%
Class Test 2	10%
Assignments	10%
End-of-semester examination	70%
Total	**100%**

References:

1. Bainbridge, Introduction *to Computer Law*, 5th edition, Pitman, 2004.
2. R. Ayers, *Essence of professional issues in computing*. Prentice Hall, 1999.
3. T Forester, Computers *in the human context*, Blackwell, 1990.
4. C Reed, Computer *Law*, 2nd edition, Blackstone Press, 1993.
5. T Forester & P Morrison, Computer *ethics,* Blackwell, 1990.

SOFTWARE ENGINEERING

SFE 4010 Human Computer Interaction
SFE 4020 Software Design and Architecture
SFE 4030 Software Testing and Quality Assurance
APP 4035 Web Application Development Frameworks
APP 4080 Collaborative (Team Work in) Software Development

NETWORKING

DST 4010 Distributed Systems
NET 4020 Network Management and Security
NET 4030 Internet Architecture and Protocols
APP 4035 Web Application Development Frameworks
NET 4050 Sensor Networks and Internet of Things

FORENSIC INFORMATION TECHNOLOGY & CYBERCRIME

FIC 4010 Information System Security
FIC 4020 Forensic Accounting and Fraud Investigation
FIC 4030 Information Systems Audit
FIC 4040 Information Technology & Cybercrime
FIC 4050 Computer Forensics and Investigation

CAREER OPTIONS

- Network Administrator
- Network Engineer
- Network Designer
- Network Architect
- Software Engineer
- Software Applications Developer
- Information Systems Developer
- Mobile Applications Developer
- Systems Analyst / Programmer
- Information Systems Project manager
- Systems Architect
- Database Administrator
- Web Applications Developer
- Information systems Auditor
- IT Forensics Engineer
- Internet and Cybercrime Consultant
- Network Security Engineer

CONTACTS

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B.Sc Applied Computer Technology

@USIUAfrica

United States International University-Africa
Education to take you places

PROGRAM DESCRIPTION

The Bachelor of Science in Applied Computer Technology program addresses the integration, design, deployment and management of computing and telecommunication resources and services, as well as the development of technology infrastructures in organizations.
It prepares students to solve complex hardware and software problems requiring fundamental knowledge and competencies in the processes of needs assessment, technology transfer and user support.

DEGREE REQUIREMENTS 150 UNITS

GENERAL EDUCATION REQUIREMENTS 39 UNITS

STRATEGIES FOR UNIVERSITY SUCCESS 3 UNITS
SUS 1010 Strategies for University Success

RESEARCH METHODS 3 UNITS
GRM2000 Introduction to Research Methods

SYMBOLIC SYSTEMS AND INTELLECTUAL SKILLS 12 UNITS

WRITTEN, ANALYTICAL, CRITICAL THINKING SKILLS 6 UNITS
ENG 1106 Composition I (WI)
ENG 2206 Composition II (WI)

QUANTITATIVE AND TECHNOLOGICAL SKILLS 6 UNITS
IST1020 Introduction to Information Systems
MTH 1109 College Algebra

LANGUAGE STUDIES 6 UNITS
Students must have credit for a foreign language or must take up to a two-course foreign language sequence of one language. USIU-Africa offers courses in Arabic, French, Japanese, Spanish, Swahili and Chinese.

COMMUNITY SERVICE OR COMMUNITY PROJECT 3 UNITS
CMS 3700 Community Service

THE SENIOR EXPERIENCE 3 UNITS
The Senior Experience is required for each undergraduate degree program.
SEN 4800 Integrated Senior Seminar

GENERAL EDUCATION ELECTIVES 9 UNITS
Students are required to pick 3 elective courses (9 Units) from the other schools. One of the courses should be an upper level course. Lower Level courses are coded 1000-2999 while upper level courses are coded 3000 - 4999.

SCHOOL OF HUMANITIES & SOCIAL SERVICES
LIST OF LOWER & UPPER LEVEL ELECTIVES

Lower Level Electives

PSY 1101: Introduction to Psychology
PHL 1104: Introduction to Philosophy
SOC 2201: Introduction to Sociology

Upper Level Electives

GEO 3000: Geography and the Environment
PSY 3135: Psychology of Communication
SOC 3301: Social Problems
PHL 3310: Ethics and Value Theory
SOC 3500: Social Conflict & Resolution
LIT 4815: Oral Literature

CHANDARIA SCHOOL OF BUSINESS
LIST OF LOWER & UPPER LEVEL ELECTIVES

Lower Level Electives

BUS 1010: Introduction to Business
ECO1010: Principles of Microeconomics
ENT1010: Introduction to Entrepreneurship
HRT1010: Introduction to Hospitality & Tourism Management

Upper Level Electives

MGT 3010: Overview of Management Practice
MKT 3010: Principles of Marketing

MAJOR 96 UNITS

LOWER DIVISION CORE COURSES 51 UNITS
MTH1110 Calculus
IST 1025 Introduction to Programming
APT 1030 Fundamentals of Programming Languages
APT 1040 Introduction to Web Design and Applications
APT 1050 Database Systems
APT 2010 Systems Analysis and Design
APT 2020 Computer Organization
APT 2022 Introduction to Assembly Programming
APT 2030 Digital Electronics
APT 2040 Operating Systems
IST 2045 Introduction to Computer Networks
APT 2050 Computer Networks and Telecommunication
APT 2055 Hardware and Software Practicum
APT 2060 Data Structures & Algorithms
APT 2080 Introduction to Software Engineering
APT 2090 Computer Graphics
MTH2215 Discrete Mathematics

UPPER DIVISION CORE COURSES 45 UNITS
APT 3010 Introduction to Artificial Intelligence
APT 3025 Applied Machine Learning
APT 3040 Object Oriented Design and Programming
APT 3050 Introduction to Project Management
APT 3060 Mobile Programming
APT 3065 Mid-Term Project
APT 3080 Management Information Systems
APT 3090 Cryptography and Network Security
APT 3095 Cloud Computing and Visualization
APT 4900 Applied Computer Technology Project
APT 4910 Applied Computer Technology Internship
IST 3015 Business Data Analytics
IST 3050 Introduction to Security Systems
IST 4035 Advanced Web Design and Applications
IST 4078 IT Innovation and Entrepreneurship

CONCENTRATION COURSES 15 UNITS
Applied Computer Technology majors must take Software Engineering, Networking, Mobile Computing & Distributed Systems or Forensic Information Technology and Cybercrime as their concentration or area of specialization

DISTRIBUTED SYSTEMS & MOBILE COMPUTING
DST 4010 Distributed Systems
DST 4020 Mobile computing
DST 4030 Parallel Computing
DST 4040 Digital Wireless Communication and Networks
DST 4050 Embedded Real-Time Systems

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SCHOOL OF SCIENCE AND TECHNOLOGY

SEMESTER:	Spring 2022
COURSE:	APT 3010 - INTRODUCTION TO ARTIFICIAL INTELLIGENCE
LECTURER :	Dr. Leah Mutanu Mwaura
TIME/DAYS:	*Tue/Thur 7:20pm-9:00pm*
VENUE:	*Online*
CREDIT:	*3 Units*
OFFICE HOURS:	TUE/THUR *8:00AM – 11:00AM / Virtually – By Appointment*
CONTACT:	*email:* **lmutanu@usiu.ac.ke** *or Tel:* **+254-730116165 / 0722661172**

Pre-requisite: APT1030

Purpose of the Course

This is an introductory course on Artificial Intelligence (AI). The main purpose of this course is to provide the most fundamental knowledge to the students so that they can understand what AI is with minimal theoretic proofs and formal notations to enable students to get the full picture of AI easily. AI techniques and algorithms for solving those problems will be examined. Students will learn about the methods and tools that will allow them to build complete systems that can interact intelligently with their environment by learning and reasoning about the world. Programming languages such as Lisp, Python, and Theano among others may be used.

Expected Learning outcomes of the Course

Upon successful completion of the course, the learner will be able to:

1. Identify an “Artificially" Intelligent system.
2. Apply Artificial Intelligence techniques for problem solving
3. Implement classical Artificial Intelligence techniques, such as search algorithms, minimax algorithm, neural networks, tracking, and robot localization
4. Explain the limitations of current Artificial Intelligence techniques
5. Apply critical skills in clarifying and ethically analyzing AI in different domains of life
6. Identify ethical and social impacts and implications of AI
7. Use ethical and socially responsible principles in professional life

Link to University Mission Outcomes

CLO	Aligned to the *following university mission outcomes*:					
	Higher order thinking	Global understanding and multicultural perspective	Community service	Literacy	Preparedness for career	Leadership and Ethics
1. Identify an "Artificially" Intelligent system	✓			✓	✓	
2. Apply Artificial Intelligence techniques for problem solving	✓			✓	✓	✓
3. Implement classical Artificial Intelligence techniques, such as search algorithms, minimax algorithm, neural networks, tracking, and robot localization	✓				✓	✓
4. Explain the limitations of current Artificial Intelligence techniques	✓			✓	✓	
5. Apply critical skills in clarifying and ethically analyzing AI in different domains of life	✓				✓	✓
6. Identify ethical and social impacts and implications of AI	✓				✓	✓
7. Use ethical and socially responsible principles in professional life	✓	✓			✓	✓

Link to School Mission Outcomes

CLO	Aligned to the *following school mission outcomes*:						
	1. Critical Thinking and Creativity	2. Effective Communication Skills	3. Preparedness for Career	4. Research and Quantitative Skills	5. Multidisciplinary and Global Perspective	6. Professional and Ethical Leadership	7. Service to Community
1. Identify an "Artificially" Intelligent system	✓		✓				
2. Apply Artificial Intelligence techniques for problem solving	✓	✓	✓	✓			
3. Implement classical Artificial Intelligence techniques, such as search algorithms, minimax algorithm, neural networks, tracking, and robot localization	✓		✓	✓			
4. Explain the limitations of current Artificial Intelligence techniques	✓	✓	✓				
5. Apply critical skills in clarifying and ethically analyzing AI in different domains of life	✓		✓	✓	✓		✓
6. Identify ethical and social impacts and implications of AI	✓		✓	✓		✓	✓
7. Use ethical and socially responsible principles in professional life	✓		✓			✓	

Link to Program Learning Outcomes

PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7
	1. Develop integrated software for businesses/organizations/institutions using modern techniques	2. Conceptualize and implement integrated systems	3. Demonstrate competence in the use of modern computer tools and Techniques	4. Write programs using modern programming languages	5. Explain the concepts underlying computer information	6. Exhibit professional behavior and ethics	7. Develop skills to use tools, techniques and application skills in one of the following specializations: Computer Networks technology; Distributed and mobile computing;
APT 3010 - Introduction to Artificial Intelligence	I	I	A	A	I	B	I

Key: B-Beginner, I-Intermediate, A-Advanced

Course Content

WEEK	TOPIC	REFERENCE
1	Introduction to Artificial Intelligence	Chapter 1
2	Introduction to Python	Class Handouts
3	Intelligent Agents	Chapter 2
4 & 5	Problem Solving • Searching • Adversarial Searching • Constraint satisfaction	Chapter 3 & 5
6	Knowledge and Reasoning • Logical Agents • First-Order Logic	Chapter 7 & 8
7	• MID SEMESTER EXAMS • Revision Exercises	Chapter 1-8
8	Knowledge and Reasoning • Planning • Knowledge Representation	Chapter 11
9	Uncertainty • Quantifying Uncertainty • Probabilistic Reasoning • Decision Making	Chapter 13
10 & 11	Machine Learning • Supervised Learning	Chapter 18