AVIATION AND AEROSPACE ENGINEERING

CURRICULUM FOR SECONDARY EDUCATION (SHS 1 – 3)

NaCCA

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION
REPUBLIC OF GHANA

SEPTEMBER 2023

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

AVIATION AND AEROSPACE ENGINEERING

CURRICULUM FOR SECONDARY EDUCATION

(SHS 1-3)

September, 2023

NaCCA
NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

AVIATION AND AEROSPACE ENGINEERING

Enquiries and comments on this Curriculum should be addressed to:

The Director-General
National Council for Curriculum and Assessment (NaCCA)
Ministry of Education

P. O. Box CT PMB 77
Cantonments Accra

Telephone: 0302909071, 0302909862

Email: info@nacca.gov.gh

Website: www.nacca.gov.gh

FOREWORD

Through the National Council for Curriculum and Assessment (NaCCA), Ghana's Ministry of Education has introduced a series of curriculum reforms to improve the quality and relevance of learning experiences in pre-tertiary schools in the country. These reforms will improve learning through the introduction of innovative pedagogies that encourage critical thinking and problem-solving. For a long time, our learners memorise facts and figures, which does not develop their analytical and practical skills. The Ministry recognises that learners need to be equipped with the right tools, knowledge, skills and competencies to deal with the fast-changing environment and the challenges facing their communities, the nation and the world.

These curriculum reforms were derived from the Education Strategic Plan (ESP 2018-2030), the National Pre-tertiary Education Curriculum Framework (NPTECF) and the National Pre-Tertiary Learning Assessment Framework (NPLAF), which were all approved by Cabinet in 2018. The new standards-based curriculum implemented in 2019 in basic schools, aims to equip learners to apply their knowledge innovatively to solve everyday problems. It also prioritises assessing learners' knowledge, skills, attitudes, and values, emphasising their achievements. The content of the basic school standards-based curriculum was therefore designed to promote a curriculum tailored to the diverse educational needs of the country's youth. It addresses the current curriculum's deficiencies in learning and assessment, especially in literacy and numeracy. These reforms have been carried out in phases. The curriculum for the basic school level – KG, Primary and Junior High School (JHS) – was developed and implemented from 2019 to 2021.

The curriculum for Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technical, Engineering and Mathematics (STEM), which constitutes the next phase, is designed to ensure the continuation of learning experiences from JHS. It introduces flexible pathways for progression to facilitate the choice of subjects necessary for further study, the world of work and adult life. The new SHS, SHTS and STEM curriculum emphasises the acquisition of 21st Century skills and competencies, character development and instilling of national values. Social and Emotional Learning (SEL), Information Communications Technology, Gender Equality and Social Inclusion, have all been integrated into the curriculum. Assessment – formative and summative has been incorporated into the curriculum and aligned with the learning outcomes throughout the three-year programme.

The Ministry of Education's reform aims to ensure that graduates of our secondary schools can successfully compete in international high school competitions and, at the same time, be equipped with the necessary employable skills and work ethos to succeed in life. The Ministry of Education, therefore, sees the Senior High School (SHS) curriculum as occupying a critical place in the education system – providing improved educational opportunities and outcomes for further studies, the world of work and adult life – and is consequently prioritising its implementation.

ACKNOWLEDGEMENTS

This standards-based SHS curriculum was created using the National Pre-Tertiary Learning Assessment Framework (NPLAF), the Secondary Education Assessment Guide (SEAG), and the Teacher and Learner Resource Packs which include Professional Learning Community (PLC) Materials and Subject Manuals for teachers and learners. All the above-mentioned documents were developed by the National Council for Curriculum and Assessment (NaCCA). The Ministry of Education (MoE) provided oversight and strategic direction for the development of the curriculum with NaCCA receiving support from multiple agencies of the MoE and other relevant stakeholders. NaCCA would like to extend its sincere gratitude, on behalf of the MoE, to all its partners who participated in the professional conversations and discussions during the development of this SHS curriculum.

In particular, NaCCA would also like to extend its appreciation to the leadership of the Ghana Education Service (GES), the National School Inspectorate Authority (NaSIA), the National Teaching Council (NTC), the Commission for Technical and Vocational Education and Training (Commission for TVET), West African Examinations Council (WAEC) and other agencies of the MoE that supported the entire process. In addition, NaCCA acknowledges and values the contributions made by personnel from various universities, colleges of education Industry players, Vice Chancellors Ghana, Vice Chancellors Technical Universities as well as educators and learners working within the Ghana education landscape.

Special appreciation is extended to consultants who contributed to development of the curriculum. The development process involved multiple engagements between national stakeholders and various groups with interests in the curriculum. These groups include the teacher unions, the Association of Ghana Industries, and heads of secondary schools.

CONTENTS

THE SHS CURRICULUM OVERVIEW

The vision for this curriculum is to ensure the nation has a secondary education system that enables all Ghanaian children to acquire the 21st Century skills, competencies, knowledge, values and attitudes required to be responsible citizens, ready for the world of work, further studies and adult life. The nation's core values drive the SHS curriculum, and it is intended to achieve Sustainable Development Goal 4: 'Inclusive, equitable quality education and life-long learning for all'. Above all, it is a curriculum enabling its graduates to contribute to the ongoing growth and development of the nation's economy and well-being.

The curriculum is inclusive, flexible, and robust. It was written under the auspices of the National Council for Curriculum and Assessment by a team of expert curriculum writers across Ghana. It reflects the needs of critical stakeholders, including industry, tertiary education, the West African Examination Council, SHS learners, teachers, and school leaders. It has been written based on the National Pre-Tertiary Learning and Assessment Framework and the Secondary Education Policy.

The key features of the curriculum include:

- flexible learning pathways at all levels, including for gifted and talented learners and those with deficiencies in numeracy and literacy, to ensure it can meet the needs of learners from diverse backgrounds and with different interests and abilities.
- the five core learning areas for secondary education: science and technology, language arts, humanities, technical and vocational and business; with emphasis placed on STEM and agriculture as integral to each subject.
- a structured, standards-based approach that supports the acquisition of knowledge, skills and competencies, and transition and seamless progress throughout secondary education, from JHS to SHS and through the three years of SHS.
- a focus on interactive approaches to teaching and assessment to ensure learning goes beyond recall enabling learners to acquire the ability to understand, apply, analyse and create.
- guidance on pedagogy, coupled with exemplars, demonstrating how to integrate cross-cutting themes such as 21st Century skills, core competencies, the use of ICT, literacy and mathematics, Social Emotional Learning, Gender Equality and Social Inclusion as tools for learning and skills for life. Shared Ghanaian values are also embedded in the curriculum.

The curriculum writing process was rigorous and involved developing and using a Curriculum Writing Guide which provided systematic instructions for writers. The process was quality assured at three levels: through (a) evaluation by national experts, (b) trialling curriculum materials in schools and (c) through an external evaluation by a team of national and international experts. Evidence and insights from these activities helped hone the draft's final version. The outcome is a curriculum coherently aligned with national priorities, policies and the needs of stakeholders. A curriculum tailored to the Ghanaian context ensures that all learners benefit from their schooling and develop their full potential.

The following section highlights the details of the front matter of the draft curriculum. The vision, philosophy and goal of the curriculum are presented. This is followed by the details of the 21st Century skills and competencies, teaching and learning approaches, instructional design and assessment strategies. The template for the curriculum frame, which outlines the scope and sequence, the design that links the learning outcomes to particular 21st Century skills and competencies, as well as Gender Equality and Social Inclusion, Social and Emotional Learning and Ghanaian values are presented together with the structure of the lesson frame showing the links between the content standards, learning indicators with their corresponding pedagogical exemplars and assessment strategies.

INTRODUCTION

Effective implementation of this Senior High School (SHS) curriculum is the key to creating a well-educated and well-balanced workforce that is ready to contribute to Ghana's progress by harnessing the potential of the growing youth population, considering the demographic transition the country is currently experiencing (Educational Strategic Plan [ESP] 2018-2030). SHS curriculum aims to expand equitable, inclusive access to relevant education for all young people, including those in disadvantaged and underserved communities, those with special educational needs and those who are gifted and talented. Senior High School allows young people to develop further skills and competencies and progress in learning achievement, building from the foundation laid in Junior High School. This curriculum intends to meet the learning needs of all high school learners by acquiring 21st Century skills and competencies to prepare them for further studies, the world of work and adult life. Changing global economic, social and technological context requires life-long learning, unlearning, and continuous processes of reflection, anticipation and action.

Philosophy of Senior High School Curriculum

The philosophy underpinning the SHS curriculum is that every learner can develop their potential to the fullest if the right environment is created and skilled teachers effectively support them to benefit from the subjects offered at SHS. Every learner needs to be equipped with skills and competencies of interest to further their education, live a responsible adult life or proceed to the world of work.

Vision of Senior High School Curriculum

The vision of the curriculum is to prepare SHS graduates equipped with relevant skills and competencies to progress and succeed in further studies, the world of work and adult life. It aims to equip all learners with the 21st Century skills and competencies required to be responsible citizens and lifelong learners. When young people are prepared to become effective, engaging, and responsible citizens, they will contribute to the ongoing growth and development of the nation's economy and well-being.

Goal of Senior High School Curriculum

The goal of the curriculum is to achieve relevant and quality SHS through the integration of 21st Century skills and competencies as set out in the Secondary Education Policy. The key features to integrate into the curriculum are:

- Foundational Knowledge: literacy, numeracy, scientific literacy, information, communication and digital literacies, financial literacy and entrepreneurship, cultural identity, civic literacy and global citizenship
- Competencies: critical thinking and problem-solving, innovation and creativity, collaboration, and communication
- Character Qualities: discipline, integrity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership, and responsible citizenship.

The JHS curriculum has been designed to ensure that learners are adequately equipped to transition seamlessly into SHS, where they will be equipped with the relevant knowledge, skills and competencies. The SHS curriculum emphasises character building, acquisition of 21st Century skills and competencies and nurturing core values within an environment of quality education to ensure the transition to further study, the world of work and adult life. This requires the delivery of robust secondary education that meets the varied learning needs of the youth in Ghana. The SHS curriculum, therefore, seeks to develop learners to become technology-inclined, scientifically literate, good problem-solvers who can think critically and creatively and are equipped to communicate with fluency, and possess the confidence and competence to participate fully in Ghanaian society as responsible local and global citizens – (referred to as 'Glocal citizens').

The SHS curriculum is driven by the nation's core values of truth, integrity, diversity, equity, discipline, self-directed learning, self-confidence, adaptability and resourcefulness, leadership, and responsible citizenship, and with the intent of achieving the Sustainable Development Goal 4: 'Inclusive, equitable quality education and life-long learning for all'. The following sections elaborate on the critical competencies required of every SHS learner:

Gender Equality and Social Inclusion (GESI)

- Appreciate their uniqueness about others.
- Pay attention to the uniqueness and unique needs of others.
- Value the perspective, experience, and opinion of others.
- Respect individuals of different beliefs, political views/ leanings, cultures, and religions.
- Embrace diversity and practise inclusion.
- Value and work in favour of a democratic and inclusive society.
- Be conscious of the existence of minority and disadvantaged groups in society and work to support them.
- Gain clarity about misconceptions/myths about gender, disability, ethnicity, age, religion, and all other excluded groups in society
- Interrogate and dispel their stereotypes and biases about gender and other disadvantaged and excluded groups in society.
- Appreciate the influence of socialisation in shaping social norms, roles, responsibilities, and mindsets.
- Identify injustice and advocate for change.
- Feel empowered to speak up for themselves and be a voice for other disadvantaged groups.

21st Century Skills and Competencies

In today's fast-changing world, high school graduates must be prepared for the 21st Century world of work. The study of Mathematics, Science, and Language Arts alone is no longer enough. High school graduates need a variety of skills and competencies to adapt to the global economy. Critical thinking, creativity, collaboration, communication, information literacy, media literacy, technology literacy, flexibility, leadership, initiative, productivity, and social skills are needed. These skills help learners to keep up with today's fast-paced job market. Employers want workers with more than academic knowledge. The 21st Century skills and competencies help graduates navigate the complex and changing workplace. Also, these help them become active citizens who improve their communities. Acquisition of 21st Century skills in high school requires a change in pedagogy from the approach that has been prevalent in Ghana in recent years. Teachers should discourage and abandon rote memorisation and passive learning. Instead, they should encourage active learning, collaboration, and problem-solving, project-based, inquiry-based, and other learner-centred pedagogy should be used. As well as aligning with global best practices, these approaches also seek to reconnect formal education in Ghana with values-based indigenous education and discovery-based learning which existed in Ghana in pre-colonial times. This is aligned with the 'glocal' nature of this curriculum, connecting with Ghana's past to create confident citizens who can engage effectively in a global world. Digitalisation, automation, technological advances and the changing nature of work globally mean that young people need a new set of skills, knowledge and competencies to succeed in this dynamic and globalised labour market.

Critical Thinking and Problem-Solving Competency

- Ability to question norms, practices, and opinions, to reflect on one's values, perceptions, and actions.
- Ability to use reasoning skills to come to a logical conclusion.
- Being able to consider different perspectives and points of view
- Respecting evidence and reasoning
- Not being stuck in one position
- Ability to take a position in a discourse
- The overarching ability to apply different problem-solving frameworks to complex problems and develop viable, inclusive, and equitable solution options that integrate the above-mentioned competencies, promote sustainable development,

Creativity

- Ability to identify and solve complex problems through creative thinking.
- Ability to generate new ideas and innovative solutions to old problems.
- Ability to demonstrate originality and flexibility in approaching tasks and challenges.
- Collaborating with others to develop and refine creative ideas
- Ability to incorporate feedback and criticism into the creative process
- Utilising technology and other resources to enhance creativity
- Demonstrating a willingness to take risks and experiment with new approaches
- Adapting to changing circumstances and further information to maintain creativity

- Integrating multiple perspectives and disciplines to foster creativity
- Ability to communicate creative ideas effectively to a variety of audiences

Collaboration

- Abilities to learn from others; to understand and respect the needs, perspectives, and actions of others (empathy)
- Ability to understand, relate to and be sensitive to others (empathic leadership)
- Ability to deal with conflicts in a group
- Ability to facilitate collaborative and participatory problem-solving
- Ability to work with others to achieve a common goal.
- Ability to engage in effective communication, active listening, and the ability to compromise.
- Ability to work in groups on projects and assignments.

Communication

- Know the specific literacy and language of the subjects studied
- Use language for academic purposes
- Communicate effectively and meaningfully in a Ghanaian Language and English Language
- Communicate confidently, ethically, and effectively in different social contexts.
- Communicate confidently and effectively to different participants in different contexts
- Ability to communicate effectively verbally, non-verbally and through writing.
- Demonstrate requisite personal and social skills that are consistent with changes in society
- Ability to express ideas clearly and persuasively, listen actively, and respond appropriately
- Ability to develop digital communication skills such as email etiquette and online collaboration.
- Ability to engage in public speaking, debate, and written communication.

Learning for Life

- Understand subject content and apply it in different contexts
- Apply mathematical and scientific concepts in daily life
- Demonstrate mastery of skills in literacy, numeracy, and digital literacy.
- Develop an inquiry-based approach to continual learning.
- Be able to understand higher-order concepts and corresponding underlying principles.
- Participate in the creative use of the expressive arts and engage in aesthetic appreciation.
- Use and apply a variety of digital technologies
- Be digitally literate with a strong understanding of ICT and be confident in its application.
- Be equipped with the necessary qualifications to gain access to further and higher education and the world of work and adult life
- Ability to apply knowledge practically in the workplace so that they are able to utilise theory by translating it into practice.
- Develop their abilities, gifts and talents to be able to play a meaningful role in the development of the country
- Be able to think critically and creatively, anticipate consequences, recognise opportunities and be risk-takers
- Ability to pursue self-directed learning with the desire to chart a path to become effective lifelong learners.
- Independent thinkers and doers who show initiative and take action.
- Ability to innovate and think creatively, building on their knowledge base so that they take risks to achieve new goals
- Ability to think critically and solve problems so that they become positive change agents at work, in further study and in their personal lives.
- Be motivated to adapt to the changing needs of society through self-evaluation and ongoing training
- Be able to establish and maintain innovative enterprises both individually and in collaboration with others.
- Be able to ethically prioritise economic values to ensure stability and autonomy
- Show flexibility and preparedness to deal with job mobility
- Be committed towards the improvement of their quality of life and that of others
- Feel empowered in decision-making processes at various levels e.g., personal, group, class, school, etc.

- Be able to seek and respond to assistance, guidance and/or support when needed.
- Ability to make and adhere to commitments.
- Adopt a healthy and active lifestyle and appreciate how to use leisure time well.
- Be enthusiastic, with the knowledge, understanding and skill that enable them to progress to tertiary level, the world of work and adult life.
- Ability to transition from school to the world of work or further study by applying knowledge, skills and attitudes in new situations.
- Be independent, have academic and communication skills such as clarity of expression (written and spoken), and the ability to support their arguments.
- Be innovative and understand the 21st Century skills and competencies and apply them to everyday life.

Global and Local (Glocal) Citizenship

- Appreciate and respect the Ghanaian identity, culture, and heritage
- Be conscious of current global issues and relate well with people from different cultures
- Act in favour of the common good, social cohesion and social justice
- Have the requisite personal and social skills to handle changes in society
- Appreciate the impact of globalisation on the society.
- Ability to be an honest global citizen displaying leadership skills and moral fortitude with an understanding of the wider world and how to enhance Ghana's standing.

Systems Thinking Competency

- Ability to recognise and understand relationships
- Ability to analyse complex systems
- Ability to think of how systems are embedded within different domains and different scales
- Ability to deal with uncertainty

Normative Competency

- Ability to understand and reflect on the norms and values that underlie one's actions
- Ability to negotiate values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions

Anticipatory Competency

- Ability to understand and evaluate multiple futures – possible, probable, and desirable
- Ability to create one's vision for the future.
- Ability to apply the precautionary principle
- Ability to assess the consequences of actions
- Ability to deal with risks and changes

Strategic Competency

- Ability to collectively develop and implement innovative actions that further a cause at the local level and beyond.
- Ability to understand the bigger picture and the implications of smaller actions on them

Self-Awareness Competency

- The ability to reflect on one's role in the local community and (global) society
- Ability to continually evaluate and further motivate one's actions
- Ability to deal with one's feelings and desires

Social Emotional Learning (SEL): Five Core Competencies with Examples

1. *Self-Awareness*

Understanding one's emotions, thoughts, and values and how they influence one's behaviour in various situations. This includes the ability to recognise one's strengths and weaknesses with a sense of confidence and purpose. For instance:

- *Integrating personal and social identities;*
- *Identifying personal, cultural, and linguistic assets;*
- *Identifying one's emotions;*
- *Demonstrating honesty and integrity;*
- *Connecting feelings, values, and thoughts;*

- *Examining prejudices and biases;*
- *Experiencing self-efficacy;*
- *Having a growth mindset;*
- *Developing interests and a sense of purpose;*

2. *Self-Management*

The capacity to control one's emotions, thoughts, and actions in a variety of situations and to realise one's ambitions. This includes delaying obtaining one's desires, dealing with stress, and feeling motivated and accountable for achieving personal and group goals. For instance:

- *Managing one's emotions;*
- *Identifying and utilising stress-management strategies;*
- *Demonstrating self-discipline and self-motivation;*
- *Setting personal and group goals;*
- *Using planning and organisation skills;*
- *Having the courage to take the initiative;*
- *Demonstrating personal and collective agency;*

3. *Social Awareness*

The capacity to comprehend and care for others regardless of their backgrounds, cultures, and circumstances. This includes caring for others, understanding larger historical and social norms for behaviour in different contexts, and recognising family, school, and community resources and supports. For instance:

- *Recognising others' strengths*
- *Demonstrating empathy and compassion*
- *Caring about others' feelings*
- *Understanding and expressing gratitude*
- *Recognising situational demands and opportunities*
- *Understanding how organisations and systems influence behaviour*

4. *Relationship Skills*

The capacity to establish and maintain healthy, beneficial relationships and adapt to various social situations and groups. This includes speaking clearly, listening attentively, collaborating, solving problems and resolving conflicts as a group, adapting to diverse social and cultural demands and opportunities, taking the initiative, and asking for or offering assistance when necessary. For instance:

- *Communicating effectively;*
- *Building positive relationships;*
- *Demonstrating cultural competence;*
- *Working as a team to solve problems;*
- *Constructively resolving conflicts;*
- *Withstanding negative social pressure;*
- *Taking the initiative in groups;*
- *Seeking or assisting when needed;*
- *Advocating for the rights of others.*

5. *Responsible Decision-Making*

The capacity to make thoughtful and constructive decisions regarding acting and interacting with others in various situations. This includes weighing the pros and cons of various personal, social, and group well-being actions. For example:

- *Demonstrating curiosity and an open mind;*
- *Solving personal and social problems;*
- *Learning to make reasonable decisions after analysing information, data, and facts;*
- *Anticipating and evaluating the effects of one's actions;*
- *Recognising that critical thinking skills are applicable both inside and outside of the classroom;*
- *Reflecting on one's role in promoting personal, family, and community well-being;*
- *Evaluating personal, interpersonal, community, and institutional impacts*

Learning and Teaching Approaches

Learning and teaching should develop learners as self-directed and lifelong learners. Learners must be helped to build up deep learning skills and competencies to develop the ability to acquire, integrate and apply knowledge and skills to solve authentic and real-life problems. Learners need to be exposed to a variety of learning experiences to enable them to collaborate with others, construct meaning, plan, manage, and make choices and decisions about their learning. This will allow them to internalise newly acquired knowledge and skills and help them

to take ownership of their education. The 21st Century skills and competencies describe the relevant global and contextualised skills that the SHS curriculum is designed to help learners acquire in addition to the 4Rs (Reading, wRiting, aRithmetic and cReativity). These skills and competencies, as tools for learning and teaching and skills for life, will allow learners to become critical thinkers, problem-solvers, creators, innovators, good communicators, collaborators, digitally literate, and culturally and globally sensitive citizens who are life-long learners with a keen interest in their personal development and contributing to national development.

Given the diverse needs of learners, teachers need to have a thorough grasp of the different pedagogies as they design and enact meaningful learning experiences to meet the needs of different learners in the classroom. The teaching-learning techniques and strategies should include practical activities, discussion, investigation, role play, problem-based, context-based, and project-based learning. Active learning strategies have become increasingly popular in education as they provide learners with meaningful opportunities to engage with the material. These strategies emphasise the use of creative and inclusive pedagogies and learner-centred approaches anchored on authentic and enquiry-based learning, collaborative and cooperative learning, differentiated teaching and learning, holistic learning, and cross-disciplinary learning. They include experiential learning, problem-based learning, project-based learning, and talk-for-learning approaches. Some of the pedagogical exemplars to guide learning and teaching of the SHS curriculum include:

- **Experiential Learning:** Experiential learning is a hands-on approach to learning that involves learners in real-world experiences. This approach focuses on the process of learning rather than the result. Learners are encouraged to reflect on their experiences and use them to develop new skills and knowledge. Experiential learning can take many forms, including internships, service learning, and field trips. One of the main benefits of experiential learning is that it allows learners to apply what they have learned in the classroom to real-world situations. This can help them develop a deeper understanding of the material and make connections between different concepts. Additionally, experiential learning can help learners develop important skills such as critical thinking, problem-solving and communication.
- **Problem-Based Learning:** Problem-based learning is an approach that involves learners in solving real-world problems. Learners are presented with a problem or scenario and are asked to work together to find a solution. This approach encourages learners to take an active role in their learning and helps them develop important skills such as critical thinking and problem-solving. One of the main benefits of problem-based learning is that it encourages learners to take ownership of their learning. By working together to solve problems, learners can develop important skills such as collaboration and communication. Additionally, problem-based learning can help learners develop a deeper understanding of the material as they apply it to real-world situations.
- **Project-Based Learning:** Project-based learning is a hands-on approach to learning that involves learners in creating a project or product. This approach allows learners to take an active role in their learning and encourages them to develop important skills such as critical thinking, problem-solving, collaboration, and communication. One of the main benefits of project-based learning is that it allows learners to apply what they have learned in the classroom to real-world situations. Additionally, project-based learning can help learners develop important skills from each other and develop a deeper understanding of the material.
- **Talk for Learning Approaches:** Talk for learning approaches (TfL) are a range of techniques and strategies that are used to encourage learners to talk by involving them in discussions and debates about the material they are learning. This approach encourages learners to take an active role in their learning and helps them develop important skills such as critical thinking, collaboration and communication and also makes them develop confidence. One of the main benefits of TfL is that it encourages learners to think deeply about the material they are learning. By engaging in discussions and debates, learners can develop a deeper understanding of the material and make connections between different concepts.
- **Initiating Talk for Learning:** Initiating talk for learning requires the use of strategies that would encourage learners to talk in class. It helps learners to talk and participate meaningfully and actively in the teaching and learning process. Apart from developing skills such as communication and critical thinking, it also helps learners to develop confidence. Some strategies for initiating talk among learners are Activity Ball; Think-Pair-Share; Always, Sometimes, Never True; Matching and Ordering of Cards.
- **Building on What Others Say:** Building on what others say is an approach that involves learners in listening to and responding to their classmates'

ideas. This approach encourages learners to take an active role in their learning and helps them develop important skills such as critical thinking and communication. One of the main benefits of building on what others say is that it encourages learners to think deeply about the material they are learning. By listening to their classmates' ideas, learners can develop a deeper understanding of the material and make connections between different concepts. Additionally, building on what others say can help learners develop important skills such as collaboration and reflection. Some of the strategies to encourage learners to build on what others say are brainstorming, concept cartoons, pyramid discussion, and 5 Whys, amongst others.

- **Managing Talk for Learning:** Managing talk for learning requires the use of various strategies to effectively coordinate what learners say in class. Effective communication is a crucial aspect of learning in the classroom. Teachers must manage talk to ensure that learners are engaged, learning, and on-task in meaningful and purposeful ways. Some strategies for managing learners' contributions are debates, think-pair-share, sage in the circle etc.
- **Structuring Talk for Learning:** One effective way to shape learners' contributions is to structure classroom discussions. Structured discussions provide a framework for learners to engage in meaningful dialogue and develop critical thinking skills. Teachers can structure discussions by providing clear guidelines, such as speaking one at a time, listening actively, and building on each other's ideas. One popular structured discussion technique is the "think-pair-share" method. In this method, learners think about a question or prompt individually, and then pair up with a partner to discuss their ideas. Finally, the pairs share their ideas with the whole class. This method encourages all learners to participate and ensures that everyone has a chance to share their thoughts. Another effective way to structure talk for learning is to use open-ended questions. Open-ended questions encourage learners to think deeply and critically about a topic. They also promote discussion and collaboration among learners. Teachers can use open-ended questions to guide classroom discussions and encourage learners to share their ideas and perspectives. Other strategies that can be used are Concept/Mind Mapping, "Know," "Want to Know," "Learned" (KWL); Participatory Feedback; and the 5 Whys.
- **Diamond Nine:** The Diamond Nine activity is a useful tool for managing talk for learning in the classroom. This activity involves ranking items or ideas in order of importance or relevance. Learners work in groups to arrange cards or sticky notes with different ideas or concepts into a diamond shape, with the most important idea at the top and the least important at the bottom. The Diamond Nine activity encourages learners to think critically about a topic and prioritise their ideas. It also promotes collaboration and discussion among group members. Teachers can use this activity to introduce a new topic, review material, or assess student understanding.
- **Group Work/Collaborative Learning:** Group work or collaborative learning are effective strategies for managing talk for learning in the classroom. These strategies encourage learners to work together to solve problems, share ideas, and learn from each other. Group work and collaborative learning also promote communication and collaborative skills that are essential for success in the workplace and in life. To implement group work effectively, teachers must provide clear guidelines and expectations for group members. They should also monitor group work to ensure that all learners are participating and on-task. Teachers can also use group work as an opportunity to assess individual student understanding and participation.
- **Inquiry-Based Learning:** Learners explore and discover new information by asking questions and investigating.
- **Problem-Based Learning:** Learners are given real-world problems to solve and must use critical thinking and problem-solving skills.
- **Project-Based Learning:** Learners work on long-term projects that relate to real-world scenarios.
- **Flipped Classroom:** Learners watch lectures or instructional videos at home and complete assignments and activities in class.
- **Mastery-Based Learning:** Learners learn at their own pace and only move on to new material once they have mastered the current material.
- **Gamification:** Learning is turned into a game-like experience with points, rewards, and competition.

These strategies provide learners with opportunities to engage with the material in meaningful ways and develop important skills such as critical thinking, problem-solving, collaboration, and communication. By incorporating these strategies into their teaching, teachers can help learners develop a deeper understanding of the material and prepare them for success in the real world. Effective communication is essential for learning in the classroom. Teachers must manage talk to ensure that learners are engaged in learning and on-task. Strategies such as structuring

talk for learning, using Diamond Nine activities, and implementing group work/ collaborative learning can help teachers manage talk effectively and promote student learning and engagement. By implementing these strategies, teachers can create a positive and productive learning environment where all learners can succeed.

Universal Design for Learning (UDL) in the SHS Curriculum

The design of the curriculum uses UDL to ensure the creation of flexible learning environments that can accommodate a wide range of learner abilities, needs, and preferences. The curriculum is designed to provide multiple means of engagement, representation, and action and expression, so teachers can create a more inclusive and effective learning experience for all learners. UDL is beneficial for all learners, but it is particularly beneficial for learners needing special support and learners who may struggle with traditional teaching approaches. The integration of UDL in the pedagogy is aimed at making learning accessible to everyone and helping all learners reach their full potential. For instance, teachers need to:

- incorporate multiple means of representation into their pedagogy, such as using different types of media and materials to present information.
- provide learners with multiple means of action and expression, such as giving them options for how they can demonstrate their learning.
- consider incorporating multiple means of engagement into their choice of pedagogy, such as incorporating games or interactive activities to make learning more fun and engaging.

By doing these, teachers can help ensure that the curriculum is accessible and effective for all learners, regardless of their individual needs and abilities.

Curriculum and Assessment Design: Revised Bloom's Taxonomy and Webb's Depth of Knowledge

The design of this curriculum uses the revised Bloom's Taxonomy and Webb's Depth of Knowledge (DoK) as frameworks to design what to teach and assess.

The Revised Bloom's Taxonomy provides a framework for designing effective learning experiences. Understanding the different levels of learning, informed the creation of activities and assessments that challenge learners at the appropriate level and help them progress to higher levels of thinking. Additionally, the framework emphasises the importance of higher-order thinking skills, such as analysis, evaluation, and creation, which are essential for success in today's complex and rapidly changing world. This framework is a valuable tool for educators who want to design effective learning experiences that challenge students at the appropriate level and help them develop higher-order thinking skills. By understanding the six levels of learning and incorporating them into their teaching, educators can help prepare students for success in the 21st century. The six hierarchical levels of the revised Bloom's Taxonomy are:

1. **Remember** – At the foundation is learners' ability to remember. That is retrieving knowledge from long-term memory. This level requires learners to recall concepts—identify, recall, and retrieve information. Remembering is comprised of identifying, listing, and describing. Retrieving relevant knowledge from long-term memory includes, recognising, and recalling is critical for this level.
2. **Understand** – At understanding, learners are required to construct meaning that can be shown through clarification, paraphrasing, representing, comparing, contrasting and the ability to predict. This level requires interpretation, demonstration, and classification. Learners explain and interpret concepts at this level.
3. **Apply** – This level requires learners' ability to carry out procedures at the right time in a given situation. This level requires the application of knowledge to novel situations as well as executing, implementing, and solving problems. To apply, learners must solve multi-step problems.
4. **Analyse** – The ability to break things down into their parts and determine relationships between those parts and being able to tell the difference between what is relevant and irrelevant. At this level, information is deconstructed, and its relationships are understood. Comparing and contrasting information and organising it is key. Breaking material into its constituent parts and detecting how the parts relate to one another and an overall structure or purpose is required. The analysis also includes differentiating, organising and attributing.
5. **Evaluate** – The ability to make judgments based on criteria. To check whether there are fallacies and inconsistencies. This level involves information evaluation, critique, examination, and formulation of hypotheses.
6. **Create** – The ability to design a project or an experiment. To create, entails learners bringing something new. This level requires generating information—planning, designing, and constructing.

Webb's Depth of Knowledge (DoK) is a framework that helps educators and learners understand the level of cognitive engagement required for different types of learning tasks. The framework includes four levels. By understanding the four DoK levels, educators can design learning activities that challenge students to engage in deeper thinking and problem-solving. DoK is an essential tool for designing effective instruction and assessments. By understanding the different levels of DoK, teachers can design instruction and assessments that align with what they intend to achieve. DoK is a useful tool for differentiating instruction and providing appropriate challenges for all learners. Teachers can use DOK to identify students who need additional support or those who are ready for more advanced tasks. The four levels of Webb's' DoK assessment framework are:

- **Level 1: Recall and Reproduction –** Assessment at this level is on recall of facts, concepts, information, and procedures—this involves basic knowledge acquisition. Learners are asked specific questions to launch activities, exercises, and assessments. The assessment is focused on recollection and reproduction.
- **Level 2: Skills of Conceptual Understanding –** Assessment at this level goes beyond simple recall to include making connections between pieces of information. The learner's application of skills and concepts is assessed. The assessment task is focused more on the use of information to solve multi-step problems. A learner is required to make decisions about how to apply facts and details provided to them.
- **Level 3: Strategic Reasoning** – At this level, the learner's strategic thinking and reasoning which is abstract and complex is assessed. The assessment task requires learners to analyse and evaluate composite real-world problems with predictable outcomes. A learner must apply logic, employ problem-solving strategies, and use skills from multiple subject areas to generate solutions. Multitasking is expected of learners at this level.
- **Level 4: Extended Critical Thinking and Reasoning –** At this level of assessment, the learner's extended thinking to solve complex and authentic problems with unpredictable outcomes is the goal. The learner must be able to strategically analyse, investigate, and reflect while working to solve a problem, or changing their approach to accommodate new information. The assessment requires sophisticated and creative thinking. As part of this assessment, the learner must know how to evaluate their progress and determine whether they are on track to a feasible solution for themselves.

The main distinction between these two conceptual frameworks is what is measured. The revised Bloom's Taxonomy assesses the cognitive level that learners must demonstrate as evidence that a learning experience occurred. The DoK, on the other hand, is focused on the context—the scenario, setting, or situation—in which learners should express their learning. In this curriculum, the revised Bloom's taxonomy guided the design, and the DoK is used to guide the assessment of learning. The taxonomy provides the instructional framework, and the DoK analyses the assignment specifics. It is important to note that Bloom's Taxonomy requires learners to master the lower levels before progressing to the next. So, suppose the goal is to apply a mathematical formula. In that case, they must first be able to identify that formula and its primary purpose (remember and understand). The cognitive rigour is therefore presented in incremental steps to demonstrate the learning progression. When measuring assessments in DoK, learners move fluidly through all levels. In the same example, while solving a problem with a formula, learners recall the formula (DoK 1) to solve the problem (DoK 2 and DoK 3). Depending on the difficulty of the problem to be solved, the learner may progress to DoK 4.

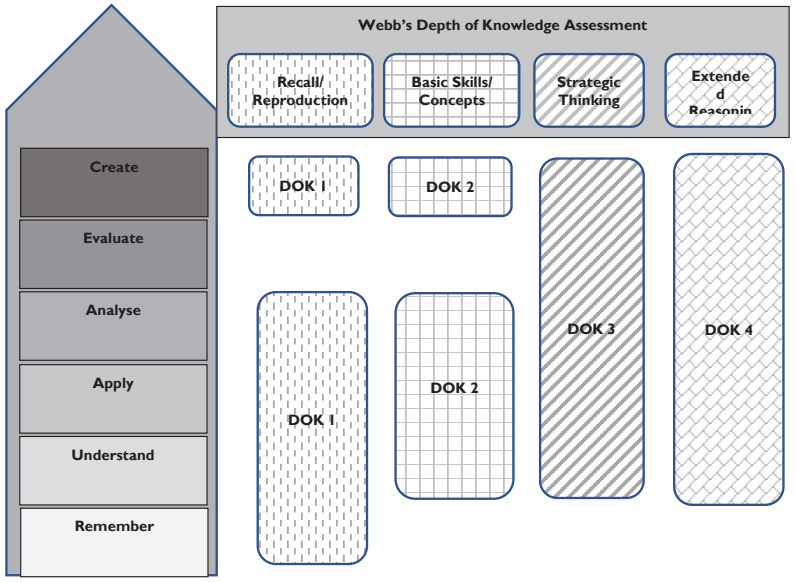

Figure 1: Revised Bloom Taxonomy combined with Webb's Depth of Knowledge for Teaching and Assessment

The structure of teaching and the assessment should align with the six levels of Bloom's knowledge hierarchy and DoK shown in Figure 1. Each level of DoK should be used to assess specific domains of Bloom's Taxonomy as illustrated in the table below:

Depth of Knowledge (DoK) Assessment	Bloom's Taxonomy applied to DoK
• Level 1: Recall and Reproduction	• Remembering, Understanding, Application, Analysis and Creation
• Level 2: Basic Skills and Concepts	• Understanding, Application, Analysis and Creation
• Level 3: Strategic Thinking	• Understanding, Application, Analysis, Evaluation and Creation
• Level 4: Extended Reasoning	• Understanding, Application, Analysis, Evaluation and Creation

In line with the National Pre-Tertiary Learning and Assessment Framework, the Secondary Education Assessment Guide (SEAG) requires that classroom assessments should cover **Assessment as learning (AaL), Assessment of learning (AoL) and Assessment for learning (AfL).** Therefore, teachers should align the Revised Bloom's Taxonomy with the DoK framework of assessment. Formative assessments should include classroom discussions, project-based assignments, and self-reflection exercises, while summative assessments should include standardised tests and rubric-based evaluations of learners' work. It is important to seek feedback from learners themselves, as they may have unique insights into how well they are developing these skills in the classroom.

To assess 21st Century skills and competencies in the classroom, teachers will have to use a combination of both formative and summative assessments to evaluate learners' acquisition of these skills and competencies. For instance:

- Identify the specific 21st Century skills and competencies to be assessed. For instance, you might want to assess *critical thinking, problem-solving, or creativity*.
- Align the skills and competencies with the DoK levels. For example, lower DoK levels might be more appropriate for assessing basic knowledge and comprehension, whereas higher DoK levels might be more appropriate for assessing more complex skills such as *analysis, synthesis, and evaluation*.
- Develop assessment items that align with the DoK levels and the skills and competencies you want to assess. These items should be designed to elicit evidence of learning across the different levels of the DoK framework.
- Administer the assessment and collect data. Analyse the data to gain insights into student learning and identify areas where learners may need additional support or instruction.

The DoK framework is a powerful tool for assessing the acquisition of 21st Century skills and competencies in the classroom, helping teachers to better understand how learners are learning and identify areas for improvement.

Educational success is no longer about producing content knowledge, but rather about extrapolating from what we know and applying the knowledge creatively in new situations.

The overall assessment of learning at SHS should be aligned with the National Pre-Tertiary Learning and Assessment Framework and the Secondary Education Assessment Guide. Formative and summative assessment strategies must be used.

Definition of Key Terms and Concepts in the Curriculum

- **Learning Outcomes:** It is a statement that defines the knowledge, skills, and abilities that learners should possess and be able to demonstrate after completing a learning experience. They are specific, measurable, attainable, and aligned with the content standards of the curriculum. It helps the teachers to determine what to teach, how to teach, and how to assess learning. Also, it communicates expectations to learners and helps them to better master the subject.
- **Learning Indicators:** They are measures that allow teachers to observe progress in the development of capacities and skills. They provide a simple and reliable means to evaluate the quality and efficacy of teaching practices, content delivery, and attainment of learning outcomes.
- **Content Standards:** It is a statement that defines the knowledge, skills, and understanding that learners are expected to learn in a particular subject area or grade level. They provide a clear target for learners and teachers and help focus resources on learner achievement.
- **Pedagogical Exemplars:** They are teaching examples used to convey values and standards to learners. Pedagogical Exemplars are usually demonstrated through teacher behaviour.
- **Assessment:** It is the systematic collection and analysis of data about learners' learning to improve the learning process or make a judgement on learner achievement levels. Assessment is aimed at developing a deep understanding of what learners know, understand, and can do with their knowledge because of their educational experiences. Assessment involves the use of empirical data on learners' learning to improve learning. Assessment is an essential aspect of the teaching and learning process in education, which enables teachers to assess the effectiveness of their teaching by linking learner performance to specific learning outcomes.
- **Teaching and Learning Resources:** Teaching and learning resources are essential tools for teachers to provide high-quality education to their learners. These resources can take various forms, including textbooks, audiovisual materials, online resources, and educational software. It is also important to avoid stereotypes and use inclusive language in teaching and learning resources. This means avoiding language that reinforces negative stereotypes and using language that is respectful and inclusive of all individuals regardless of their background. Using a consistent tone, style, and design is very important.

PHILOSOPHY, VISION AND GOAL OF AVIATION AND AEROSPACE ENGINEERING

Philosophy

Every learner can be trained in aviation and aerospace engineering given the right environment and qualified, skilled facilitators/teachers.

Vision

A trained learner grounded in fundamental knowledge and hands-on aviation and aerospace engineering skill sets required to solve the industry's developmental challenges beyond 21st century needs.

Goal

To equip learners with the right skill sets (logical thinking, problem solving, team player, creativity, innovation, entrepreneurship, communication, resilience and attention to details) required for work and further studies in the transportation sector.

Contextual Issues

There is a general perception among students that STEM subjects are difficult and are meant for gifted and talented (GATE) learners only. STEM courses are well understood when taught in relation to the behavior of the universe/earth. Aerospace and Aviation Science is one of the STEM courses which faces a similar challenge.

The main barriers are:

1. Ghana has four operational airports within four regions, out of the existing sixteen regions
2. A significant number of students may not have been to or seen an airport and may not have seen or flown in an aircraft, their only knowledge being on the radio, television, social media
3. Most facilitators relate piloting and other related engineering roles in aviation to males rather than the full Gender Equality and Social Inclusion (GESI) interventions as a result of cultural stereotyping
4. Capital intensiveness of aviation trainings
5. Facilitators hardly relate the flight dynamics of birds with aircraft

Rationale

Man's desire for efficient, safe, secure, affordable and timely travel from one destination to the other has led to the massive expansion of the aerospace and aviation industry. Globally, the aerospace and aviation industry contributes to the overall growth of GDP and development. In Ghana, the government's desire is to expand the industry by building capacity in terms of manpower and infrastructure to become an aviation hub within the West-African Sub-Region to the standards of the International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA). The main rationale of this course is to equip learners with the right skill sets to design, fabricate and test prototype aircrafts as well as manage basic aviation operations to contribute to achieving the nation's vision.

AVIATION AND AEROSPACE ENGINEERING CURRICULUM DEVELOPMENT PANEL

WRITERS			
	Name	Institution	
1.	Dr. Eunice Akyereko Adjei	Department of Mechanical Engineering, KNUST	
2.	David Kofi Oppong	Department of Mechanical Engineering, KNUST	
REVIEWERS			
	Name	Institution	
1.	Dr. Joshua Ampofo	Department of Mechanical Engineering, KNUST	
CURRICULUM WRITING GUIDE TEAM			
	Name	Institution	
1.	Prof. Winston Abroampa	Kwame Nkrumah University of Science and Technology	
2.	Cosmos Eminah	University of Education, Winneba	
3.	Aaron Akwaboah	Ministry of Education	
4.	Evans Odei	Achimota School	
5.	Paul Michael Cudjoe	Prempeh College	
6.	Ahmed Amihere	University of Education, Winneba	
NaCCA TEAM			
1.	Prof. K. O. Kwarteng	12.	Bridget Anku
2.	Prof. Edward Appiah	13.	Anthony Sarpong
3.	Mr. Matthew Owusu	14.	Seth Nii Nartey
4.	Reginald Quartey	15.	Kenneth Wontumi
5.	Joana Vanderpuije	16.	Sharon Antwi-Baah
6.	Anita Collison	17.	Dennis Adjasi
7.	Rebecca Abu Gariba	18.	Ogyampo S. Amankwah
8.	Genevieve Mensah	19.	Abigail Owusu Oduro
9.	Veronica Odom	20.	Priscilla B. Plange
10.	Joachim Seyram Honu	21.	Abigail Birago Owusu
11.	Dr. Mercy Nyamekye	22.	Uriah Otoo
EXTERNAL QUALITY ASSURANCE TEAM			
1.	Prof. Kwame Akyeampong	4.	Dr. Esinam Avornyo
2.	Dr. Jane Cullen	5.	Dr. Christopher Yaw Kwaah
3.	Dr. Sean Higgins		

SCOPE AND SEQUENCE

Aviation and Aerospace Engineering Summary

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1	Core Concepts In Aerospace Engineering	Fundamentals of Flight	3	3	6	-	-	-	-	-	-
		Aerodynamics and Propulsion	-	-	-	3	3	7	-	-	-
		Aircraft Structures and Control	-	-	-	-	-	-	3	3	8
2	Avionics	Fundamentals of Avionics	2	2	6	-	-	-	-	-	-
		Aircraft Instrumentation	-	-	-	2	2	4	-	-	-
		Communication, Navigation and Surveillance System	-	-	-	-	-	-	3	3	6
3	Aviation Industry	The Aviation Profession and Operations	2	2	4	-	-	-	-	-	-
		Aviation Organisations	-	-	-	2	2	4	-	-	-
		Aircraft Maintenance	-	-	-	-	-	-	2	2	4
4	Unmanned Aerial Vehicles (UAVS)	UAV Applications	2	2	4	-	-	-	-	-	-
		Safety And Deregulations	-	-	-	1	1	3	-	-	-
		Design And Fabrications Of UAVS	-	-	-	-	-	-	3	3	5
Total			**9**	**9**	**20**	**8**	**8**	**18**	**11**	**11**	**23**

Overall Totals (SHS 1 – 3)

Content Standards	28
Learning Outcomes	28
Learning Indicators	61

YEAR ONE

Subject Aviation and Aerospace Engineering
Strand 1 Core Concepts in Aerospace Engineering
Sub-Strand 1 Fundamentals of Flight

Learning Outcomes	21st Century Skills and Competencies	GESI[1], SEL[2] and Shared National Values
1.1.1.LO.1		
Explain the key stages characterising the evolution of flight from its inception to the advent of powered, controlled flight.	**Information Literacy:** By discussing the history of flight, students are exposed to the important players and events that heralded the development of flight vehicles. **Communication/Social Skills/Collaboration:** As students work in groups, they share ideas among themselves, taking turns both to speak and listen to their peers.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society.

[1] Gender Equality and Social Inclusion
[2] Socio-Emotional Learning

		Leadership and Respect for Others' Views: Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning

		through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions. **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources.
1.1.1.LO.2		
Examine the types of aerospace vehicles (aircraft and spacecraft) and the interconnections between and among parts of aerospace vehicles.	**Communication:** As the teacher makes his presentation to the class, students observe him and learn to apply their communication skills by asking questions and making contributions. **Technology Literacy:** Air travel is the safest form of travel, and the most advanced. Introducing students to the types and parts of aerospace vehicles provides them with knowledge of state-of-the-art technology. **Creativity:** ● As students learn about aerospace vehicles, their desire to design same kindles their inventive skills, and they begin to create paper/milk-tin models of the vehicles. ● As students sketch aerospace vehicles, their desire to design the same kindles their inventive skills, and they begin to create paper/milk-tin models of the vehicles.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the

		various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to

		responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions, **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources.
1.1.1.LO.3		
Discuss recommended practices in the aerospace laboratory.	**Social Skills:** By participating in the question-and-answer session, students build up their confidence, and relationship skills. **Information Literacy:** Students learn safety practices applicable in many fields of work. **Observation Skills:** Identifying possible sources of incidents and accidents at home as well as in the laboratory, sharpens learners' observation skills. **Critical Thinking:** As learners investigate the right application of safety regulations and interpretation of the observed sources of incidents and accidents, they learn to think critically.	

<table>
<tr><th>Content Standards</th><th colspan="3">Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI</th><th>Assessment</th></tr>
<tr><td>1.1.1.CS.1</td><td colspan="3">1.1.1.LI.1</td><td>1.1.1.AS.1</td></tr>
<tr><td rowspan="3">Demonstrate knowledge and understanding of the evolution of flight.</td><td colspan="3">Trace the evolution of flight prior to powered and controlled flight.

Collaborative Learning: In a class discussion, explore learners' experiences with flying objects (balloons, kites, paper aeroplanes) and birds, with the aid of relevant resources.

Building on What Others Say: Brainstorm and build on what others say about humans' attempt to fly like birds; using lighter-than-air- balloons and kites. Organise thoughts using webbing or concept maps.

Experiential Learning/Collaborative Learning:
● With the aid of a video documentary, textbooks, webpages or any other relevant sources, work in small mixed ability groups to develop posters or Powerpoint presentations on the various phases or stages of flight development.
● Encourage all learners to participate, respect and tolerate the views of all learners whilst working in groups or in pairs.</td><td>Level 1 Recall
Level 2 Skills of conceptual understanding
Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td colspan="3">1.1.1.LI.2</td><td>1.1.1.AS.2</td></tr>
<tr><td colspan="3">Describe the stages that led to the attainment of powered and controlled flight.

Collaborative Learning: With the aid of relevant resources, assign learners to work in groups to make presentations on the development of powered and controlled flight. Encourage them to respect and tolerate the views of all learners.</td><td>Level 1 Recall
Level 2 Skills of conceptual understanding
Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td>Teaching and Learning Resources</td><td>● A kite
● A balloon
● A paper/toy airplane</td><td>● A toy bird
● Legos
● Documentaries about the evolution of flight</td><td colspan="2">● A toy airplane
● Documentaries about the development of powered and controlled flight</td></tr>
</table>

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.1.1.CS.2	1.1.1.LI.1	1.1.1.AS.1
Demonstrate understanding of flight vehicle nomenclature.	**Differentiate the types of aerospace vehicles.** **Project-Based Learning:** Assign learners to small task groups for them to research and do PowerPoint or poster presentations on the differences between aircraft and spacecraft. Let them work in mixed ability groups and encourage respect of views and tolerance among all group members. Initiate a class discussion after each presentation and summarise. **Requirement for flight:** Movement of an airfoil through the air **Broad classes of aircraft:** ● Fixed wing and rotary wing ● Major parts of a helicopter and a fixed-wing aircraft ● Major differences between rotary and fixed-wing aircrafts ● Types and components of space vehicles	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	1.1.1.LI.2	1.1.1.AS.2
	Make freehand sketches of current and future aerospace vehicles, labeling their major parts. **Experiential Learning/Collaborative Learning:** In small mixed ability task groups, assign each group to specific aerospace vehicles for them to make freehand sketches. Learners should pay attention to details and show commitment to the assigned task and tolerate one another's input.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	● A toy/model helicopter ● A toy/model fixed wing airplane ● A model rocket/satellite ● Sketching materials	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI			Assessment
1.1.1.CS.3	1.1.1.LI.1			1.1.1.AS.1
Show understanding of safety regulations in the aerospace laboratory.	**Explain safety precautions in the laboratory (Aerospace, Physics, Electrical/Electronics).** **Building on What Others Say:** Initiate a question and answer session by asking learners to add to a list of rules and regulations on safety at home. **Talk for Learning:** Relate safety rules at home to those in the aerospace laboratory through a class discussion. Through the use of a short video/documentary, learners should identify safety roles in an aerospace lab. Encourage all learners to participate freely. **Experiential Learning:** Visit the laboratory where they interact with technicians/assistants; they are introduced to items in the laboratory, as well as the do's and dont's in the laboratory. In the absence of a lab, documentaries/videos should be used. Learners should observe, take notes and present their observations in class.			Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.1.LI.2			1.1.1.AS.2
	Discuss the advantages of adhering to safety precautions in the laboratory (Aerospace, Physics, Electrical/Electronics). **Building on What Others Say:** With the use of think-pair and share, learners identify sources of incidents and accidents and recommend the appropriate solution or precautionary measures. Encourage learners to respect their partners' opinion and agree on what to say before presenting to the class. **Problem-Based Learning:** ● With the aid of case studies of laboratory incidents and accidents, lead learners to assess the effects of not adhering to safety regulations in the laboratory. ● Use webbing or mind maps to organise learners' thoughts on advantages of adhering to safety regulations in the laboratory based on their experiences at home.			Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	● Safety signs ● Laboratory rules and regulations document	● Reports of incident and accident occurrences in laboratories ● Laboratory safety manual	● Fire Service safety manual ● ICAO Safety regulations	

Subject Aviation and Aerospace Engineering
Strand 2 Avionics
Sub-Strand 1 Fundamentals of Avionics

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.2.1.LO.1		
Use analogies in nature to explain avionics systems.	**Technology Literacy:** ● Introducing students to avionics communication systems makes them aware of the advanced technologies used to provide communication solutions in the aviation industry. ● Introducing students to avionics navigation systems makes them aware of the advanced technologies used by aviators to navigate to their destinations. ● Introducing students to aerospace surveillance systems makes them aware of the advanced technologies used in the industry to keep track of aerospace vehicles in flight. **Critical Thinking/Problem-Solving Skills:** ● Avionics communication systems were birthed out of the desire to minimize crew workload and maximize the use of the latest communication technologies. By learning about these systems, students are encouraged to brainstorm solutions to the problems they face. ● Avionics navigation systems were birthed out of the desire to minimize crew workload and ensure timely arrival at the destination. By learning about these systems, students are encouraged to brainstorm solutions to the problems they face. ● Aerospace surveillance systems were birthed out of the desire to know precisely, the location of aerospace vehicles in real time. By learning about these systems, students are encouraged to brainstorm solutions to the problems they face.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life.

		• value and promote justice at home and in society. **Leadership and Respect for others' views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **National Core Values**: • Tolerance • Friendliness • Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and

		honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions. **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources.
1.2.1.LO.2		
Enumerate the uses of avionics systems in aircraft and spacecraft.	**Technology Literacy:** ● Introducing students to avionics communication systems makes them aware of the advanced technologies used to provide communication solutions in the aviation industry. ● Introducing students to avionics navigation systems makes them aware of the advanced technologies used by aviators to navigate to their destinations. ● Introducing students to aerospace surveillance systems makes them aware of the advanced technologies used in the industry to keep track of aerospace vehicles in flight. **Critical Thinking/Problem-Solving Skills:** ● Avionics communication systems were birthed out of the desire to minimize crew workload and maximize the use of the latest communication technologies.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/

	By learning about these systems, students are encouraged to brainstorm solutions to the problems they face. ● Avionics navigation systems were birthed out of the desire to minimize crew workload and ensure timely arrival at the destination. By learning about these systems, students are encouraged to brainstorm solutions to the problems they face. ● Aerospace surveillance systems were birthed out of the desire to know precisely, the location of aerospace vehicles in real time. By learning about these systems, students are encouraged to brainstorm solutions to the problems they face.	myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing transition:** This can be realised if teachers guide and facilitate learning by generating discourse among

		learners and challenging them to accept and share responsibility for their own learning based on their unique individual differences (including GESI and gifted and talented leaners). **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners

		equitable opportunities to interact and use teaching and learning resources.

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.2.1.CS.1	1.2.1.LI.1	1.2.1.AS.1
Demonstrate knowledge of various classes of avionics systems.	**Discuss avionics systems in relation to traditional musical instruments and dance for communication.** **Building on What Others Say, Talk for Learning:** ● Explore learners' experiences with traditional instruments for demonstration of communication technologies. Through question and answer sessions, learners take turns in talking about how the instruments work. Encourage as many learners as possible to share their experiences freely and with respect for one another's views. ● A resource person who uses sign language/traditional instruments for communication, e.g., drums, flute, etc. should demonstrate to students the use of the instruments for communication.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.2.1.LI.2	1.2.1.AS.2
	Explain avionics systems in relation to the flight of a flock of birds for navigation. **Talk for Learning:** Use audio-visuals to explain the principles of navigation behind the flight of a flock of birds (e.g., bats in the evening/morning) and a swarm of bees. Learners watch/observe and share their observations with the class.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.2.1.LI.3	1.2.1.AS.3
	Illustrate avionics systems in relation to the monitoring abilities of dogs or other animals in security for surveillance. **Talk for Learning;** With the aid of audio-visuals, demonstrate the surveillance characteristics of animals, linking them to aerospace surveillance systems, e.g., dogs sensing unfamiliar people and a lion monitoring its prey. Learners watch and share their observations with the class	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**

Teaching and Learning Resources	• Books about avionics systems, e.g., Introduction to Avionics (by R. P. G. Collinson), Aircraft Communication and Navigation Systems (by Mike Tooley and David Wyatt) • Talking drums • Smoke generator/flares • Audio-visuals, e.g., wildlife documentaries

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.2.1.CS.2	1.2.1.LI.1	1.2.1.AS.1
Demonstrate knowledge of the vast functions of avionics systems.	**Explain the functions of avionics communication systems.** **Talk for Learning:** Through the use of audio-visuals, learners work in pairs, watch, and share ideas on the uses of avionics communication systems. Ideas shared should be organized using webbing. **Experiential Learning:** Guide learners to work in pairs to demonstrate the use of two canned tins with thread/wire for communication. They share their experiences with the class. Encourage learners to work collaboratively and respect the views of others.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.2.1.LI.2	1.2.1.AS.2
	Explain the functions of avionics navigation systems. **Project-Based Learning:** ● Initiate discussion on how learners find things they have misplaced or hidden. Encourage learners to talk in turns. Demonstrate how, in the olden days, our forefathers were able to track their hidden valuables and give direction to places for learners to observe and comment individually. ● With the aid of relevant resources, learners work in pairs to create maps for tracing hidden valuables or objects and use them to track objects. As they work in pairs, encourage them to be creative in their thinking and work collaboratively to achieve set target. **Talk for Learning; Building on What Others Say:** Illustrates, with the aid of audio-visuals, how lighthouses are used to aid ship navigation. Learners should observe and comment in turns.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.2.1.LI.3	1.2.1.AS.3
	Explain the functions of surveillance systems. **Talk for Learning** ● Initiate a question and answer session on what CCTV cameras are and how they are used for surveillance. Encourage learners to contribute in class as individuals and respect the views of others. ● In pairs or small mixed ability groups, learners identify surveillance objects/gadgets such as CCTV cameras and telescope. They should explain what they are and their use and present to the class	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and**

	in turns. Guide presentation and organise their thought. **Experiential Learning:** In pairs, let students monitor an event outside the classroom and give a report.	**reasoning**
Teaching and Learning Resources	● A catalogue of products from an avionics company, e.g., Garmin ● Books about avionics systems, e.g., *Introduction to avionics (by R. P. G. Collinson), Aircraft Communication and Navigation Systems (by Mike Tooley and David Wyatt)* ● Two-way radios (two canned tins with thread/wire)	● Magnetic compasses ● Movies such as Dora the adventurer, and cartoons about pirates ● Satellite dish

Subject Aviation and Aerospace Engineering
Strand 3 Aviation Industry
Sub-Strand 1 The Aviation Profession and Operations

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.3.1.LO.1		
Describe the learning pathways that lead to various professions in the aviation industry.	**Information Literacy:** Teaching aviation professions to students exposes them to possible work opportunities after school. **Productivity:** By studying about aviation professions, students are prepared to contribute to the development of the society.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life.

		• Value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **National Core Values**: • Tolerance • Friendliness • Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and

		honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions, **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources.
1.3.1.LO.2		
Make a flowchart to explain the functions of the various aviation operations in air travel.	**Information Literacy:** Teaching aviation professions to students exposes them to possible work opportunities after school. **Productivity:** By studying about aviation professions, students are prepared to contribute to the development of the society. **Creativity/Innovation:** Students exercise their imagination when they play the roles of aviation professionals.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion.

		• examine and dispel misconceptions/ myths about gender as they relate home management and human development. • interrogate their stereotypes and biases about gender and the role men and women play in home management. • identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. • be sensitive to the inter-relatedness of the various aspects of life. • value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate

		learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects,

		holding class/group meetings, talking about managing emotions,

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.3.1.CS.1	1.3.1.LI.1	1.3.1.AS.1
Demonstrate knowledge of various career paths in the aviation industry.	**Describe the various career paths in the aviation industry.** **Talk for Learning:** With the aid of audio-visuals, introduce the various aviation professions to learners *(pilots, air traffic controllers, emergency services, luggage handlers, security officers, immigration officers, check-in assistants, engineers, maintenance and operation technicians/assistants)*. Learners choose or align with any of the aviation professions. In the profession groups, learners research and do a brief presentation on the training required to enter each role and their importance in the aviation supply chain.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.3.1.LI.2	1.3.1.AS.2
	Describe the learning pathways that lead to careers in aviation. **Building on What Others Say:** ● Invite a resource person/aviation professional from the aviation industry to have a seminar with students on learning pathways ● With the aid of audio-visuals, teacher explains the learning pathways that lead to the aviation careers to learners and how they operate.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	● Videos of aviation professionals at work, e.g., pilots flying an aircraft ● Copies of job advertisements for aviation roles	● ICAO Annexes ● Copies of job advertisements for aviation roles

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.3.1.CS.2	1.3.1.LI.1	1.3.1.AS.1
Demonstrate knowledge of the various operations in the aviation industry	**Identify the roles of professionals in the aviation industry.** **Talk for Learning:** Invite a resource person/aviation professional from the aviation industry to have a seminar with students on the roles they play in their respective professions.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.3.1.LI.2	1.3.1.AS.2
	Demonstrate how the different aviation operations work together to achieve smooth air travel. **Collaborative Learning; Project-Based Learning:** Teacher forms mixed-ability groups of learners to make a drama skit of the flowchart of aviation operations for smooth air travel and demonstrate the interrelationship among them.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	● Videos of aviation professionals at work, e.g., pilots flying an aircraft ● Copies of job advertisements for aviation roles ● ICAO Annexes	

Subject Aviation and Aerospace Engineering
Strand 4 Unmanned Aerial Vehicles (UAVS)
Sub-Strand 1 UAV Applications

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.4.1.LO.1		
Distinguish between the classes of UAVs (fixed wing, multicopters, rotary wing, missiles, etc.)	**Technology Literacy:** UAVs have found widespread use for both personal and industrial purposes; learning about them gives students the upper hand when they finally decide to progress with their studies or find jobs.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life.

		● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness

		• Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
1.4.1.LO.2		
Explain the uses of UAVs.	**Creativity/Critical Thinking/Problem-Solving Skills:** As students brainstorm new uses of UAVs, their creative potential is unleashed, and they come up with new ways to solve society's problems.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: • respect individuals of different backgrounds. • embrace diversity and practice inclusion.

		• examine and dispel misconceptions/ myths about gender as they relate home management and human development. • interrogate their stereotypes and biases about gender and the role men and women play in home management. • identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. • be sensitive to the inter-relatedness of the various aspects of life. • value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate

		learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on

		projects, holding class/group meetings, talking about managing emotions

<table>
<tr><th>Content Standards</th><th colspan="3">Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI</th><th>Assessment</th></tr>
<tr><td>1.4.1.CS.1</td><td colspan="3">1.4.1.LI.1</td><td>1.4.1.AS.1</td></tr>
<tr><td rowspan="3">Demonstrate knowledge and understanding of the types of UAVs.</td><td colspan="3">Analyse the features of Unmanned Aerial Vehicles (UAVs).

Talk for Learning: With the aid of audio-visuals or pictures, learners identify various features of UAVs. Use webbing or concept maps to organise the thoughts of learners on the functions of the various features after they think-pair and share. Encourage learners to confer and share ideas with peers in a cordial and respectful manner. Guide them to do a freehand sketch of UAVs for peers to review one another’s sketches.</td><td>Level 1 Recall
Level 2 Skills of conceptual understanding
Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td colspan="3">1.4.1.LI.2</td><td>1.4.1.AS.2</td></tr>
<tr><td colspan="3">Explain the principles of operation of UAVs.

Experiential Learning; Talk for Learning: Through question and answer sessions, learners demonstrate how to use remote control to operate a system, e.g., a TV, etc. Use audio-visuals to show how remote controls are used in UAV operations and their relationships.

Project-Based Learning:
● In mixed-ability groups, learners design UAV with cards and examine functions of the various parts. In pairs, learners discuss one principles of operation of UAV and share with class. Encourage participation of females in a free and cordial manner.
● Use Newton's laws to demonstrate the principles of operation of spacecraft, e.g., rockets</td><td>Level 1 Recall
Level 2 Skills of conceptual understanding
Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td>Teaching and Learning Resources</td><td>● Model fixed wing UAV
● Model multicopter UAV</td><td>● Model rocket
● Videos of UAVs</td><td colspan="2">● TV remote control
● Paper</td></tr>
</table>

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.4.1.CS.2	1.4.1.LI.1	1.4.1.AS.1
Demonstrate knowledge of the various uses of UAVs.	**Examine the uses of military applications of Unmanned Aerial Vehicles (UAVs).** **Experiential Learning:** With the aid of audio-visuals, discuss military uses of UAVs. Invite a resource person who is military personnel to do a presentation on the military application of UAVs. **Group Work/Collaborative Learning:** ● Let learners work in small mixed groups to summarise uses, etc. ● Encourage female participation, respect and tolerance for views.	Level 1 Recall: Level 2 Skills of conceptual understanding: Level 3 Strategic reasoning: **Level 4 Extended critical thinking and reasoning:**
	1.4.1.LI.2	1.4.1.AS.2
	Describe civilian uses of Unmanned Aerial Vehicles **Experiential Learning:** ● With the aid of audio-visuals, discuss civilian uses of UAVs. Invite operators of UAVs to do a presentation. ● Let learners work in small mixed ability groups to summarise uses of UAVs to the society (health, education, business, agriculture, research etc.). Encourage female participation, respect and tolerance for views and opinions.	Level 1 Recall: Level 2 Skills of conceptual understanding: Level 3 Strategic reasoning: **Level 4 Extended critical thinking and reasoning:**
Teaching and Learning Resources	● Videos of UAVs ● A brochure of the services offered by a UAV (drone) operator	

YEAR TWO

Subject Aviation and Aerospace Engineering
Strand 1 Core Concepts in Aerospace Engineering
Sub-Strand 2 Aerodynamics and Propulsion

Learning Outcomes	21st Century Skills and Competencies	GESI[3], SEL[4] and Shared National Values
2.1.2.LO.1		
Explain the importance of weather in flight	**Problem-Solving Skills/Technology Literacy:** Students are able to understand the use and principle of operation of the instruments and how to interpret the readings measured and determine errors in readings. **Critical Thinking/Leadership:** During the brainstorming session, students exercise their mental faculties, and some students assume leadership positions over their respective groups. **Critical Thinking:** Walking students through the process of deriving the equations governing the international atmosphere stimulate them to think critically.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice in home and in society. **Leadership and Respect for Others' Views:**

[3] Gender Equality and Social Inclusion
[4] Socio-Emotional Learning

		Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty

		as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of social-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
2.1.2.LO.2		
Identify the forces acting on an aerospace vehicle in flight.	**Problem-Solving Skills:** Through this lesson, students learn to apply the principles they have learned to solve real-life problems. **Critical Thinking:** ● Students exercise their thinking capacities as they perform calculations to determine the forces of aerospace vehicles. ● Students are encouraged to identify the relationship between common forces experienced in their environment and those that act on aircraft.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● sensitive to the inter-relatedness of the various aspects of life.

		● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience

		• Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
2.1.2.LO.3		
Compute the thrust generated by the propulsion system of an aerospace vehicle.	**Information Literacy:** Through the use of videos of aerospace propulsion systems, students gain valuable knowledge and are well informed about the technology **Creativity and Innovation/Collaboration/Social Skills:** As students work in groups to build and fly rockets, their creativity is unlocked, and they learn to work together as a team. **Critical Thinking:** Students' minds are stimulated to apply the laws they have learned to solve the problem of aircraft propulsion.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: • respect individuals of different backgrounds. • embrace diversity and practice inclusion. • examine and dispel misconceptions/ myths about gender as they relate home management and human development. • interrogate their stereotypes and biases about gender and the role men and women play in home management. • identify injustice, especially in recognition of the contributions of different groups and

		individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**:

		• Tolerance • Friendliness • Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.1.2.CS.1	2.1.2.LI.1	2.1.2.AS.1
Demonstrate knowledge of the properties of the international standard atmosphere.	**Identify and measure the elements of weather using the appropriate instruments.** **Experiential Learning:** Students pay a visit to a weather station to learn about the elements of weather and how they are measured. Share experiences with the class. **Problem-Based Learning:** In pairs/small groups, conduct an experiment to measure the elements of weather, e.g., temperature, rainfall, wind direction and speed. Share findings with the class.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.1.2.LI.2	2.1.2.AS.2
	Explain the impact of the weather elements on flight. **Talk for Learning:** Think-pair and share possible effects of bad weather on flight. Organize thoughts and views of learners using mind maps. Listen to learners' views respectfully and comment	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.2.LI.3	2.1.2.AS.3
	Explain the impact of altitude on the state of the atmosphere. **Talk for Learning:** Derive from first principles, the equations that describe the standard atmosphere, building on the popular saying "The higher you go, the cooler it becomes"	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Thermometer • Anemometer	• National Geographic videos on aircraft incidents and accidents investigation

	• Wind vane • Introduction to flight *(a book by John D. Anderson Jr.)*	• A picture of the profile of the atmosphere • Introduction to flight *(a book by John D. Anderson Jr.)*

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.1.2.CS.2	2.1.2.LI.1	2.1.2.AS.1
Demonstrate knowledge and understanding of the balance of forces acting on an aerospace vehicle in flight.	**Distinguish between the four major forces (lift, drag, thrust and weight) that act on an aerospace vehicle in flight.** **Talk for Learning:** Building on the basic knowledge students have about forces, teacher goes on to identify the forces of lift, drag, thrust and weight, showing their interrelationship during the flight of aerospace vehicles. **Building on What Others Say:** Students draw on their knowledge about forces from Physics lessons to relate forces at work in the environment (e.g., gravitational force, frictional force) to those that act on aircraft.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.2.LI.2	2.1.2.AS.2
	Calculate the lift, drag and weight of an aircraft. **Talk for Learning:** ● Teacher presents to students the equations for computing lift and drag, solving a good number of problems so that students better understand the subject. ● In pairs, learners go through the process of computing the weight of an aircraft and share with class. Class critique responses of groups in a respectful manner.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	● Model aircraft ● Audio-visuals showing the forces along the axes of an aircraft ● Introduction to flight (a book by John D. Anderson Jr.)	● The Pilot's handbook of aeronautical knowledge (FAA) ● Airline manuals for estimation of weight

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.1.2.CS.3	2.1.2.LI.1	2.1.2.AS.1
Demonstrate understanding of the force required for propulsion of an aerospace vehicle.	**Explain the principles of operation of the different propulsion systems: rockets, jet engines and internal combustion (spark) engines.** **Experiential Learning:** With the aid of audio-visuals, teacher demonstrates the operation of aerospace propulsion systems. **Project-Based Learning:** Students work in mixed-ability groups to build and fly water bottle rockets.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	2.1.2.LI.2	2.1.2.AS.2
	Calculate the thrust generated from different power sources, e.g., battery and internal combustion engines (rocket, jet engine and internal piston engine) **Problem-Based Learning:** ● Teacher makes use of videos to demonstrate the principles of operation of the different aerospace propulsion systems. ● With reference to the relevant physical laws (e.g., Newton's laws, Ohm's law in Physics), teacher goes ahead to explain to students the process of determining the thrust of an aerospace propulsion system.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	● Videos of aerospace propulsion systems in operation ● Water bottle rocket ● Videos of the various aerospace propulsion systems in operation ● Model jet engine ● Glow engine ● Remote-controlled aircraft propellers	

Subject Aviation and Aerospace Engineering
Strand 2 Avionics
Sub-Strand 2 Aircraft Instrumentation

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.2.2.LO.1		
Explain the various airborne and ground operation instruments used to ensure safe and secure flight.	**Collaboration:** As students flock to the laboratory, they learn to work together as a team. **Technology Literacy/Critical Thinking:** By learning about the principles of operation of the aircraft instruments, students come to appreciate the ingenuity behind their creation.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● Value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership

		through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to

		responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
2.2.2.LO.2		
Describe the nature of flight data storage equipment (black box).	**Technology and Computer Literacy:** Students are exposed to some of the latest technology when they learn about the features of flight data storage equipment. **Critical Thinking:** Learning about the ingenuity behind the design of flight data storage equipment incites students to exercise their mental capacities.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.2.2.CS.1	2.2.2.LI.1	2.2.2.AS.1
Demonstrate knowledge of the instruments used for airborne and ground operations, and their principles of operation.	**Relate the physical variables that are measured in aircraft applications with the instruments used to measure them.** **Experiential Learning:** In a laboratory, learners identify several aircraft instruments	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	2.2.2.LI.2	2.2.2.AS.2
	Explain the principles of operation of the aircraft instruments. **Talk for Learning:** Teacher explains to students the quantities they measure, the associated instruments and their principles of operation, as well as to identify those that are on ground and airborne.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Aircraft instruments • Animations and videos showing the principles of operation of the various aircraft instruments	

<table>
<tr><th>Content Standards</th><th colspan="3">Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI</th><th>Assessment</th></tr>
<tr><td>2.2.2.CS.2</td><td colspan="3">2.2.2.LI.1</td><td>2.2.2.AS.1</td></tr>
<tr><td rowspan="3">Demonstrate understanding of flight data storage in aircraft.</td><td colspan="3">Identify the salient features of flight data storage equipment, how data was previously stored and the importance of flight data storage.

Talk for Learning: With the aid of audio-visuals, teacher makes a presentation to students about flight data storage.

Experiential Learning
● Students visit the laboratory to observe a flight data recorder.
● Teacher makes a demonstration on saving data on a flash drive, Google drive, iCloud; and explains how it is protected from hacking.</td><td>Level 1 Recall
Level 2 Skills of conceptual understanding
Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td colspan="3">2.2.2.LI.2</td><td>2.2.2.AS.2</td></tr>
<tr><td colspan="3">Indicate the various aircraft parameters that are recorded.

Talk for Learning: With the aid of audio-visuals, teacher makes a presentation to students about flight data storage.

Experiential Learning: Students visit the laboratory to observe a flight data recorder.

Talk for Learning: Teacher explains how the entire data in aircraft is stored, e.g., Airborne data from the pilots, Air Traffic Controller (ATC) data, meteorological data, check-in data, Airport Fire Service</td><td>Level 1 Recall
Level 2 Skills of conceptual understanding
Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td>Teaching and Learning Resources</td><td>● Flash drive
● Pictures of a flight data recorder</td><td>● Google drive webpage
● iCloud</td><td colspan="2">● Other storage devices</td></tr>
</table>

Subject Aviation and Aerospace Engineering
Strand 3 Aviation Industry
Sub-Strand 2 Aviation Organisations

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.3.2.LO.1		
Explain the ICAO and IATA regulations underlining the operations of both the aerospace and aviation agencies.	**Information Literacy:** Through this sub-strand, students are educated about the major players (organisations) in the aviation industry	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership

		through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to

		responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
2.3.2.LO.2		
Enumerate the functions of both local and international aviation organisations.	**Critical Thinking:** As students participate in the brainstorming session, they exercise their mental abilities	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of

		the various aspects of life. ● value and promote justice in home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness

		• Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.3.2.CS.1	2.3.2.LI.1	2.3.2.AS.1
Demonstrate understanding of the relationship between aerospace and aviation organizations and how this helps to regulate operations.	**Identify the major aviation agency in Ghana and its key operations.** **Managing Talk for Learning:** Teacher facilitates a discussion session where he/she presents to (and receives inputs from) students about the Ghana Civil Aviation Authority (GCAA), their mandate and operations	**Level 1 Recall** Level 2 Skills of conceptual understanding Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	2.3.2.LI.2	2.3.2.AS.2
	Identify global aviation agencies. **Managing Talk for Learning:** Teacher facilitates a discussion session where he/she presents to (and receives inputs from) students about the organisations that influence aviation worldwide *(International Civil Aviation Organization [ICAO]; International Air Transport Association [IATA], Federal Aviation Agency [FAA], European Union Aviation Safety Agency [EASA])*.	**Level 1 Recall** Level 2 Skills of conceptual understanding Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Slides/posters that show the logo and full name of GCAA, FAA, IATA, ICAO, EASA, etc.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.3.2.CS.2	2.3.2.LI.1	2.3.2.AS.1
Demonstrate understanding of the roles of the aviation agencies in ensuring the safety of air transport.	**Identify the functions of local aviation organisations.** **Collaborative Learning:** In small tasks groups, students brainstorm possible roles played by various local aviation organisations**.** Groups present their findings on the organisation they worked on for others to comment or add what has been left out.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.3.2.LI.2	2.3.2.AS.2
	Explain the functions of ICAO, IATA, FAA, EASA, etc. **Building on What Others Say:** In small different task groups, learners brainstorm possible roles played by the various international aviation organizations. Teacher summarises the discussion and emphasises their relevant functions.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Slides/posters that list the functions of the local aviation organisations	

Subject Aviation and Aerospace Engineering
Strand 4 Unmanned Aerial Vehicles (UAVs)
Sub-Strand 2 UAV Safety and Regulations

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.4.2.LO.1		
Explain the need for UAV regulations.	**Critical Thinking:** ● Learners study the regulations as well as case studies on UAV building and operation. ● Students study the byelaws governing the operations of UAVs and exercise their ability to reason through them as they make an effort to understand them. **Information Literacy:** ● Students learn safety practices applicable in many fields of work. ● Through the seminar session, students gain information about rules and regulations for building and operating UAVs.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● sensitive to the inter-relatedness of the various aspects of life.

		• value and promote justice in home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: • Tolerance • Friendliness

		• Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.4.2.CS.1	2.4.2.LI.1	2.4.2.AS.1
Show understanding of safety regulations for building and operating UAVs.	**Explain safety practices with regards to building and operating UAVs.** **Building on What Others Say:** Teacher leads discussions on byelaws on building and operating UAVs. Individuals add to what others have said. Organise views using webbing or mind maps.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	2.4.2.LI.2	2.4.2.AS.2
	Evaluate official regulations relating to the possession and operation of UAVs. **Talk for Learning:** Students summarise their understanding from the discussion on byelaws for building and operating UAVs and share with the class.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.4.2.LI.3	2.4.2.AS.3
	Discuss the need for observing regulations that govern the operation of UAVs. **Talk for Learning:** Teacher organises a seminar session where an official from the GCAA walks students through safety regulations for building and operating drones. Learners take notes and share what they learnt in class.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• GCAA Remotely Piloted Aircraft Systems (RPAS) regulations	

YEAR THREE

Subject Aviation and Aerospace Engineering
Strand 1 Core Concepts in Aerospace Engineering
Sub-Strand 3 Aircraft Structures and Control

Learning Outcomes	21st Century Skills and Competencies	GESI[5], SEL[6] and Shared National Values
3.1.3.LO.1		
Identify the structural design of an airframe.	**Social Skills:** Through the discussion session, students gain confidence as they make contributions. **Creativity/Critical Thinking:** As students watch the teacher demonstrate the construction of aircraft, their creative ability is enhanced.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures.

		Diversity: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning

		through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
3.1.3.LO.2		
Discuss the flight controls of an aerospace vehicle and its impact on the movement of the vehicle.	**Technology Literacy:** Students are brought up to speed with the latest technology used in controlling various aircraft and spacecrafts. **Critical Thinking, Communication and Collaboration:** Learners use the opportunity to brainstorm on the differences in control systems and communicate their findings	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● Value and promote justice in home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through

		teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL**: Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to

		responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
3.1.3.LO.3		
Explain the concepts of static and dynamic stability of aerospace vehicles.	**Critical Thinking:** As the teacher uses different scenarios to illustrate the topic of flight vehicle stability, students are able to form relationships between everyday scenarios and aerospace concepts.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in

		society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work

		• Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.1.3.CS.1	3.1.3.LI.1	3.1.3.AS.1
Demonstrate knowledge of various types of aircraft construction.	**Identify the right materials for construction of a small UAV.** **Talk for Learning:** In a question and answer session, discuss with students, the properties of common materials, emphasizing their weight and strength when considering their suitability for aerospace vehicle construction. Summarise ideas using maps	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.1.3.LI.2	3.1.3.AS.2
	Evaluate the different types of aircraft construction. **Project-Based Learning:** In small mixed gender groups, build models of the various aircraft construction types (truss, monocoque, semi-monocoque, composite) using basic materials such as styrofoam, broomsticks and cardboard. Display and let learners comment on one another's projects.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Audio-visuals showing the different types of aircraft construction • Styrofoam • Broomsticks • Cardboard	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.1.3.CS.2	3.1.3.LI.1	3.1.3.AS.1
Demonstrate understanding of how an aerospace vehicle (aircraft, spacecraft) is controlled in flight.	**Describe the flight controls (and control surfaces) of a fixed-wing aircraft.** **Talk for Learning:** With the aid of audio-visuals, learners watch and describe the control mechanisms for fixed-wing aircraft	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.1.3.LI.2	3.1.3.AS.2
	Describe the flight controls of a rotary-wing aircraft. **Talk for Learning:** With the aid of audio-visuals, learners watch and describe the control mechanisms for rotary-wing aircraft.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.1.3.LI.3	3.1.3.AS.3
	Describe the control mechanisms of spacecraft. **Talk for Learning:** With the aid of audio-visuals, learners watch and describe the control mechanisms for spacecraft.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	3.1.3.LI.4	3.1.3.AS.4
	Distinguish between the features of fly-by-wire (automatic) control, mechanical control	Level 1 Recall
	and hydraulic control of aircrafts. **Collaborative Learning/Building on What Others Say:** Teacher forms mixed-ability groups and let learners do brainstorming and presentation on the features of the control systems of aerospace vehicles.	Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Audio-visuals on how fixed-wing aircraft are controlled • Audio-visuals on how rotary wing aircraft are controlled • Flip board paper/A4 sheets • Audio-visuals on how spacecraft are controlled	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI			Assessment
3.1.3.CS.3	3.1.3.LI.1			3.1.3.AS.1
Demonstrate knowledge and understanding of the factors that account for stability of an aerospace vehicle.	**Apply the understanding of moments in Physics to aircraft movement and stability configurations.** **Experiential Learning:** ● Teacher reviews moments and its applications from Physics. ● Through demonstrations, use the motion of a small ball on a plate, a concave surface, and a convex surface to illustrate neutral, stable and unstable static modes, respectively, of aerospace vehicles. ● Using the breaking of a twig after being excited by strong wind, teacher explains dynamic stability to students.			Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning: Level 4 Extended critical thinking and reasoning
	3.1.3.LI.2			3.1.3.AS.2
	Determine the relationship between the location of the center of gravity of an aircraft and its stability. **Experiential Learning: T**hrough demonstrations, use different movement patterns (crawling baby, upright movement of a grownup and bending over of an elderly person) to explain static stability. With this analogy, and emphasizing on the movement of center of gravity from one position to another, explains aerospace vehicle stability to learners.			Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	● A small ball ● Flat plate	● Pendulum ● Snapshots of birds in flight	● Introduction to flight (a book by John D. Anderson, Jr.)	

Subject Aviation and Aerospace Engineering
Strand 2 Avionics
Sub-Strand 3 Communication, Navigation and Surveillance Systems

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.2.3.LO.1		
Justify which communication systems are suitable for different communication scenarios in aviation.	**Information/Technology Literacy:** ● Students learn the requirements for aviation communication as well as the different technologies available. ● Students learn the requirements for aviation communication as well as the different technologies available, highlighting their advantages and limitations.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● Value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership

		through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to

		responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
3.2.3.LO.2		
Describe the aircraft and spacecraft navigation systems.	**Communication:** Students improve their communication skills as they share their thoughts about navigation. **Technology Literacy:** Students learn about the latest avionics navigation systems.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of

		the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realized if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility

		Truth and Integrity: Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
3.2.3.LO.3		
Use illustrations to demonstrate knowledge of aerospace surveillance systems.	**Technology Literacy:** Students learn about aerospace vehicle surveillance technologies.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the

		effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience

		• Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources.

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.2.3.CS.1	3.2.3.LI.1	3.2.3.AS.1
Demonstrate knowledge of the different communication technologies used in aviation.	**Identify the different communication technologies used in the aviation industry.** **Problem-Based Learning:** By exploring the requirements for aviation communication in different scenarios (short to medium range, long range), teacher presents to students the major communication technologies in aviation using videos or pictures.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.2.3.LI.2	3.2.3.AS.2
	Illustrate the pros and cons of each aviation communication technology. **Collaborative Learning:** By exploring the requirements for aviation communication in different scenarios (short to medium range, long range), students think, pair and share the merits and limitations of each communications technology.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• A two-way radio • Canned tins with thread/wire • A mobile phone • Talking drums	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.2.3.CS.2	3.2.3.LI.1	3.2.3.AS.1
Demonstrate an understanding of the different navigation systems used in aircraft and spacecraft.	**Explain the concept of navigation (dead reckoning and position fixing).** **Building on What Others Say:** Building on students' knowledge of moving from one place to another with the aid of technologies such as compasses and GPS, discuss the different navigation technologies used by aerospace vehicles.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.2.3.LI.2	3.2.3.AS.2
	Identify the advantages and disadvantages of the different navigation technologies. **Collaborative Learning:** By exploring the requirements for aircraft navigation in different scenarios, learners discuss the merits and limitations of each navigation technology. Organise views of learners.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• A handheld compass • Google map app on a smart phone • Navigation charts	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.2.3.CS.3	3.2.3.LI.1	3.2.3.AS.1
Demonstrate knowledge of different aerospace surveillance technologies.	**Present a summary of on-board surveillance systems.** **Collaborative Learning:** In small mixed ability groups, learners research on on-board aerospace vehicle surveillance systems for class presentations. **Talk for Learning:** Learners add on to what others say based on the group presentations.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.2.3.LI.2	3.2.3.AS.2
	Present a summary of ground-based surveillance systems. **Talk for Learning:** Through a question and answer session, learners share views on ground-based aerospace vehicle surveillance systems. Let learners summarise views shared.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• GPS tracking devices • Satellite dish antenna	

Subject Aviation and Aerospace Engineering
Strand 3 Aviation Industry
Sub-Strand 3 Aircraft Maintenance

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.3.3.LO.1		
Expatiate the types of aircraft maintenance (routine, periodic, etc.) and the equipment required.	**Initiative/Leadership:** As students study aircraft maintenance, they learn to initiate projects, and to take responsibility for their safety	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures.

		Diversity: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by

		creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
3.3.3.LO.2		
Apply standard practices in the performance of simple maintenance tasks.	**Initiative/Leadership:** As students carry out maintenance activities, they learn to initiate projects, and to take responsibility for their safety, as well as appreciate corrective and preventive maintenance.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:**

		Inculcate the habit of leadership through teamwork; respect for individuals' views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values** ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty

		as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.3.3.CS.1	3.3.3.LI.1	3.3.3.AS.1
Demonstrate knowledge of aircraft maintenance activities.	**Classify various maintenance tasks as routine, periodic, etc.** **Experiential Learning:** Learners visit an aircraft maintenance facility or watch video/ pictures to learn about maintenance activities. Learners take notes and share with the class. Others add to the presentation. Organise views using flowchart.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	3.3.3.LI.2	3.3.3.AS.2
	Identify aircraft maintenance equipment. **Experiential Learning:** Learners visit an aircraft maintenance facility or watch video/pictures to learn about aircraft maintenance equipment. Organise views using flowchart or webbing.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Aircraft maintenance manual • Maintenance tools and equipment such as screw drivers, set of spanners, etc.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.3.3.CS.2	3.3.3.LI.1	3.3.3.AS.1
Demonstrate knowledge of aircraft maintenance standards and certification.	**Carry out simple maintenance tasks, according to established standards.** **Talk for Learning:** ● Teacher discusses with students' regulations that govern aircraft maintenance, including personnel certification. ● Teacher presents to students a case study of aviation incidents due to improper maintenance practices for discussion. **Experiential Learning**: Visit a workshop to undertake maintenance duties under the supervision of resource persons.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning: **Level 4 Extended critical thinking and reasoning**
	3.3.3.LI.2	3.3.3.AS.2
	Make log entries of maintenance activities performed. **Talk for Learning:** Through a question and answer session, learners brainstorm what a logbook is. Show learners what a logbook is using videos or pictures. **Project-Based Learning:** In pairs/ small groups, learners develop a logbook and make entries of maintenance activities. Using manila cards and display in class for comments. Encourage learners to respect and tolerate others comments.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning:**
Teaching and Learning Resources	● Aircraft maintenance regulations ● Aircraft maintenance logbook	

Subject Aviation and Aerospace Engineering
Strand 4 Unmanned Aerial Vehicles (UAVs)
Sub-Strand 3 Design and Fabrication of UAVs

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.4.3.LO.1		
Make sketches of several UAV concepts to satisfy stipulated mission requirements.	**Creativity:** Students sharpen their creativity as they develop concepts to satisfy stipulated requirements. **Critical Thinking:** As students go about to select the best concept, they are encouraged to think through all the features of the concepts, sharpening their critical thinking skills.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life.

		• value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**:

		• Tolerance • Friendliness • Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of social-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
3.4.3.LO.2		
Determine by analytical means, the physical properties of a UAV.	**Productivity:** Students learn to be efficient in their operations as they walk through the design of a UAV from conception through fabrication to testing.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: • respect individuals of different backgrounds. • embrace diversity and practice

		inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society. **Leadership and Respect for Others' Views:** Inculcate the habit of leadership through teamwork; respect for individuals views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners.

		Managing Transition: This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness ● Open-mindedness ● Patience ● Hard work ● Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional**

		activities such as: Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions
3.4.3.LO.3		
Construct and fly a small UAV.	**Productivity:** Students learn to make the best use of their time and other resources as they construct their UAVs. **Critical Thinking:** As students pilot their UAVs, they learn to think critically.	**GESI:** Learners having experienced a teaching approach that ensures gender equality and social inclusion, where they work with each other in an inclusive way; cross-sharing knowledge and understanding among groups and individuals lead them to: ● respect individuals of different backgrounds. ● embrace diversity and practice inclusion. ● examine and dispel misconceptions/ myths about gender as they relate home management and human development. ● interrogate their stereotypes and biases about gender and the role men and women play in home management. ● identify injustice, especially in recognition of the contributions of different groups and individuals to the effective management and maintenance of the home. ● be sensitive to the inter-relatedness of the various aspects of life. ● value and promote justice at home and in society.

		Leadership and Respect for Others' Views: Inculcate the habit of leadership through teamwork; respect for individuals views, beliefs, religions, and cultures. **Diversity**: Promote divergent views to ensure inclusivity in the learning environment. **Equity:** Develop fair and impartial opportunities or resources for learners devoid of unwanted segregation or discrimination among learners. **Managing Transition:** This can be realised if teachers guide and facilitate learning by generating discourse among learners and challenging them to accept and share responsibility for their own learning, based on their unique individual differences (including GESI and gifted and talented leaners). **SEL:** Give responsibilities to everyone in the groups. As much as possible, offer all learners equitable opportunities to interact and use teaching and learning resources. **National Core Values**: ● Tolerance ● Friendliness

		• Open-mindedness • Patience • Hard work • Humility **Truth and Integrity:** Reward truth and honesty as strong moral principles, leading to responsible citizenship. **Tolerance:** Model tolerance among learners by creating opportunities for collaborative learning through mixed ability grouping within a differentiated classroom instruction. **Make use of socio-emotional activities such as:** Consolidated project report/journal writing, reading project reports aloud, doing daily consultation on projects, holding class/group meetings, talking about managing emotions

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.4.3.CS.1	3.4.3.LI.1	3.4.3.AS.1
Demonstrate knowledge of how to develop and evaluate conceptual designs of UAVs.	**Generate UAV concepts given a set of mission requirements.** **Talk-for Learning:** Through question and answer sessions, learners discuss a set of requirements and the process of designing and building a UAV that satisfies the requirements.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	3.4.3.LI.2	3.4.3.AS.2
	Apply evaluation tables to select the best concept from a number of UAV concepts. **Experiential Learning:** In pairs, guide learners to create an evaluation table and decision matrix in selecting UAV concepts.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	● A sample of aircraft design requirements ● Sample concept evaluation tables and decision matrices	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.4.3.CS.2	3.4.3.LI.1	3.4.3.AS.1
Demonstrate knowledge of how to undertake basic UAV design calculations.	**Perform simple calculations that yield the properties (such as wing area, number of motors, propellant, etc.) for a small UAV** **Talk for Learning**: Through a question and answer session, guide learners to make simple calculations to determine the properties of a UAV.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• A scientific calculator	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI			Assessment
3.4.3.CS.3	3.4.3.LI.1			3.4.3.AS.1
Demonstrate knowledge and understanding of how to fabricate and test a selected design.	**Build a small UAV (aircraft/rocket) using locally available materials** **Experiential Learning/Project-Based Learning:** In mixed ability groups, learners apply the requirements in building a small UAV with local materials. Display UAVs in class for comments from colleagues.			Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	3.4.3.LI.2			3.4.3.AS.2
	Fly the fabricated UAV. **Experiential Learning:** ● Learners use the simulation software to practice the flying of UAV. ● Learners fly model UAVs.			Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	● Wood ● Styrofoam ● Epoxy glue	● Screws ● Flight simulation software and equipment	● A small UAV ● A model rocket	