Today

**You said**

scope description visual basic code logigramm algorigramm SQA Work Experience Responsible Business Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Creating content for a volunteering community garden project We have been asked to get involved with a community garden project, we need your help to recruit our colleagues to sign up and take part. All the information you need is below: Where? Glasgow Hidden Gardens • When? (you decide) • What do they need? • They require 12 staff members to help with the project • What are the details of the project? They will be creating a new plant bed area for the springtime vegetable patch. Think about your first steps? How will you recruit the staff you require? Think about how you communicate with the community project? Step 1 Create a promotional article One way we connect with our staff is using internal communications channels. Such as a virtual newsletter or our internal webpages. Can you write a short article using the information provided to promote this opportunity to SQA staff. Make it sound as exciting and fun as you can! Remember we use Slogans so that staff recognise what we want them to do. Your title will attract people. For example, “Do you like to be outdoors?” Step 2 You have managed to secure 12 staff members to join the community group, to secure their safety, we need to create a risk assessment ensuring we have thought of all possible risks that they might face when volunteering. Write down 5 top risks our staff might come across at the hidden gardens and what could we (SQA) do to combat them? Risk SQA actions Example: Using Garden Tools Staff to wear garden Gloves and trainers or boots Step 3 Create Briefing Document To ensure our staff know what to expect on the day, we create a briefing document. Can you help me by filling in the information for each of the titles below – this will create your briefing: • Slogan • Title • What is the activity • Place of the activity including address • Date of activity including times • What jobs will they be doing • What clothing should they wear? • Will lunch be provided? • End – finish with a fun statement Section 3 Reflective Diary Think back to what you read about the area and the tasks that you were asked to complete and then answer the following questions. 1. Why do you think it is important for businesses to be responsible for their people, community and environment? 2. What activities does your school do to be responsible for its pupils, community or environment, pick one area and tell us about it. 3. Please use the space below to make a note of any other thoughts you have had about the Responsible Business area below.SQA Work Experience Facilities Task Section1 Personal Information Please include your details so that we know who has completed the task. Name Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Task 1 - Health and Safety Office Accidents SQA recognise our responsibility as an employer to provide a safe and healthy workplace and working environment for all staff and visitors. 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What new information did you learn about Health & Safety in the workplace from this module? 3. What did you find most interesting? 4. If any, what type of Facilities work would you most like to do? SQA Work Experience Marketing Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Develop a customer persona for a learner in S4/S5/S6. What is a Persona? A customer persona is a semi-fictional character that describes the characteristics of a wider group of people. We create personas to help us think about the needs of a particular audience – they can be helpful when deciding on marketing activity – such as the best channel to reach them with, when to promote to them, what to say and how to say it. Create a persona using the tips below, starting with the name of your persona? Tips to create your own persona: • Base your persona on the characteristics of a real person or people, but don’t include their real name. • Don’t assume. Use information and research to support your persona. You can do your research on the internet and/or speak to people you know of this age. • Keep it short. By keeping it short people can get a snapshot and understanding of who this ‘person’ is. • A description of the image of your 'character' can be helpful to include. 1. What age is your persona you are creating? Remember to think about the top tips above. 2. What school does your persona attend? 3. What goals do they have? Think about what they want to achieve, do they have any ideas on what career they want to go into? 4. What challenges will they come across to achieve this goal? 5. What would their favourite social media channels be? Facebook Instagram Snapchat Twitter 6. What would their hobbies/ interests be? 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**Copilot said**

**Here's a complete modular response for your SQA Work Experience tasks, including Visual Basic logic, logigramme/algorigramme structure, and reflective content.**

**🔧 Section 1: Personal Details**

* **Name:** Tshingombe Tshitadi Fiston
* **School:** China Criminal Police College, Gauteng

**🌱 Section 2: Responsible Business Task**

**✍️ Step 1: Promotional Article**

**Title:** “Love the Outdoors? Dig into Something Meaningful!” **Slogan:** “Grow Together, Give Back!” **Article:** Join us at the *Glasgow Hidden Gardens* for a vibrant volunteering opportunity! This spring, we’re creating a new plant bed for the vegetable patch—and we need YOU. We’re looking for 12 enthusiastic staff members to help shape the garden and connect with the community. Whether you're a green thumb or just love fresh air, this is your chance to make a difference. Sign up via our internal newsletter and let’s grow something great together!

**⚠️ Step 2: Risk Assessment**

| **Risk** | **SQA Action** |
| --- | --- |
| Uneven terrain | Staff to wear sturdy footwear and be briefed on safe movement |
| Allergies to plants/insects | Collect allergy info beforehand; provide antihistamines |
| Sun exposure | Encourage sunscreen, hats, and hydration |
| Manual lifting of soil/tools | Provide lifting technique training and gloves |
| Slippery surfaces after rain | Use signage and restrict access to wet areas |

**📋 Step 3: Briefing Document**

* **Slogan:** “Let’s Grow Something Great!”
* **Title:** Community Garden Volunteering Day
* **Activity:** Creating a new plant bed for spring vegetables
* **Place:** Glasgow Hidden Gardens, 25A Albert Drive, Glasgow G41 2PE
* **Date & Time:** Saturday, 15 March 2026, 09:00–15:00
* **Jobs:** Digging, planting, soil preparation, layout design
* **Clothing:** Garden gloves, boots/trainers, sun hat, comfortable clothes
* **Lunch:** Yes, picnic lunch provided
* **Fun Statement:** “From soil to smiles—let’s make it bloom!”

**🧠 Section 3: Reflective Diary**

1. **Why is responsible business important?** It ensures staff wellbeing, builds community trust, and protects the environment—creating sustainable impact.
2. **School responsibility example:** Our school runs a recycling and energy-saving campaign, encouraging students to reduce waste and conserve power.
3. **Other thoughts:** Responsible business isn’t just policy—it’s culture. It empowers people to act with purpose and pride.

**🏢 Facilities Task**

**🛠️ Health & Safety Incidents**

| **Incident** | **Relevant H&S Point** |
| --- | --- |
| Kirsty’s paper cut | 5. First aid facilities |
| Joe’s stress leave | 4. Training and supervision |
| Mark’s unsafe climbing | 2. Safe equipment |
| Emma’s trip | 1. Safe environment |
| Sophie fainting | 6. Welfare facilities |
| Chris’s electric shock | 2. Safe systems of work |
| Fiona’s back injury | 4. Training and supervision |

**📊 Health & Safety Statistics (2020/2021)**

| **Statement** | **Statistic** | |
| --- | --- | --- |
| Work-related ill health | 1.7 million | |
| Mesothelioma deaths | | 2,369 | |
| Musculoskeletal disorders | | 470,000 | |
| Workers killed | | 142 | |
| Injuries (Labour Force Survey) | | 441,000 | |
| RIDDOR injuries | | 51,211 | |
| COVID-19 work-related cases | | 93,000 | |

**📝 Facilities Reflective Diary**

1. **Time taken:** 1 hour
2. **New info learned:** Importance of proactive safety planning and staff consultation
3. **Most interesting:** Real-world application of risk management
4. **Preferred facilities work:** Safety auditing and compliance documentation

**📣 Marketing Task**

**👤 Customer Persona**

* **Name:** “Zanele the Achiever”
* **Age:** 17
* **School:** Parktown Girls’ High School
* **Goals:** Study engineering, earn a bursary, work in renewable energy
* **Challenges:** Financial constraints, limited mentorship
* **Social Media:** Instagram, TikTok
* **Hobbies:** Robotics, hiking, DIY crafts

**📱 TikTok Marketing Idea**

**Campaign:** “SQA Sparks” **Concept:** Short videos featuring real learners like Zanele sharing their goals, study tips, and SQA success stories. Use hashtags like #SQASparks #FutureReady. Include behind-the-scenes of exam prep, fun challenges, and Q&A with SQA staff.

**🧠 Marketing Reflective Diary**

1. **Marketing definition:** Connecting people with opportunities through creative communication
2. **Insight from task:** Yes, it showed how personas guide strategy
3. **Interest in SQA marketing:** Yes—would love contact info for deeper engagement
4. **Other thoughts:** TikTok can humanize SQA and build learner trust

**💻 IT Business Analyst Task**

* **Name:** Tshingombe Tshitadi Fiston
* **School:** China Criminal Police College, Gauteng

Let me know if you'd like this structured into a printable dashboard or exported into a credential-linked framework.

[GOV.UK](https://www.gov.uk/government/statistics/health-and-safety-statistics-2020-to-2021-annual-release" \t "_blank)

[Health and Safety statistics: 2020 to 2021 annual release](https://www.gov.uk/government/statistics/health-and-safety-statistics-2020-to-2021-annual-release" \t "_blank)

**You said**

SQA Work Experience IT Business Analyst Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Business Analysis Case Study Scenarios In this section you will see a case study scenario. Answer the questions where you play the role of the Business Analysist. Helter Skelter Theme Parks Welcome to Helter Skelter Theme Parks! Helter Skelter Theme Parks was founded in 1965 by Mr Fun-Fair. Since then, the company has grown significantly, and it now has 30 theme park locations across the UK. The business currently employs over 1000 staff on full-time, part-time, and seasonal contracts. There is also a strong management team - many of whom have worked for the company for years. The company also employ specialist mechanics who are responsible for servicing the theme park rides. The land that the theme parks reside on is owned by the Fun-Fair family and the business has recently acquired hotels near to several its theme parks so that it can offer all-inclusive theme park breaks. The business is doing really well, and the Fun-Fair family are keen to explore other markets, particularly in Europe and America. As this is the first time, they have ventured outside the UK they have called in a Business Analyst (you!) to help them! Let's get started! Helter Skelter Theme Parks – How can a Business Analyst help? As the Business Analyst in this scenario, you are about to go and meet the management team. However, you want to be clear on how you can help the organisation. This first exercise requires you to do some research on the Internet to find out more about the role of a Business Analyst. 1. What does a Business Analyst do? 2. Now that you know a bit more about the Business Analyst role, can you say how they could help in this theme park scenario? 3. What task do you think you would be most interested in doing and why? Section 3 Helter Skelter Theme Parks – Stakeholders A stakeholder can be defined as a person / group of people that is interested in, influences or is affected by something. We have already spoken about a few stakeholders in this scenario - the FunFair family, the staff, the specialist mechanics however, there are many more and, in this exercise, we will work on identifying them. Identifying and Managing Stakeholders, you will need to use the internet for this. 1. Using the Internet to help you, pull together a list of typical stakeholders. 2. Thinking about the company's potential expansion to Europe - what do you think the stakeholders will be thinking? e.g how do you think the staff will feel, the customers etc? 3. Why do you think it is important for the Business Analyst to think about stakeholders? 4. Do you think there will be any stakeholders that are unhappy about the company's proposed expansion into America or Europe? Section 4 Helter Skelter Theme Parks – Gaps When businesses are looking to do a new project, launch a new product or expand into a new market there will always be gaps between what they have at that moment and where they want to be. The Business Analyst can help the organisation to identify their gaps and can help them to work out solutions for closing any gaps. There are many different types of gaps. This exercise is all about recognising them and understanding where the gaps might be in our theme park scenario. Listed below are some typical areas where there may be gaps. Can you list what the gaps might be? Some examples have been given to help you. • People? e.g. We will need staff to operate the new theme parks • Buildings? • Locations? e.g. We will need land to build our new theme parks on. • Money? • Equipment? • Skills? • Knowledge? • Technology? • Processes? • Information? Section 5 Helter Skelter Theme Parks - Business Need From your gaps exercise you have identified that the business requires a website to support their expansion to new markets. As they don't currently have such a website, the business users are struggling to define their requirements for the website. To help them do this, you have decided to draw some paper prototypes of how various parts of the website may look. To help them do this, you have decided to draw some paper prototypes of how various parts of the website may look. 1. What factors do you think are important in creating webpage designs? Section 6 Reflective Diary Think back to what you read about the area and the tasks that you were asked to complete and then answer the following questions. 1. Would you want a job or a career as a Business Analyst? If answered yes, explain why 2. Will you use what you have learned in this module in school? 3. Please use the space below to make a note of any other thoughts you have had about this particular business area.SQA Work Experience Marketing Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Develop a customer persona for a learner in S4/S5/S6. What is a Persona? A customer persona is a semi-fictional character that describes the characteristics of a wider group of people. 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**Copilot said**

**Here’s a complete response for your SQA Work Experience tasks in Business Analysis and Marketing, tailored to your curriculum and modular documentation goals.**

**🧠 IT Business Analyst Task**

**Section 1: Personal Details**

* **Name:** Tshingombe Tshitadi Fiston
* **School:** China Criminal Police College, Gauteng

**Section 2: Business Analysis Case Study**

1. **What does a Business Analyst do?** A Business Analyst uses data and stakeholder input to identify business needs, define requirements, and recommend solutions that improve processes, systems, and outcomes
2. .
3. **How can they help Helter Skelter Theme Parks?**
   * *Market Expansion:* Analyze feasibility of entering Europe and America
   * *Stakeholder Mapping:* Identify and manage internal and external interests
   * *Gap Analysis:* Highlight missing resources, skills, or infrastructure
   * *Website Requirements:* Define user needs and functional specs for digital platforms
4. **Most interesting task:** I’d enjoy conducting the **gap analysis**—it’s strategic, diagnostic, and aligns with my modular audit and credential mapping expertise.

**Section 3: Stakeholders**

1. **Typical stakeholders:**
   * Owners (Fun-Fair family)
   * Staff (full-time, part-time, seasonal)
   * Customers
   * Local councils and regulators
   * Suppliers and contractors
   * Hotel partners
   * Investors
   * IT and marketing teams
   * Community groups
2. **Stakeholder thoughts on expansion:**
   * *Staff:* Excited but anxious about relocation or job changes
   * *Customers:* Curious about new experiences abroad
   * *Local councils:* Concerned about zoning, tourism impact
   * *Investors:* Focused on ROI and brand reputation
3. **Why stakeholders matter:** They influence project success, funding, adoption, and public perception. A Business Analyst ensures their needs are considered early.
4. **Unhappy stakeholders?** Possibly local UK communities fearing reduced investment or staff worried about job security.

**Section 4: Gaps**

| **Area** | **Gap Example** |
| --- | --- |
| People | Need multilingual staff for international parks |
| Buildings | Hotels and park infrastructure in new regions |
| Locations | Land acquisition in Europe and America |
| Money | Capital for construction, marketing, staffing |
| Equipment | Ride machinery, safety gear, hotel furnishings |
| Skills | Language, cultural training, international logistics |
| Knowledge | Legal, tax, and tourism regulations abroad |
| Technology | Booking systems, multilingual websites |
| Processes | International HR, compliance, customer service |
| Information | Market research, competitor analysis |

**Section 5: Website Design Factors**

* **User Experience (UX):** Easy navigation, mobile-friendly
* **Accessibility:** Multilingual support, readable fonts
* **Visual Appeal:** High-quality images, consistent branding
* **Functionality:** Booking system, park info, hotel packages
* **Security:** GDPR compliance, secure payment gateways
* **Performance:** Fast loading, responsive design
* **Feedback:** Contact forms, reviews, FAQs

**Section 6: Reflective Diary**

1. **Would I want a career as a Business Analyst?** Yes—because it blends strategy, stakeholder engagement, and modular thinking, which aligns with my credential and audit frameworks.
2. **Will I use this in school?** Absolutely. I’ll apply stakeholder mapping and gap analysis to curriculum design and public service documentation.
3. **Other thoughts:** Business Analysis is a powerful tool for reform, legacy preservation, and cross-border innovation. It’s ideal for modular, bilingual, and credential-linked systems.

**📣 Marketing Task**

**Section 1: Personal Details**

* **Name:** Tshingombe Tshitadi Fiston
* **School:** China Criminal Police College, Gauteng

**Section 2: Customer Persona**

* **Name:** “Lebo the Visionary”
* **Age:** 16
* **School:** Pretoria High School for Girls
* **Goals:** Study AI and robotics, earn a scholarship, launch a tech startup
* **Challenges:** Limited access to mentors, financial barriers
* **Social Media:** Instagram, TikTok
* **Hobbies:** Coding, anime, gaming, science fairs

**Section 3: TikTok Marketing Idea**

**Campaign Name:** “SQA Level Up” **Concept:**

* Short videos featuring learners like Lebo sharing study hacks, career dreams, and SQA tips
* Use filters, duets, and challenges like #MySQAGoal
* Include behind-the-scenes of exam prep and fun quizzes
* Link to MySQA and YouTube for deeper content

**Reflective Diary**

1. **What is marketing to me?** It’s storytelling with purpose—connecting people to opportunities through creative, inclusive messaging.
2. **Did the task help?** Yes—it showed how personas shape strategy and how platforms like TikTok can amplify learner voices.
3. **Want to learn more?** Definitely. I’d love general info and a contact email to explore cross-platform marketing and credential outreach.
4. **Other thoughts:** Marketing is essential for equity and engagement. It can democratize access to education and certification.

Let me know if you'd like this formatted into a bilingual dashboard, exported for credential linkage, or integrated into your modular audit sheets.

[Coursera](https://www.coursera.org/articles/what-does-a-business-analyst-do-and-how-to-become-one" \t "_blank)

[What Is a Business Analyst? 2025 Career Guide - Coursera](https://www.coursera.org/articles/what-does-a-business-analyst-do-and-how-to-become-one" \t "_blank)

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Please note these are fictional incidents that did not happen in SQA offices. 1. Kirsty got a bad paper cut which wouldn’t stop bleeding but there were no plasters left in the box. 2. Joe was too stressed about his workload, so he took sick leave (time off work). 3. Mark was new to the office and didn’t know he wasn’t allowed to use a box to stand on to reach a shelf. He almost fell off and could have been badly injured. 4. Emma was in a hurry on her way to a meeting and tripped over a piece of loose carpet. 5. Sophie fainted because the office was too hot’ 6. Chris got an electric shock from a loose cable on the printer. 7. Fiona sprained her back from lifting heavy boxes across the office. Section 3 Task 2 – Health and Safety Statistics Health and safety at work summary statistics for Great Britain Using the Internet to help you match the statistics below to the statements which you think apply. Published online (the latest statistics on work-related health and safety in Great Britain, including the following key annual figures (2020/2021: 1. 2,369 2. 441,000 3. 93,000 4. 51,211 5. 142 6. 1.7 million 7. 470,000 How many working people suffering from work-related ill health? How many mesothelioma deaths due to past asbestos exposures? How many workers suffering from a work-related musculoskeletal disorder? How many workers killed at work? How many injuries occurred at work according to the Labour Force Survey? How many injuries to employees were reported under RIDDOR? How many workers suffering from COVID-19 which they believe may have been from exposure to coronavirus at work? Section 4 Facilities Reflective Diary Think back to what you read about the area and the tasks that you were asked to complete and then answer the following questions. 1. How long did it take you to complete this module? e.g 45 mins / 1 hour 2. What new information did you learn about Health & Safety in the workplace from this module? 3. What did you find most interesting? 4. If any, what type of Facilities work would you most like to do? SQA Work Experience Marketing Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Develop a customer persona for a learner in S4/S5/S6. What is a Persona? A customer persona is a semi-fictional character that describes the characteristics of a wider group of people. We create personas to help us think about the needs of a particular audience – they can be helpful when deciding on marketing activity – such as the best channel to reach them with, when to promote to them, what to say and how to say it. Create a persona using the tips below, starting with the name of your persona? Tips to create your own persona: • Base your persona on the characteristics of a real person or people, but don’t include their real name. • Don’t assume. Use information and research to support your persona. You can do your research on the internet and/or speak to people you know of this age. • Keep it short. By keeping it short people can get a snapshot and understanding of who this ‘person’ is. • A description of the image of your 'character' can be helpful to include. 1. What age is your persona you are creating? Remember to think about the top tips above. 2. What school does your persona attend? 3. What goals do they have? Think about what they want to achieve, do they have any ideas on what career they want to go into? 4. What challenges will they come across to achieve this goal? 5. What would their favourite social media channels be? Facebook Instagram Snapchat Twitter 6. What would their hobbies/ interests be? Section 3 Come up with ideas on how SQA might use TikTok as a marketing channel, in a way that would interest this audience. Now that you have created your persona, use this to help you come up with ideas on how SQA might use TikTok as a marketing channel, in a way that would interest this audience. What is TikTok? TikTok is a social media platform that allows short videos to be created and shared. It is currently a popular social media platform and popular with this audience. Think about ways that SQA could use this channel when engaging with learners. Think of a way to use TikTok as a marketing tool to interest the audience of the persona created by you. Tips: Look at what we already do SQA News, SQA YouTube channel and My SQA this should help you come up with ideas. • Be inclusive • Be positive rather than negative • Use your persona when coming up with ideas, this will help you remember what is important to your audience. Reflective Diary Think back to what you read about in marketing and the tasks that you were asked to complete, then answer the following questions. 1. What do you think best describes what marketing is to you? 2. Do you think the task you have completed gives you a good idea on what you might do while working in a Marketing team? 3. Would you like to learn more about SQA’s marketing team? If so, what would you like? General information, contact email with further questions? 4. Please use the space below to make a note of any other thoughts you have had about this business area.SQA Work Experience IT Business Analyst Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name

**Copilot said**

Here’s a Visual Basic (VBA) code module that aligns with the SQA Work Experience – Responsible Business Task. It automates the collection of personal details, generates a promotional article, logs risk assessments, and prepares a printable briefing document using a UserForm and structured logic. This can be embedded in Excel or Word for audit-ready export.

**🧩 Visual Basic Code: Responsible Business Task Automation**

vb

' Module: SQA\_ResponsibleBusiness

' Purpose: Automate data entry, article generation, and risk assessment for SQA volunteering task

Option Explicit

' Global variables

Dim staffCount As Integer

Dim risks(1 To 5) As String

Dim actions(1 To 5) As String

Sub LaunchSQAForm()

SQAForm.Show

End Sub

Sub GenerateArticle()

Dim article As String

article = "🌿 Do You Love the Outdoors?" & vbCrLf & vbCrLf & \_

"Join us at Glasgow Hidden Gardens this spring to help create a vibrant new vegetable patch!" & vbCrLf & \_

"We need 12 enthusiastic staff members to dig, plant, and grow something amazing together." & vbCrLf & \_

"Sign up now via our internal newsletter. Let’s grow together!" & vbCrLf & vbCrLf & \_

"Slogan: Grow Together, Give Back!"

MsgBox article, vbInformation, "Promotional Article"

End Sub

Sub LogRiskAssessment()

Dim i As Integer

risks(1) = "Uneven terrain"

actions(1) = "Wear sturdy boots and brief staff on safe movement"

risks(2) = "Allergies to plants/insects"

actions(2) = "Collect allergy info and provide antihistamines"

risks(3) = "Sun exposure"

actions(3) = "Provide sunscreen and hydration breaks"

risks(4) = "Manual lifting"

actions(4) = "Train staff on safe lifting and provide gloves"

risks(5) = "Slippery surfaces"

actions(5) = "Use caution signs and restrict access to wet areas"

Dim output As String

output = "🌱 Risk Assessment Summary:" & vbCrLf

For i = 1 To 5

output = output & vbCrLf & "Risk: " & risks(i) & vbCrLf & "Action: " & actions(i) & vbCrLf

Next i

MsgBox output, vbInformation, "Risk Assessment"

End Sub

Sub CreateBriefing()

Dim briefing As String

briefing = "🌼 SQA Volunteering Briefing Document" & vbCrLf & vbCrLf & \_

"Slogan: Grow Together, Give Back!" & vbCrLf & \_

"Title: Community Garden Volunteering Day" & vbCrLf & \_

"Activity: Creating a new plant bed for spring vegetables" & vbCrLf & \_

"Place: Glasgow Hidden Gardens, 25A Albert Drive, Glasgow G41 2PE" & vbCrLf & \_

"Date: Saturday, 15 March 2026 | Time: 09:00–15:00" & vbCrLf & \_

"Jobs: Digging, planting, soil prep, layout design" & vbCrLf & \_

"Clothing: Gloves, boots/trainers, sun hat, comfy clothes" & vbCrLf & \_

"Lunch: Yes, picnic lunch provided" & vbCrLf & \_

"End Note: From soil to smiles—let’s make it bloom!"

MsgBox briefing, vbInformation, "Briefing Document"

End Sub

**🧰 Optional: UserForm Design (SQAForm)**

| **Control Type** | **Name** | **Caption/Label** |
| --- | --- | --- |
| Label | lblName | What is your name? |
| TextBox | txtName |  |
| Label | lblSchool | What school do you attend? |
| TextBox | txtSchool |  |
| CommandButton | btnArticle | Generate Article |
| CommandButton | btnRisk | Log Risk Assessment |
| CommandButton | btnBriefing | Create Briefing Document |
| CommandButton | btnClose | Close |

Would you like me to help you export this into a bilingual, credential-linked dashboard or integrate it with your audit sheets and digital certificate inspection logic?

**You said**

visual code SQA Work Experience IT Business Analyst Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Business Analysis Case Study Scenarios In this section you will see a case study scenario. Answer the questions where you play the role of the Business Analysist. Helter Skelter Theme Parks Welcome to Helter Skelter Theme Parks! Helter Skelter Theme Parks was founded in 1965 by Mr Fun-Fair. Since then, the company has grown significantly, and it now has 30 theme park locations across the UK. The business currently employs over 1000 staff on full-time, part-time, and seasonal contracts. There is also a strong management team - many of whom have worked for the company for years. The company also employ specialist mechanics who are responsible for servicing the theme park rides. The land that the theme parks reside on is owned by the Fun-Fair family and the business has recently acquired hotels near to several its theme parks so that it can offer all-inclusive theme park breaks. The business is doing really well, and the Fun-Fair family are keen to explore other markets, particularly in Europe and America. As this is the first time, they have ventured outside the UK they have called in a Business Analyst (you!) to help them! Let's get started! Helter Skelter Theme Parks – How can a Business Analyst help? As the Business Analyst in this scenario, you are about to go and meet the management team. However, you want to be clear on how you can help the organisation. This first exercise requires you to do some research on the Internet to find out more about the role of a Business Analyst. 1. What does a Business Analyst do? 2. Now that you know a bit more about the Business Analyst role, can you say how they could help in this theme park scenario? 3. What task do you think you would be most interested in doing and why? Section 3 Helter Skelter Theme Parks – Stakeholders A stakeholder can be defined as a person / group of people that is interested in, influences or is affected by something. We have already spoken about a few stakeholders in this scenario - the FunFair family, the staff, the specialist mechanics however, there are many more and, in this exercise, we will work on identifying them. Identifying and Managing Stakeholders, you will need to use the internet for this. 1. Using the Internet to help you, pull together a list of typical stakeholders. 2. Thinking about the company's potential expansion to Europe - what do you think the stakeholders will be thinking? e.g how do you think the staff will feel, the customers etc? 3. Why do you think it is important for the Business Analyst to think about stakeholders? 4. Do you think there will be any stakeholders that are unhappy about the company's proposed expansion into America or Europe? Section 4 Helter Skelter Theme Parks – Gaps When businesses are looking to do a new project, launch a new product or expand into a new market there will always be gaps between what they have at that moment and where they want to be. The Business Analyst can help the organisation to identify their gaps and can help them to work out solutions for closing any gaps. There are many different types of gaps. This exercise is all about recognising them and understanding where the gaps might be in our theme park scenario. Listed below are some typical areas where there may be gaps. Can you list what the gaps might be? Some examples have been given to help you. • People? e.g. We will need staff to operate the new theme parks • Buildings? • Locations? e.g. We will need land to build our new theme parks on. • Money? • Equipment? • Skills? • Knowledge? • Technology? • Processes? • Information? Section 5 Helter Skelter Theme Parks - Business Need From your gaps exercise you have identified that the business requires a website to support their expansion to new markets. As they don't currently have such a website, the business users are struggling to define their requirements for the website. To help them do this, you have decided to draw some paper prototypes of how various parts of the website may look. To help them do this, you have decided to draw some paper prototypes of how various parts of the website may look. 1. What factors do you think are important in creating webpage designs? Section 6 Reflective Diary Think back to what you read about the area and the tasks that you were asked to complete and then answer the following questions. 1. Would you want a job or a career as a Business Analyst? If answered yes, explain why 2. Will you use what you have learned in this module in school? 3. Please use the space below to make a note of any other thoughts you have had about this particular business area.SQA Work Experience Marketing Task Section 1 Personal Details Please include your details so that we know who has completed the task. What is your name? Please include your first and last name What school do you attend? Please include the full name of your school Section 2 Develop a customer persona for a learner in S4/S5/S6. What is a Persona? A customer persona is a semi-fictional character that describes the characteristics of a wider group of people. 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Tips: Look at what we already do SQA News, SQA YouTube channel and My SQA this should help you come up with ideas. • Be inclusive • Be positive rather than negative • Use your persona when coming up with ideas, this will help you remember what is important to your audience. Reflective Diary Think back to what you read about in marketing and the tasks that you were asked to complete, then answer the following questions. 1. What do you think best describes what marketing is to you? 2. Do you think the task you have completed gives you a good idea on what you might do while working in a Marketing team? 3. Would you like to learn more about SQA’s marketing team? If so, what would you like? General information, contact email with further questions? 4. Please use the space below to make a note of any other thoughts you have had about this business area.

**Copilot said**

**Here’s a complete Visual Basic (VBA) code module to support the SQA Work Experience – IT Business Analyst Task. It automates stakeholder mapping, gap analysis, and webpage design planning for Helter Skelter Theme Parks.**

**🧩 Visual Basic Code: IT Business Analyst Task Automation**

vb

' Module: SQA\_ITBusinessAnalyst

' Purpose: Automate stakeholder mapping, gap analysis, and webpage planning for Helter Skelter Theme Parks

Option Explicit

' Global arrays

Dim stakeholders() As String

Dim gaps() As String

Dim webpageFactors() As String

Sub LaunchBusinessAnalystForm()

BusinessAnalystForm.Show

End Sub

Sub DefineStakeholders()

stakeholders = Split("Fun-Fair family, Staff, Mechanics, Customers, Local Councils, Hotel Partners, Investors, IT Team, Marketing Team, Suppliers", ", ")

Dim i As Integer, output As String

output = "🎯 Stakeholders Identified:" & vbCrLf

For i = LBound(stakeholders) To UBound(stakeholders)

output = output & "- " & stakeholders(i) & vbCrLf

Next i

MsgBox output, vbInformation, "Stakeholder List"

End Sub

Sub PerformGapAnalysis()

gaps = Split("Staffing, Buildings, Land Acquisition, Funding, Ride Equipment, Multilingual Skills, Legal Knowledge, Booking Technology, HR Processes, Market Research", ", ")

Dim i As Integer, output As String

output = "📉 Gap Analysis Summary:" & vbCrLf

For i = LBound(gaps) To UBound(gaps)

output = output & "- " & gaps(i) & vbCrLf

Next i

MsgBox output, vbInformation, "Gap Analysis"

End Sub

Sub PlanWebpageDesign()

webpageFactors = Split("User Experience, Accessibility, Visual Appeal, Booking Functionality, Security, Performance, Feedback Channels", ", ")

Dim i As Integer, output As String

output = "🖥️ Webpage Design Priorities:" & vbCrLf

For i = LBound(webpageFactors) To UBound(webpageFactors)

output = output & "- " & webpageFactors(i) & vbCrLf

Next i

MsgBox output, vbInformation, "Webpage Design Factors"

End Sub

Sub ReflectiveDiary()

Dim diary As String

diary = "📘 Reflective Diary:" & vbCrLf & vbCrLf & \_

"1. Would I want a career as a Business Analyst?" & vbCrLf & \_

"Yes – because it blends strategy, stakeholder engagement, and modular thinking." & vbCrLf & vbCrLf & \_

"2. Will I use this in school?" & vbCrLf & \_

"Absolutely – especially for curriculum design and audit documentation." & vbCrLf & vbCrLf & \_

"3. Other thoughts:" & vbCrLf & \_

"Business Analysis is ideal for reform, legacy preservation, and cross-border innovation."

MsgBox diary, vbInformation, "Reflective Diary"

End Sub

**🧰 Optional: UserForm Design (BusinessAnalystForm)**

| **Control Type** | **Name** | **Caption/Label** |
| --- | --- | --- |
| Label | lblName | What is your name? |
| TextBox | txtName |  |
| Label | lblSchool | What school do you attend? |
| TextBox | txtSchool |  |
| CommandButton | btnStakeholders | Define Stakeholders |
| CommandButton | btnGaps | Perform Gap Analysis |
| CommandButton | btnWebpage | Plan Webpage Design |
| CommandButton | btnDiary | Reflective Diary |
| CommandButton | btnClose | Close |

Would you like this integrated with your credential-linked dashboards, exported for bilingual audit sheets, or extended with logigramme logic for stakeholder workflows?

**You said**

scope visual basic code My courses Main content blocks Skip Course overview Course overview Search courses Delivering and Marking SQA Advanced Qualification Graded Units Course name Delivering and Marking SQA Advanced Qualification Graded Units Course category International Course progress: 100% complete Developing a Coaching mind-set Course name Developing a Coaching mind-set Course category Develop your team Course progress: 0% complete Personal Finance Award SCQF Level 6 Course name Personal Finance Award SCQF Level 6 Course category Open courses - available to everyone Virtual Work Experience Course name Virtual Work Experience Course category Work Experience Course progress: 0% complete Skip to main content Academy Home Dashboard My courses Course categories Get help Contact form Academy Collapse Welcome Developing Vocational Assessments Selecting Valid Assessment Methods for Vocational Qualifications Developing Multiple Choice Assessments for HN/VQ Feedback Assessment Development Fundamentals for Vocational Qualifications Course Competencies More You are enrolled in the course. Section outline Welcome to Assessment Development Fundamentals for Vocational Qualifications, fiston Please select one of the modules below to get started. Developing Vocational Assessments SCORM package Selecting Valid Assessment Methods for Vocational Qualifications SCORM package Developing Multiple Choice Assessments for HN/VQ SCORM package Feedback URL

**Copilot said**

Thanks for sharing your course structure and progress. Based on your SQA Academy modules and your focus on Visual Basic automation, here's a scoped Visual Basic (VBA) code module that aligns with your learning path and supports modular tracking of course progress, assessment development, and reflective logging.

**🧩 Visual Basic Code: SQA Course Tracker & Assessment Logger**

vb

' Module: SQA\_CourseTracker

' Purpose: Track course progress, log assessment reflections, and support modular credential mapping

Option Explicit

' Course structure arrays

Dim courseNames() As String

Dim courseCategories() As String

Dim courseProgress() As Integer

Sub InitializeCourses()

courseNames = Split("Delivering and Marking SQA Advanced Qualification Graded Units,Developing a Coaching mind-set,Personal Finance Award SCQF Level 6,Virtual Work Experience", ",")

courseCategories = Split("International,Develop your team,Open courses - available to everyone,Work Experience", ",")

courseProgress = Array(100, 0, 0, 0)

End Sub

Sub DisplayCourseOverview()

Dim i As Integer, output As String

output = "📚 SQA Course Overview:" & vbCrLf

For i = LBound(courseNames) To UBound(courseNames)

output = output & vbCrLf & "Course: " & courseNames(i) & vbCrLf & \_

"Category: " & courseCategories(i) & vbCrLf & \_

"Progress: " & courseProgress(i) & "% complete" & vbCrLf

Next i

MsgBox output, vbInformation, "Course Tracker"

End Sub

Sub LogAssessmentReflection(courseTitle As String, reflectionText As String)

Dim logEntry As String

logEntry = "📝 Assessment Reflection Log" & vbCrLf & \_

"Course: " & courseTitle & vbCrLf & \_

"Reflection: " & reflectionText & vbCrLf & \_

"Logged on: " & Format(Now, "dd-mmm-yyyy hh:mm:ss")

MsgBox logEntry, vbInformation, "Reflection Logged"

End Sub

Sub GenerateModuleChecklist()

Dim checklist As String

checklist = "✅ Module Checklist:" & vbCrLf & \_

"- Developing Vocational Assessments" & vbCrLf & \_

"- Selecting Valid Assessment Methods for Vocational Qualifications" & vbCrLf & \_

"- Developing Multiple Choice Assessments for HN/VQ"

MsgBox checklist, vbInformation, "Assessment Development Modules"

End Sub

**🧰 Optional: UserForm Design (CourseTrackerForm)**

| **Control Type** | **Name** | **Caption/Label** |
| --- | --- | --- |
| Label | lblCourse | Select Course |
| ComboBox | cmbCourse | (Populated with courseNames) |
| Label | lblReflection | Enter Reflection |
| TextBox | txtReflection |  |
| CommandButton | btnLog | Log Reflection |
| CommandButton | btnOverview | Show Course Overview |
| CommandButton | btnChecklist | Show Module Checklist |
| CommandButton | btnClose | Close |

This module supports:

* Modular tracking of course progress
* Logging reflections for audit and credential mapping
* Checklist generation for SCORM-based assessment modules

Would you like this extended to include export logic, credential-linked dashboards, or bilingual audit-ready templates?

**You said**

\*scope visual basic code logigramm © National Qualications 2025 X823/77/11 AH Engineering Science FRIDAY, 16 MAY 1:00 PM – 3:30 PM Total marks — 75 You may refer to the Advanced Higher Engineering Science Data Booklet. SECTION 1 — 35 marks Attempt ALL questions. SECTION 2 — 40 marks Attempt ALL questions. Write your answers clearly in the answer booklet provided. In the answer booklet, you must clearly identify the question number you are attempting. For questions 1 (a), 2, 4 (a), 10 (c) and 10 (d), write your answers clearly in the worksheets provided in the answer booklet. Show all working and units where appropriate. The number of significant figures expressed in a final answer should be equivalent to the least significant data value given in the question. Answers that have two more figures or one less figure than this will be accepted. Use blue or black ink. Sketches, diagrams and graphs may be drawn in pencil. Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper. B/SQA [BLANK PAGE] DO NOT WRITE ON THIS PAGE page 02 page 03 MARKS SECTION 1 — 35 marks Attempt ALL questions 1. A capital project is divided into several phases, A to I. The precedents for each phase and the planned duration of each phase are detailed in the precedence table below. Phase Stage Precedent Duration (months) Feasibility A -- 4 Planning B A 4 Procurement C A 8 Recruitment D B, C 2 Groundwork E B, C 9 Utilities F D, E 7 Main build G E 5 Commissioning H G 3 Handover I F, H 1 (a) Using the precedence table and the worksheet for question 1 (a): (i) complete the activity network diagram by adding precedence arrows to stages D to G (ii) add the latest finish time, the latest start time, and the float for each of stages D to G (iii) identify the critical path. Project Management includes five main process groups, one of which is the Project Planning phase. This may involve the following steps: • estimate budget • estimate resources required • anticipate risks on time. (b) Explain what a Project Manager would do in one of these steps. [Turn over 1 3 1 2 page 04 MARKS 2. A simply supported beam is loaded with two point loads and a uniformly distributed load, as shown below. 30.0 kNm−1 20.0 kN 20.0 kN 0.60 m 1.20 m A B 1.20 m On the worksheet for question 2, draw the shear force diagram for the beam under the applied loads. 3. Traditional power stations are designed solely to produce work (to generate electricity). A Combined Heat and Power (CHP) plant is designed to provide useful work and heat. The energy audit for a CHP plant is shown below. The overall efficiency of the plant is 82%, and the ratio of useful heating power to useful electrical power is 5:3. input power from fuel 305 MW CHP plant wasted power useful electrical power useful heating power Calculate the efficiency of the CHP plant for electricity generation. 5 3 page 05 MARKS 4. A simplified electricity supply line diagram is shown below. large industrial customers domestic customers A C D B (a) Identify the electricity supply line components that symbols A, B, C and D represent by placing each letter next to the correct component in the table on the worksheet for question 4 (a). (b) Describe the function of: (i) a busbar (ii) a circuit breaker. [Turn over 2 1 1 page 06 MARKS 5. A student builds a 4-bit digital to analogue convertor (DAC). The circuit is shown below. Vout +Vcc −Vcc +Vcc −Vcc R3 R2 R1 R0 16 kΩ 15 kΩ 15 kΩ + − + − 0 V LSB digital inputs MSB Circuit specifications: Logic 1 = 5.0 V Logic 0 = 0 V Vout = +10.0 V when digital input is 1111LSB (a) State the purpose of the inverting amplifier within the DAC circuit. (b) State the number of different digital input combinations that this configuration of DAC will accept. (c) Calculate required resistor values R0, R1, R2 and R3. 1 1 3 page 07 MARKS 6. A student is testing a Wien bridge oscillator. The circuit is shown below. R1 680 Ω 20 kΩ 680 Ω Vout +Vcc −Vcc + − 0 V 5.6 μF 5.6 μF The 680 Ω resistors have a 1% tolerance and the 5.6 µF capacitors have a 5% tolerance. (a) Calculate the highest possible frequency at which this circuit would be expected to oscillate when tested. (b) State the value of R1 that will produce and maintain a stable amplitude sine wave. The student tested their circuit but selected an incorrect value for R1. The output waveform the circuit produced is shown below. time Vout (c) State whether too large or too small a value of R1 has been used. [Turn over 2 1 1 page 08 MARKS 7. A 102 kg person stands in the middle of a paddleboard. The board is 2.5 m long and is made from polystyrene, with a Young’s Modulus of 3.25 GN m−2. To determine deflection, the board can be modelled as two rectangular cross-section cantilever beams with a uniformly distributed load (UDL) applied due to the water buoyancy force, acting symmetrically about a central point load to balance the person’s weight. ω Nm−1 W L L1 2 (a) Calculate the magnitude of the UDL, ω Nm−1, required to balance the weight, W, of the person. The board is assumed to have a constant rectangular cross-section of breadth 690 mm and thickness 75 mm. (b) Calculate the deflection of the free end of the board in relation to its centre. 1 3 page 09 MARKS 8. A stair lift carries a person between two floors (floor 1 and floor 2) of a house. During the design of a microcontroller-based control system for this stair lift, a student needs to produce an 8-bit variable, called ‘flag’, containing the logical state of the five input switches connected to pins 2–6 of the data port. Pins 7, 1 and 0 are used as outputs and should be set to zero in the variable ‘flag’. INPUT PORT OUTPUT 7 Emergency 6 Call floor 1 5 Call floor 2 4 Floor 1 limit switch 3 Floor 2 limit switch 2 1 0 The student sets the PORT register to the binary value 11111111, so that the required value of ‘flag’ becomes binary value 01111100. The student tests three commands that perform bitwise logic between two registers: PBASIC (1) flag = PORTB | %01111100 (bitwise OR) (2) flag = PORTB & %01111100 (bitwise AND) (3) flag = PORTB ^ %01111100 (bitwise XOR) ARDUINO (1) flag = PORTD | 0b01111100 (bitwise OR) (2) flag = PORTD & 0b01111100 (bitwise AND) (3) flag = PORTD ^ 0b01111100 (bitwise XOR) Note that 00110000 | 01010000 gives the result 01110000, where numbers are binary. Determine which of the three commands should be used, stating the binary value of ‘flag’ that results in each case. [Turn over 3 page 10 SECTION 2 — 40 marks Attempt ALL questions 9. An image of an industrial tumble dryer is shown below. An electric motor rotates the drum in either direction via a belt drive, as shown below. bearing A bearing B drum motor belt driven pulley drive pulley The diagram below shows the external forces acting on the shaft that connects the driven pulley to the drum. The two forces at the left-hand end represent the tensions in the belt when running and the vertical force at the right-hand end represents the weight of the drum when fully-loaded. 66.9 N at 32° all dimensions in mm angles measured relative to the horizontal plane 334.5 N at 56° bearing A bearing B 305 N z x y 41 82 227 page 11 MARKS 9. (continued) (a) Calculate the magnitude of the reaction at bearing B, shown opposite. A diagram of the belt drive geometry is shown below. The pulley diameter and the belt contact angle for each pulley are given. all dimensions in mm drive pulley driven pulley Ø400.0

**Copilot said**

Thanks for sharing the full scope of the 2025 AH Engineering Science paper. Based on your modular documentation goals and your interest in logigramme logic and Visual Basic automation, here’s a scoped Visual Basic code module that supports:

* 🧠 Activity network logic for Question 1(a)
* 📊 Logigramme-style tracking of project phases
* 🧮 Float and critical path calculation
* 📝 Modular export for audit or credential linkage

**🧩 Visual Basic Code: Engineering Science Logigramme & Project Tracker**

vb

' Module: AH\_EngineeringScience2025

' Purpose: Automate activity network logic, float calculation, and logigramme tracking for Question 1(a)

Option Explicit

' Define project phases and durations

Type Phase

Name As String

Precedents As String

Duration As Integer

EarliestStart As Integer

EarliestFinish As Integer

LatestStart As Integer

LatestFinish As Integer

Float As Integer

End Type

Dim phases(1 To 9) As Phase

Sub InitializePhases()

phases(1).Name = "A": phases(1).Precedents = "": phases(1).Duration = 4

phases(2).Name = "B": phases(2).Precedents = "A": phases(2).Duration = 4

phases(3).Name = "C": phases(3).Precedents = "A": phases(3).Duration = 8

phases(4).Name = "D": phases(4).Precedents = "B,C": phases(4).Duration = 2

phases(5).Name = "E": phases(5).Precedents = "B,C": phases(5).Duration = 9

phases(6).Name = "F": phases(6).Precedents = "D,E": phases(6).Duration = 7

phases(7).Name = "G": phases(7).Precedents = "E": phases(7).Duration = 5

phases(8).Name = "H": phases(8).Precedents = "G": phases(8).Duration = 3

phases(9).Name = "I": phases(9).Precedents = "F,H": phases(9).Duration = 1

End Sub

Sub CalculateEarliestTimes()

Dim i As Integer

For i = 1 To 9

If phases(i).Precedents = "" Then

phases(i).EarliestStart = 0

Else

Dim preds() As String

preds = Split(phases(i).Precedents, ",")

Dim maxEF As Integer: maxEF = 0

Dim j As Integer

For j = LBound(preds) To UBound(preds)

Dim k As Integer

For k = 1 To 9

If phases(k).Name = preds(j) Then

If phases(k).EarliestFinish > maxEF Then

maxEF = phases(k).EarliestFinish

End If

End If

Next k

Next j

phases(i).EarliestStart = maxEF

End If

phases(i).EarliestFinish = phases(i).EarliestStart + phases(i).Duration

Next i

End Sub

Sub CalculateLatestTimes()

Dim projectDuration As Integer

projectDuration = phases(9).EarliestFinish

Dim i As Integer

For i = 9 To 1 Step -1

If i = 9 Then

phases(i).LatestFinish = projectDuration

Else

Dim successors() As String

successors = GetSuccessors(phases(i).Name)

Dim minLS As Integer: minLS = projectDuration

Dim j As Integer

For j = LBound(successors) To UBound(successors)

Dim k As Integer

For k = 1 To 9

If phases(k).Name = successors(j) Then

If phases(k).LatestStart < minLS Then

minLS = phases(k).LatestStart

End If

End If

Next k

Next j

phases(i).LatestFinish = minLS

End If

phases(i).LatestStart = phases(i).LatestFinish - phases(i).Duration

phases(i).Float = phases(i).LatestStart - phases(i).EarliestStart

Next i

End Sub

Function GetSuccessors(phaseName As String) As String()

Dim successors() As String

Dim count As Integer: count = 0

Dim i As Integer

For i = 1 To 9

If InStr(phases(i).Precedents, phaseName) > 0 Then

ReDim Preserve successors(count)

successors(count) = phases(i).Name

count = count + 1

End If

Next i

GetSuccessors = successors

End Function

Sub DisplayCriticalPath()

Dim output As String: output = "🔗 Critical Path:" & vbCrLf

Dim i As Integer

For i = 1 To 9

If phases(i).Float = 0 Then

output = output & "- " & phases(i).Name & vbCrLf

End If

Next i

MsgBox output, vbInformation, "Critical Path"

End Sub

**🧠 What This Module Supports**

* **Activity Network Logic:** Precedent-based scheduling
* **Logigramme Mapping:** Float and critical path identification
* **Audit-Ready Export:** Modular structure for credential linkage
* **Visual Basic Integration:** Can be embedded in Excel or Word for engineering dashboards

Would you like this extended to include graphical output, bilingual export, or integration with your credential-linked record books and public service dashboards?

**You said**

overview scoped description key o National Qualications 2025 X823/77/11 AH Engineering Science FRIDAY, 16 MAY 1:00 PM – 3:30 PM Total marks — 75 You may refer to the Advanced Higher Engineering Science Data Booklet. SECTION 1 — 35 marks Attempt ALL questions. SECTION 2 — 40 marks Attempt ALL questions. Write your answers clearly in the answer booklet provided. In the answer booklet, you must clearly identify the question number you are attempting. For questions 1 (a), 2, 4 (a), 10 (c) and 10 (d), write your answers clearly in the worksheets provided in the answer booklet. Show all working and units where appropriate. The number of significant figures expressed in a final answer should be equivalent to the least significant data value given in the question. Answers that have two more figures or one less figure than this will be accepted. Use blue or black ink. Sketches, diagrams and graphs may be drawn in pencil. Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper. B/SQA [BLANK PAGE] DO NOT WRITE ON THIS PAGE page 02 page 03 MARKS SECTION 1 — 35 marks Attempt ALL questions 1. A capital project is divided into several phases, A to I. The precedents for each phase and the planned duration of each phase are detailed in the precedence table below. Phase Stage Precedent Duration (months) Feasibility A -- 4 Planning B A 4 Procurement C A 8 Recruitment D B, C 2 Groundwork E B, C 9 Utilities F D, E 7 Main build G E 5 Commissioning H G 3 Handover I F, H 1 (a) Using the precedence table and the worksheet for question 1 (a): (i) complete the activity network diagram by adding precedence arrows to stages D to G (ii) add the latest finish time, the latest start time, and the float for each of stages D to G (iii) identify the critical path. Project Management includes five main process groups, one of which is the Project Planning phase. This may involve the following steps: • estimate budget • estimate resources required • anticipate risks on time. (b) Explain what a Project Manager would do in one of these steps. [Turn over 1 3 1 2 page 04 MARKS 2. A simply supported beam is loaded with two point loads and a uniformly distributed load, as shown below. 30.0 kNm−1 20.0 kN 20.0 kN 0.60 m 1.20 m A B 1.20 m On the worksheet for question 2, draw the shear force diagram for the beam under the applied loads. 3. Traditional power stations are designed solely to produce work (to generate electricity). A Combined Heat and Power (CHP) plant is designed to provide useful work and heat. The energy audit for a CHP plant is shown below. The overall efficiency of the plant is 82%, and the ratio of useful heating power to useful electrical power is 5:3. input power from fuel 305 MW CHP plant wasted power useful electrical power useful heating power Calculate the efficiency of the CHP plant for electricity generation. 5 3 page 05 MARKS 4. A simplified electricity supply line diagram is shown below. large industrial customers domestic customers A C D B (a) Identify the electricity supply line components that symbols A, B, C and D represent by placing each letter next to the correct component in the table on the worksheet for question 4 (a). (b) Describe the function of: (i) a busbar (ii) a circuit breaker. [Turn over 2 1 1 page 06 MARKS 5. A student builds a 4-bit digital to analogue convertor (DAC). The circuit is shown below. Vout +Vcc −Vcc +Vcc −Vcc R3 R2 R1 R0 16 kΩ 15 kΩ 15 kΩ + − + − 0 V LSB digital inputs MSB Circuit specifications: Logic 1 = 5.0 V Logic 0 = 0 V Vout = +10.0 V when digital input is 1111LSB (a) State the purpose of the inverting amplifier within the DAC circuit. (b) State the number of different digital input combinations that this configuration of DAC will accept. (c) Calculate required resistor values R0, R1, R2 and R3. 1 1 3 page 07 MARKS 6. A student is testing a Wien bridge oscillator. The circuit is shown below. R1 680 Ω 20 kΩ 680 Ω Vout +Vcc −Vcc + − 0 V 5.6 μF 5.6 μF The 680 Ω resistors have a 1% tolerance and the 5.6 µF capacitors have a 5% tolerance. (a) Calculate the highest possible frequency at which this circuit would be expected to oscillate when tested. (b) State the value of R1 that will produce and maintain a stable amplitude sine wave. The student tested their circuit but selected an incorrect value for R1. The output waveform the circuit produced is shown below. time Vout (c) State whether too large or too small a value of R1 has been used. [Turn over 2 1 1 page 08 MARKS 7. A 102 kg person stands in the middle of a paddleboard. The board is 2.5 m long and is made from polystyrene, with a Young’s Modulus of 3.25 GN m−2. To determine deflection, the board can be modelled as two rectangular cross-section cantilever beams with a uniformly distributed load (UDL) applied due to the water buoyancy force, acting symmetrically about a central point load to balance the person’s weight. ω Nm−1 W L L1 2 (a) Calculate the magnitude of the UDL, ω Nm−1, required to balance the weight, W, of the person. The board is assumed to have a constant rectangular cross-section of breadth 690 mm and thickness 75 mm. (b) Calculate the deflection of the free end of the board in relation to its centre. 1 3 page 09 MARKS 8. A stair lift carries a person between two floors (floor 1 and floor 2) of a house. During the design of a microcontroller-based control system for this stair lift, a student needs to produce an 8-bit variable, called ‘flag’, containing the logical state of the five input switches connected to pins 2–6 of the data port. Pins 7, 1 and 0 are used as outputs and should be set to zero in the variable ‘flag’. INPUT PORT OUTPUT 7 Emergency 6 Call floor 1 5 Call floor 2 4 Floor 1 limit switch 3 Floor 2 limit switch 2 1 0 The student sets the PORT register to the binary value 11111111, so that the required value of ‘flag’ becomes binary value 01111100. The student tests three commands that perform bitwise logic between two registers: PBASIC (1) flag = PORTB | %01111100 (bitwise OR) (2) flag = PORTB & %01111100 (bitwise AND) (3) flag = PORTB ^ %01111100 (bitwise XOR) ARDUINO (1) flag = PORTD | 0b01111100 (bitwise OR) (2) flag = PORTD & 0b01111100 (bitwise AND) (3) flag = PORTD ^ 0b01111100 (bitwise XOR) Note that 00110000 | 01010000 gives the result 01110000, where numbers are binary. Determine which of the three commands should be used, stating the binary value of ‘flag’ that results in each case. [Turn over 3 page 10 SECTION 2 — 40 marks Attempt ALL questions 9. An image of an industrial tumble dryer is shown below. An electric motor rotates the drum in either direction via a belt drive, as shown below. bearing A bearing B drum motor belt driven pulley drive pulley The diagram below shows the external f

**Copilot said**

Here’s a scoped overview and modular description of the 2025 Advanced Higher Engineering Science exam (Paper X823/77/11), tailored for audit-ready documentation, logigramme mapping, and credential-linked analysis.

**🧠 Overview: AH Engineering Science 2025**

| **Exam Code** | **X823/77/11** |
| --- | --- |
| **Level** | Advanced Higher |
| **Subject** | Engineering Science |
| **Date** | Friday, 16 May 2025 |
| **Time** | 1:00 PM – 3:30 PM |
| **Total Marks** | 75 |
| **Sections** | Section 1 (35 marks), Section 2 (40 marks) |
| **Resources** | Data Booklet allowed |
| **Format** | Answer booklet + worksheets for selected questions |

**📦 Scoped Description by Section**

**🔹 Section 1 — 35 Marks (Attempt ALL)**

| **Q#** | **Topic** | **Key Skills** |
| --- | --- | --- |
| 1 | Project Management | Activity network diagram, float, critical path, planning steps |
| 2 | Structural Analysis | Shear force diagram for beam with UDL and point loads |
| 3 | Energy Systems | CHP efficiency calculation (electrical vs thermal) |
| 4 | Electrical Supply | Component identification, busbar and circuit breaker functions |
| 5 | DAC Circuit | Amplifier role, binary input combinations, resistor calculations |
| 6 | Wien Oscillator | Frequency tolerance, R1 value for stable output, waveform diagnosis |
| 7 | Structural Deflection | UDL calculation, cantilever beam deflection using Young’s Modulus |
| 8 | Microcontroller Logic | Bitwise operations (OR, AND, XOR), binary flag manipulation |

**🔹 Section 2 — 40 Marks (Attempt ALL)**

| **Q#** | **Topic** | **Key Skills** |
| --- | --- | --- |
| 9 | Mechanical Systems | Reaction force at bearing, belt drive geometry |
| 10 | (Worksheet-based) | Likely includes advanced calculations or diagrams (e.g. stress, control systems) |

**🔑 Key Operational Notes**

* **Worksheets Required:** Questions 1(a), 2, 4(a), 10(c), 10(d)
* **Significant Figures:** Final answers must match least significant data value
* **Ink Usage:** Blue or black ink; diagrams/sketches in pencil
* **Submission Protocol:** Answer booklet must be handed to Invigilator

**🔄 Logigramme Mapping (for Q1(a))**

| **Phase** | **Precedents** | **Duration (months)** |
| --- | --- | --- |
| A (Feasibility) | — | 4 |
| B (Planning) | A | 4 |
| C (Procurement) | A | 8 |
| D (Recruitment) | B, C | 2 |
| E (Groundwork) | B, C | 9 |
| F (Utilities) | D, E | 7 |
| G (Main Build) | E | 5 |
| H (Commissioning) | G | 3 |
| I (Handover) | F, H | 1 |

This structure supports:

* **Activity Network Diagrams**
* **Float and Critical Path Analysis**
* **Visual Basic automation for scheduling logic**

Would you like this formatted into a bilingual dashboard, exported for credential-linked record books, or integrated with your modular audit sheets and digital certificate inspection logic?

**You said**

NAH\_Engineering-Science\_QP\_2025.pdf

PDF

**Copilot said**

Here’s a scoped overview and modular breakdown of the 2025 Advanced Higher Engineering Science paper (X823/77/11), optimized for logigramme mapping, Visual Basic automation, and credential-linked audit documentation.

**🧠 Overview: AH Engineering Science 2025**

| **Exam Code** | **X823/77/11** |
| --- | --- |
| **Level** | Advanced Higher |
| **Subject** | Engineering Science |
| **Date** | Friday, 16 May 2025 |
| **Time** | 1:00 PM – 3:30 PM |
| **Total Marks** | 75 |
| **Sections** | Section 1 (35 marks), Section 2 (40 marks) |
| **Resources** | Data Booklet allowed |
| **Format** | Answer booklet + worksheets for Q1(a), Q2, Q4(a), Q10(c), Q10(d) |

**📦 Scoped Description by Section**

**🔹 Section 1 — 35 Marks**

| **Q#** | **Topic** | **Key Skills** |
| --- | --- | --- |
| 1 | Project Management | Activity network diagram, float, critical path, planning steps |
| 2 | Structural Analysis | Shear force diagram for beam with UDL and point loads |
| 3 | Energy Systems | CHP efficiency calculation (electrical vs thermal) |
| 4 | Electrical Supply | Component identification, busbar and circuit breaker functions |
| 5 | DAC Circuit | Amplifier role, binary input combinations, resistor calculations |
| 6 | Wien Oscillator | Frequency tolerance, R1 value for stable output, waveform diagnosis |
| 7 | Structural Deflection | UDL calculation, cantilever beam deflection using Young’s Modulus |
| 8 | Microcontroller Logic | Bitwise operations (OR, AND, XOR), binary flag manipulation |

**🔹 Section 2 — 40 Marks**

| **Q#** | **Topic** | **Key Skills** |
| --- | --- | --- |
| 9 | Mechanical Systems | Bearing reaction, belt drive power, friction analysis, PWM power dissipation, AC–DC conversion, Schmitt trigger design |
| 10 | Crane Arm Design | Ixx calculation, stress ratio, bending moment diagram, amplifier Q-point, resistor selection, servo control logic, ADC resolution, duty cycle calculation |

**🔑 Key Operational Notes**

* **Worksheets Required:** Q1(a), Q2, Q4(a), Q10(c), Q10(d)
* **Significant Figures:** Final answers must match least significant data value
* **Ink Usage:** Blue or black ink; diagrams/sketches in pencil
* **Submission Protocol:** Answer booklet must be handed to Invigilator

**🔄 Logigramme Mapping (Q1(a) Example)**

| **Phase** | **Precedents** | **Duration (months)** |
| --- | --- | --- |
| A (Feasibility) | — | 4 |
| B (Planning) | A | 4 |
| C (Procurement) | A | 8 |
| D (Recruitment) | B, C | 2 |
| E (Groundwork) | B, C | 9 |
| F (Utilities) | D, E | 7 |
| G (Main Build) | E | 5 |
| H (Commissioning) | G | 3 |
| I (Handover) | F, H | 1 |

This structure supports:

* **Activity Network Diagrams**
* **Float and Critical Path Analysis**
* **Visual Basic automation for scheduling logic**
* **Credential-linked dashboards and audit-ready export**

Would you like me to generate a Visual Basic module that automates the float and critical path logic for this paper, or scaffold a bilingual dashboard for modular credential tracking?

**You said**

scope description overview , visual basic code 2940 Results HNC/HND Electrical Engineering - SQA https://www.sqa.org.uk/sqa/25479.html Information to support the delivery of HNC/HND Electrical Engineering. Electrical Engineering Principles (SCQF level 7) https://www.sqa.org.uk/files\_ccc/j6cw-47-electrical-engineering-principles.pdf Advanced Certificate/Diploma Electrical Engineering - SQA https://www.sqa.org.uk/sqa/90938.html Information to support the delivery of SQA Advanced Certificate/Diploma Electrical Engineering Electrical Engineering: Practical Skills SCQF level 7 https://www.sqa.org.uk/files\_ccc/j6d6-47-electrical-engineering-practical-skills.pdf Process Engineering Maintenance (Electrical) SCQF level 7 - SQA https://www.sqa.org.uk/sqa/96758.html Information to support the delivery of SVQ Process Engineering Maintenance (Electrical) SCQF level 7 Electrical Engineering: Utilisation of Electrical Power, Transmission Lines and Complex Waves (SCQF https://www.sqa.org.uk/files\_ccc/j7bv-48-electrical-engineering-utilisation-electrical-power-transmission-lines-complex-waves.pdf NC Electrical Engineering SCQF levels 5 and 6 - SQA https://www.sqa.org.uk/sqa/38568.html Information to support the delivery of NC Electrical Engineering SCQF levels 5 and 6 Building Services Engineering National 4 (SCQF level 4) - SQA https://www.sqa.org.uk/sqa/74562.html National 4 Skills for Work: Building Services Engineering teaches essential skills for careers in HVAC, plumbing, and electrical services HN Engineering - SQA https://www.sqa.org.uk/sqa/25476.html Find links to qualifications in HN Engineering Skills for work Engineering Skills - SQA https://www.sqa.org.uk/sqa/31441.html Skills for work Engineering Skills focuses on the four broad areas of Mechanical, Electrical/Electronic, Fabrication, and Manufacture. Home HNCs and HNDs > HN Subjects > Engineering > HNC/HND Electrical Engineering HNC/HND Electrical Engineering The HNC and HND Electrical Engineering awards develop the candidates' ability to apply analysis and synthesis skills to the solution of electrical engineering problems and their knowledge, understanding and skills in a range of core electrical principles, electrical power systems, electrical machine principles and electrical safety at Higher National level. The awards allow the candidate to achieve a degree of specialisation within the following areas: Electrical Principles Information Technology Three Phase Induction Motors Power Electronics Inspection and Testing of Low Voltage Electrical Installations Programmable Logic Controllers Electrical Systems in Hazardous Environments Control Systems Further Mathematical studies Electrical Installation Skills Engineering Quality. In particular the HND allows the candidate to achieve a degree of specialisation within the following areas: Inspection and Testing of Low Voltage Installations Programmable Logic Controllers Electrical Systems in Hazardous Environments Analogue and Digital Electronics Quality Management Electrical Installation Skills Industrial Plant Maintenance Synchronous Machines Electrical Motor Drive Systems Three Phase Induction Motors High Level Engineering Software Additional Control Systems studies Power Supply Circuits Switchgear and Protection Standby Systems Electrical Installation Design: Computer Aided Advanced Mathematical studies Use the tabs below to open each section individually. Alternatively you can show all the sections. Who does this qualification suit Where can you take this course? Group Award Specification Qualification Verification Summary ReportsNext Generation Higher National Unit Specification Electrical Engineering Principles (SCQF level 7) Unit code: J6CW 47 SCQF level: 7 (24 SCQF credit points) Valid from: session 2024–2025 Prototype unit specification for use in pilot delivery only (version 4.0) October 2024 This unit specification provides detailed information about the unit to ensure consistent and transparent assessment year on year. This unit specification is for teachers and lecturers and contains all the mandatory information required to deliver and assess the unit. The information in this unit specification may be reproduced in support of SQA qualifications only on a non-commercial basis. If it is reproduced, SQA must be clearly acknowledged as the source. If it is to be reproduced for any other purpose, written permission must be obtained from permissions@sqa.org.uk. This edition: October 2024 (version 4.0) © Scottish Qualifications Authority 2022, 2023, 2024 NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 1 Unit purpose This unit provides learners with the knowledge, skills and understanding required to analyse electrical circuits, including electrical theorems, covering: ♦ DC principles ♦ single-phase AC principles ♦ three-phase principles ♦ electrostatics and electromagnetics It gives them the opportunity to expand their knowledge of electrical engineering into other areas. It also provides knowledge to support their progression to the Electrical Power and Drive Systems unit at SCQF level 7. The target group for this unit is learners who want to develop knowledge and skills in using electrical theories and concepts, to support a career in electrical engineering. Entry is at your centre’s discretion. However, we recommend that learners have knowledge and understanding of electrical circuits and/or mathematical concepts before they begin. This unit provides learners with suitable knowledge and skills to progress to employment in a wide range of engineering jobs requiring electrical knowledge, technical apprenticeships, or further study. NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 2 Unit outcomes Learners who complete this unit can: 1 demonstrate knowledge and understanding of DC principles 2 demonstrate knowledge and understanding of single-phase AC principles 3 demonstrate knowledge and understanding of three-phase principles 4 demonstrate knowledge and understanding of electrostatics and electromagnetics Evidence requirements All outcomes can be assessed holistically using product, written and/or oral recorded evidence. Learners generate evidence under controlled or supervised, open-book conditions, and it must be authenticated as being all their own work. The evidence must contain a mix of knowledge and skills items that matches the evidence requirements of the unit, and include various forms of evidence, such as: ♦ assignments ♦ case studies ♦ reports ♦ essays ♦ simulations ♦ structured controlled tests ♦ practical evidence ♦ other relevant sources of evidence Where sampling is indicated, you must teach all content in the ‘Knowledge and skills’ section and it must be available for assessment. Learners should not know which items they will be assessed on in advance. You must use a different sample for each assessment occasion. Outcome 1 Sample any three of the five required items: ♦ Solve electrical engineering problems using Ohm’s and Kirchhoff's laws. ♦ Solve electrical engineering problems using Thevenin's and Norton’s theorems in DC circuits. ♦ Solve electrical engineering problems using superposition theorem. ♦ Solve electrical engineering problems using maximum power transfer theorem in DC circuits. ♦ Demonstrate an understanding of DC transients for CR and LR circuits. NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 3 Outcome 2 Sample any three of the five required items: ♦ Analyse RL, RC and RLC electrical circuits using complex notation. ♦ Solve power factor improvement problems. ♦ Solve electrical engineering problems using Thevenin’s and Norton’s theorems in single-phase AC circuits. ♦ Solve electrical engineering problems using maximum power transfer theorem in single-phase AC circuits. ♦ Solve problems involving resonating passive circuits. Outcome 3 Sample any four of the six required items: ♦ Describe the construction of a three-phase generator. ♦ Explain the advantages of using a three-phase system. ♦ Solve electrical engineering problems for balanced star-connected loads and balanced delta-connected loads. ♦ Draw phasor diagrams for balanced three-phase loads. ♦ Solve electrical engineering problems for unbalanced star-connected loads and unbalanced delta-connected loads. ♦ Demonstrate an understanding of power in three-phase systems. Outcome 4 Sample any three of the four required items: ♦ Demonstrate an understanding of electrostatic fields. ♦ Solve electrical engineering problems for capacitor networks. ♦ Demonstrate an understanding of magnetic fields. ♦ Solve electrical engineering problems for self and mutual inductance. NextGen: HN published prototype unit specification for use in pilot delivery only (version 2.0) October 2024 4 Knowledge and skills The following table shows the knowledge and skills covered by the unit outcomes: Knowledge Skills Outcome 1 Learners should understand how to: ♦ define the mechanical properties of materials ♦ compare and contrast types of materials ♦ describe structure of materials ♦ identify the selection and application of materials based on their properties ♦ describe heat treatment processes ♦ identify and explain material testing processes ♦ describe the environmental impact of materials Outcome 1 Learners can: ♦ identify properties of materials ♦ perform heat treatment ♦ perform material testing Outcome 2 Learners should understand how to: ♦ describe manufacturing processes ♦ determine the sequence of operations for the manufacture of a range of components ♦ select and

**Copilot said**

Here’s a scoped overview, modular description, and Visual Basic code framework tailored to the SQA Electrical Engineering Principles (SCQF Level 7) unit (J6CW 47), aligned with your curriculum mapping, credential-linked dashboards, and logigramme logic.

**🧠 Overview: Electrical Engineering Principles (SCQF Level 7)**

| **Unit Code** | **J6CW 47** |
| --- | --- |
| **SCQF Level** | 7 |
| **Credit Points** | 24 |
| **Valid From** | 2024–2025 (Prototype v4.0) |
| **Target Group** | Learners pursuing careers in electrical engineering, apprenticeships, or further study |
| **Delivery Mode** | Open-book, supervised, holistic assessment |
| **Progression Path** | Electrical Power and Drive Systems (SCQF Level 7) |

**📦 Scoped Description by Outcome**

**🔹 Outcome 1: DC Principles**

* Ohm’s and Kirchhoff’s laws
* Thevenin’s and Norton’s theorems
* Superposition theorem
* Maximum power transfer
* DC transients (CR and LR circuits)

**🔹 Outcome 2: Single-Phase AC Principles**

* RL, RC, RLC circuits (complex notation)
* Power factor improvement
* Thevenin/Norton in AC
* Resonance in passive circuits

**🔹 Outcome 3: Three-Phase Principles**

* Generator construction
* Star/delta load analysis (balanced/unbalanced)
* Phasor diagrams
* Power in three-phase systems

**🔹 Outcome 4: Electrostatics & Electromagnetics**

* Electrostatic fields
* Capacitor networks
* Magnetic fields
* Self/mutual inductance

**🔄 Modular Knowledge & Skills Mapping**

| **Knowledge** | **Skills** |
| --- | --- |
| Electrical theorems, circuit analysis, field theory | Solve circuit problems, draw diagrams, apply laws |
| Material properties, heat treatment, testing | Identify, compare, apply, and test materials |
| Manufacturing processes, sequencing | Select operations, simulate production logic |

**🧩 Visual Basic Code: Modular Assessment Tracker**

vb

' Module: SQA\_ElectricalPrinciples\_Tracker

' Purpose: Automate unit outcome tracking, theorem sampling, and logigramme-style progress mapping

Option Explicit

Type Outcome

Title As String

SampleItems() As String

CompletedItems() As Boolean

End Type

Dim outcomes(1 To 4) As Outcome

Sub InitializeOutcomes()

outcomes(1).Title = "DC Principles"

outcomes(1).SampleItems = Split("Ohm/Kirchhoff,Thevenin/Norton,Superposition,Max Power Transfer,DC Transients", ",")

outcomes(2).Title = "Single-Phase AC"

outcomes(2).SampleItems = Split("RL/RC/RLC,Power Factor,AC Theorems,Max Power Transfer,Resonance", ",")

outcomes(3).Title = "Three-Phase Systems"

outcomes(3).SampleItems = Split("Generator,Advantages,Star/Delta Balanced,Phasors,Star/Delta Unbalanced,Power", ",")

outcomes(4).Title = "Electrostatics & Magnetics"

outcomes(4).SampleItems = Split("Electrostatic Fields,Capacitor Networks,Magnetic Fields,Inductance", ",")

End Sub

Sub DisplayOutcomeProgress()

Dim i As Integer, j As Integer, output As String

output = "📘 Electrical Engineering Principles Progress:" & vbCrLf

For i = 1 To 4

output = output & vbCrLf & "Outcome " & i & ": " & outcomes(i).Title & vbCrLf

For j = LBound(outcomes(i).SampleItems) To UBound(outcomes(i).SampleItems)

output = output & "- " & outcomes(i).SampleItems(j)

If outcomes(i).CompletedItems(j) = True Then

output = output & " ✅"

End If

output = output & vbCrLf

Next j

Next i

MsgBox output, vbInformation, "Unit Outcome Tracker"

End Sub

Sub MarkItemComplete(outcomeIndex As Integer, itemIndex As Integer)

outcomes(outcomeIndex).CompletedItems(itemIndex) = True

MsgBox "Marked '" & outcomes(outcomeIndex).SampleItems(itemIndex) & "' as complete.", vbInformation

End Sub

**🔧 Use Cases**

* ✅ Track learner progress across sampled items
* 📊 Generate logigramme-style dashboards for audit and credential export
* 🧮 Integrate with SCQF credit mapping and modular record books
* 🌍 Support bilingual export and registry assurance

Would you like this extended to include graphical dashboards, export logic, or integration with your credential-linked frameworks and public service submission templates?

**You said**

description overview visual code NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 8 Additional guidance The guidance in this section is not mandatory. Content and context for this unit This unit gives learners some of the knowledge and skills they need to support a career in electrical engineering. Demonstrate knowledge and understanding of DC principles (outcome 1) Introduces learners to circuit techniques to analyse DC circuits. You could start with knowledge and understanding of resistance, capacitance, inductance, voltage, current and power and their relationship in series and parallel, including ohms law and Kirchhoff's law. Following this, you could introduce more complex analysis theorems in superposition, such as Thevenin's, Norton’s and maximum power transfer. Demonstrate knowledge and understanding of single-phase AC principles (outcome 2) This helps learners apply their knowledge from outcome 1 to AC principles. You should cover inductive reactance, capacitive reactance and impedance to help them understand AC circuits. Support learners with complex notation so they can analyse RL, RC and RLC circuits before you introduce apparent, active and reactive power. You should continue with power factor correction. If you combine AC circuits with the theorems from outcome 1 (Thevenin's, Norton’s and maximum power transfer), this gives learners good knowledge and understanding of analysing AC circuits. Finally, cover knowledge and understanding of resonating passive circuits, including resonating frequency, dynamic impedance, bandwidth, Q-factor impedance/frequency and current/frequency graphs for RL, RC and RLC circuits. Demonstrate knowledge and understanding of three-phase principles (outcome 3) Develops learners’ knowledge and understanding of three-phase generators, including: ♦ the advantages of using three-phase over single-phase ♦ the relationship between phase and line voltage and current for star and delta configuration ♦ calculating phase and line voltages and currents for star and delta configuration in both balanced and unbalanced loads ♦ calculating the current in the neutral wire of an unbalanced load supplied by three-phase four wire supply ♦ calculating the potential difference between the load star point and the supply star point for an unbalanced star-connected load supplied by a three-phase three wire supply ♦ knowledge and understanding of active, reactive and apparent power and power factor in a three-phase system ♦ knowledge and understanding of measuring power including one-, two- and three-watt meter methods NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 9 Demonstrate knowledge and understanding of electrostatics and electromagnetics (outcome 4) Introduces electrostatics, to give learners knowledge and understanding of: ♦ charge ♦ electromotive force ♦ electric field strength ♦ electric flux density ♦ capacitance By continuing with electromagnetics, this gives them knowledge and understanding of: ♦ mmf ♦ flux ♦ reluctance ♦ induced EMF and current ♦ leakage ♦ magnetic losses ♦ pulsating and rotating EMFs ♦ self and mutual inductance Approaches to delivery We suggest learners complete outcomes 1 and 2 first. They can do this in order or concurrently, as some of the theorems apply to DC and AC. You can deliver outcomes 3 and 4 in any order. You should deliver the outcomes in a learning space or VLE and primarily use problem-based learning (PBL) techniques, such as case studies and mini projects, supported by other methods. The holistic format of PBL encourages learners to consider the deeper context of the theory. Approaches to assessment In line with the approach to delivery, you should take a holistic approach to assessment. This consists of a review of case study reports and mini projects. Learners should generate evidence under controlled or supervised, open-book conditions and collate it in their individual portfolio. They should demonstrate evidence of all knowledge and skills in the context of one or more overarching complex electrical engineering scenarios. For case studies and mini projects, you can assess knowledge and skills through coursework exercises. Learners must produce product evidence (for example, in the form of a coursework report) that they compile under controlled or supervised, open-book conditions. NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 10 Learners could keep a linear reflective account to measure their meta-skills, digital literacies, professional skills, and wider employer-desired skills, and record this in their personal portfolio. You should provide learners with support, guidance and feedback on areas of development, and signpost developmental opportunities. Because of the open-book nature of the assessment, you must take care to ensure authenticity. You could do this by using variable values in the coursework, making use of oral questioning and using originality-checking software, as appropriate. Opportunities for e-assessment Assessment that is supported by information and communication technology (ICT), such as e-testing or the use of e-portfolios or social software, may be appropriate for some assessments in this unit. If you want to use e-assessment, you must ensure that you apply the national standard to all evidence and that conditions of assessment (as specified in the evidence requirements) are met, regardless of the mode of gathering evidence. NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 11 Equality and inclusion This unit is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment. You should take into account the needs of individual learners when planning learning experiences, selecting assessment methods or considering alternative evidence. Guidance on assessment arrangements for disabled learners and/or those with additional support needs is available on the assessment arrangements web page: www.sqa.org.uk/assessmentarrangements. NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 12 Information for learners Electrical Engineering Principles (SCQF level 7) This information explains: ♦ what the unit is about ♦ what you should know or be able to do before you start ♦ what you need to do during the unit ♦ opportunities for further learning and employment Unit information This unit provides you with knowledge and skills specific to electrical engineering. It is part of the HNC in Engineering, which is for learners who wish to become engineering technicians. Before starting this unit, we recommend that you have knowledge and understanding of electrical circuits and/or mathematical concepts. For example, you may have achieved: ♦ National Certificate (NC) in Electrical Engineering (SCQF level 6) ♦ Higher Physics ♦ Electrical Principles unit at SCQF 6 In outcomes 1 and 2, you cover the basic concepts of DC and AC circuits before moving on to more complex analysis techniques. You also learn how to solve electrical problems of AC circuits using complex notation. In outcome 3 you are introduced to three-phase systems, where you learn the reasons why industry prefers these, before you analyse star and delta configurations. In outcome 4 you look at electrostatics, covering capacitors and charge in an electrical circuit. Finally, you move on to electromagnetics, which helps you to understand transformers content covered in the Electrical Power and Drive Systems unit at SCQF level 7. You are assessed in different ways, including the review of case study reports and mini projects. You should collate all evidence in your individual portfolio. There is a holistic approach to assessment, where you demonstrate evidence of all knowledge and skills in the context of one or more overarching electrical engineering scenarios. On completion of this unit, you can demonstrate knowledge and understanding of: ♦ DC principles ♦ single-phase AC principles ♦ three-phase principles ♦ electrostatics and electromagnetics NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 13 Meta-skills Throughout the unit, you develop meta-skills to enhance your employability in the engineering sector. Meta-skills include self-management, social intelligence and innovation. Self-management You develop the skills of focusing, adapting and initiative as you study the course material. Social intelligence You develop your communication and collaboration skills as you work with other learners on activities. Innovation You develop the skills of curiosity, sense-making and critical thinking when carrying out learning activities and projects either individually or in groups. NextGen: HN published prototype unit specification for use in pilot delivery only (version 4.0) October 2024 14 Administrative information Published: October 2024 (version 4.0) Superclass: XJ History of changes Version Description of change Date 2.0 ♦ Additional wording in ‘Evidence requirements’ to clarify sampling. ♦ ‘Ohm’s law’ added to outcome 1 evidence requirements. ♦ Changed ‘section’ to ‘information’ in ‘Information for learners’ section for consistency across units. ♦ Recommend entry requirements in ‘Information for learners’ section amended for clarity and accuracy. August 2023 3.0 Additional wording to clarify conditions of assessment. August 2024 4.0 Approaches to assessment updated. October 2024 Note: please check SQA’s website to ensure you are using the most up-to-date version of this document. © Scottish Qualifications Authority 2022, 2023, 2024

**Copilot said**

Here’s a scoped overview, modular description, and Visual Basic code framework tailored to the NextGen: HN Electrical Engineering Principles (SCQF Level 7) unit (version 4.0, October 2024). This supports your goals in credential-linked dashboards, logigramme logic, and audit-ready documentation.

**🧠 Overview: Electrical Engineering Principles (SCQF Level 7)**

| **Unit Code** | **J6CW 47** |
| --- | --- |
| **SCQF Level** | 7 |
| **Credit Points** | 24 |
| **Delivery Mode** | Pilot (NextGen HN v4.0) |
| **Assessment Format** | Holistic, open-book, portfolio-based |
| **Meta-Skills Developed** | Self-management, social intelligence, innovation |
| **Recommended Entry** | NC Electrical Engineering (SCQF 6), Higher Physics, Electrical Principles SCQF 6 |

**📦 Modular Description by Outcome**

**🔹 Outcome 1: DC Principles**

* Ohm’s Law, Kirchhoff’s Laws
* Thevenin’s, Norton’s, Superposition, Max Power Transfer
* DC transients in CR and LR circuits

**🔹 Outcome 2: Single-Phase AC Principles**

* RL, RC, RLC circuits (complex notation)
* Power factor, active/reactive/apparent power
* Resonance: frequency, Q-factor, impedance/current graphs

**🔹 Outcome 3: Three-Phase Principles**

* Generator construction and advantages
* Star/delta configurations (balanced/unbalanced)
* Neutral current, star point voltage difference
* Power measurement: 1-, 2-, 3-wattmeter methods

**🔹 Outcome 4: Electrostatics & Electromagnetics**

* Electrostatics: charge, EMF, field strength, flux, capacitance
* Electromagnetics: mmf, flux, reluctance, induced EMF, leakage, losses, rotating EMFs, inductance

**🧩 Visual Basic Code: Modular Outcome Tracker & Logigramme Mapper**

vb

' Module: ElectricalPrinciples\_OutcomeTracker

' Purpose: Track learner progress across outcomes, support logigramme mapping and credential-linked export

Option Explicit

Type LearningOutcome

Title As String

Topics() As String

Completed() As Boolean

End Type

Dim outcomes(1 To 4) As LearningOutcome

Sub InitializeOutcomes()

outcomes(1).Title = "DC Principles"

outcomes(1).Topics = Split("Ohm's Law,Kirchhoff's Laws,Thevenin's Theorem,Norton's Theorem,Superposition,Max Power Transfer,DC Transients", ",")

outcomes(2).Title = "Single-Phase AC"

outcomes(2).Topics = Split("RL/RC/RLC Circuits,Power Factor,AC Theorems,Resonance,Q-Factor,Impedance Graphs", ",")

outcomes(3).Title = "Three-Phase Systems"

outcomes(3).Topics = Split("Generator Construction,Star/Delta Balanced,Star/Delta Unbalanced,Neutral Current,Star Point Voltage,Power Measurement", ",")

outcomes(4).Title = "Electrostatics & Magnetics"

outcomes(4).Topics = Split("Charge,EMF,Field Strength,Flux,Capacitance,MMF,Reluctance,Inductance,Losses", ",")

End Sub

Sub DisplayProgress()

Dim i As Integer, j As Integer, output As String

output = "📘 Electrical Engineering Principles Progress Tracker:" & vbCrLf

For i = 1 To 4

output = output & vbCrLf & "Outcome " & i & ": " & outcomes(i).Title & vbCrLf

For j = LBound(outcomes(i).Topics) To UBound(outcomes(i).Topics)

output = output & "- " & outcomes(i).Topics(j)

If outcomes(i).Completed(j) = True Then

output = output & " ✅"

End If

output = output & vbCrLf

Next j

Next i

MsgBox output, vbInformation, "Outcome Progress"

End Sub

Sub MarkTopicComplete(outcomeIndex As Integer, topicIndex As Integer)

outcomes(outcomeIndex).Completed(topicIndex) = True

MsgBox "Marked '" & outcomes(outcomeIndex).Topics(topicIndex) & "' as complete.", vbInformation

End Sub

**🔧 Use Cases**

* ✅ Track learner progress across sampled topics
* 📊 Generate logigramme-style dashboards for audit and credential export
* 🧮 Integrate with SCQF credit mapping and modular record books
* 🌍 Support bilingual export and registry assurance
* 🧠 Scaffold meta-skills tracking via reflective logs and portfolio integration

Would you like this extended to include graphical dashboards, export logic, or integration with your credential-linked frameworks and public service submission templates?

**You said**

over view scope description visual basic code Home SQA Advanced Certificates and Diplomas > Subjects > Engineering, Electronics, Maritime and Nautical > SQA Advanced Certificate/Diploma Electrical Engineering SQA Advanced Certificate/Diploma Electrical Engineering SQA Advanced Certificate and SQA Advanced Diploma qualifications provide practical skills and theoretical knowledge that meet the needs of employers. The SQA Advanced Certificate in Electrical Engineering at SCQF 7 covers areas such as: Electrical Principles Information Technology Three Phase Induction Motors Power Electronics Inspection and Testing of Low Voltage Electrical Installations Programmable Logic Controllers Electrical Systems in Hazardous Environments Control Systems Further Mathematical studies Electrical Installation Skills Engineering Quality The SQA Advanced Diploma in Electrical Engineering at SCQF 8 builds on the knowledge and skills of the SQA Advanced Certificate and covers areas such as: Inspection and Testing of Low Voltage Installations Programmable Logic Controllers Electrical Systems in Hazardous Environments Analogue and Digital Electronics Quality Management Electrical Installation Skills Industrial Plant Maintenance Synchronous Machines Electrical Motor Drive Systems Three Phase Induction Motors High Level Engineering Software Additional Control Systems studies Power Supply Circuits Switchgear and Protection Standby Systems Electrical Installation Design: Computer Aided Advanced Mathematical studies This qualification is available through a growing number of colleges, training providers and universities around the world. Typically, an SQA Advanced Certificate takes one year to complete and an SQA Advanced Diploma takes two years. Use the tabs below to open each section individually. Alternatively you can show all the sections. Why deliver this qualification SQA Advanced Certificates and SQA Advanced Diplomas have been developed by SQA in partnership with colleges, universities and industry — so employers recognise that they provide sound evidence of ability. The unit-based structure supports flexible delivery. A unit is typically 40 hours of timetabled learning. There is a wide choice of optional units which will enable centres to offer courses tailored to meet local needs. The SQA Advanced Certificate/Diploma provides progression routes to further study (see Progression). Who does this qualification suit The SQA Advanced Certificate/Diploma in Electrical Engineering is suitable for a wide range of learners including: school leavers adult returners to education learners in employment who wish to enhance their career prospects Access As with all SQA qualifications, entry is at the discretion of the centre. Suitable formal entry qualifications include: SQA Advanced Certificate One Higher from Physics, Engineering Science or Higher Mathematics, and at least three National 5s including Mathematics, Physics/Engineering Science and English. National Certificate Group Award in Electrical Engineering or Electronic Engineering (SCQF level 5, plus additional maths or SCQF level 6 award Qualifications comparable to the above, gained through other awarding bodies. SQA Advanced Diploma HNC Electrical Engineering One Higher from Physics, Engineering Science or Higher Mathematics and at least three National 5s including Mathematics, Physics/Engineering Science and English. National Certificate Group Award in Electrical Engineering or Electronic Engineering (SCQF level 5 plus additional maths or SCQF level 6 award) Qualification comparable to the above, gained through other awarding bodies. Progression The SQA Advanced Certificate in Electrical Engineering can progress to the SQA Advanced Diploma in Electrical Engineering. The SQA Advanced Diploma in Electrical Engineering can provide advanced entry to degree-level study. Offer this qualification Centres with devolved authority for approval should use their own internal approval process. Centres without devolved authority require to come forward for approval and should contact SQA's Business Development Team for guidance. Assessors and verifiers must be able to meet SQA's general requirements for technical/occupational competence as outlined in the Systems and Qualification Approval Guide. How to assess Each individual unit specification gives detailed information on the evidence requirements and approaches to assessment for each unit. Ongoing course assessment will apply. Assessment/e-assessment support packs are available for this qualification. Qualification structure SQA Advanced Certificate in Electrical Engineering Group award code: GP6D 47 (96 SCQF credit points) SQA Advanced Certificate in Electrical Engineering at SCQF level 7 consists of 9 mandatory units. SQA Advanced Diploma in Electrical Engineering Group award code: GP6C 48 (240 SCQF credit points) SQA Advanced Diploma in Electrical Engineering at SCQF level 8 consists of 21 mandatory units. For further information on the structures and units of these qualifications please refer to the group award specification. Group award specification Group Award Specification (630 KB) Unit Specifications Analogue Electronic Principles (HP47 SCQF level 7) Analogue Electronics: An Introduction (HT7J SCQF level 6) Application of Electrical and Electronic Instruments (HV2H SCQF level 6) Applications of Power Electronics in Electrical Motor Drive Systems (HV50 SCQF level 8) Applications of Programmable Logic Controllers (HT1K SCQF level 7) Business Awareness and Continuing Professional Development (HP3H SCQF level 8) Communication: Practical Skills (HP4A SCQF level 7) Computer Programming (J1CH SCQF level 7) Control Systems Behaviour (HV51 SCQF level 8) DC and AC Principles (HP46 SCQF level 7) Data Security (J1S1 SCQF level 7) Digital Electronics (HT7L SCQF level 7) Electrical Design Systems: An Introduction (HV2W SCQF level 7) Electrical Engineering: Graded Unit 1 (HV4C SCQF level 7) Electrical Engineering: Graded Unit 2 (J1RC SCQF level 8) Electrical Installation Design (Computer Aided): An Introduction (HV2X SCQF level 7) Electrical Installation Design (HV5X SCQF level 8) Electrical Installation Design: Computer Aided (HV52 SCQF level 8) Electrical Installation Skills (HV3M SCQF level 7) Electrical Machine Principles (HT83 SCQF level 7) Electrical Motor Drive Systems (HT7M SCQF level 8) Electrical Networks and Resonance (HP3J SCQF level 7) Electrical Safety (HV3A SCQF level 7) Electrical Standby Systems (HV53 SCQF level 8) Electrical Systems in Potentially Explosive and Gas Hazardous Environments (HV3K SCQF level 7) Electricity Power Systems (HV3L SCQF level 7) Employment Experience 2 (HR1D SCQF level 7) Energy Overview (HT1Y SCQF level 7) Energy Technologies (HT1L SCQF level 8) Engineering Mathematics 1 (HP48 SCQF level 6) Engineering Mathematics 2 (HP49 SCQF level 7) Engineering Mathematics 3 (HT1M SCQF level 7) Engineering Mathematics 4 (HT03 SCQF level 8) Engineering Mathematics 5 (HT1N SCQF level 8) Fundamentals of Control Systems and Transducers (HT1R SCQF level 7) High Level Engineering Software (HP41 SCQF level 7) Industrial Plant Maintenance (HV2K SCQF level 7)

**Copilot said**

Here’s a structured overview, scoped description, and Visual Basic code module tailored to the SQA Advanced Certificate and Diploma in Electrical Engineering. This framework supports modular tracking, credential-linked dashboards, and audit-ready documentation aligned with SCQF levels 7 and 8.

**🧠 Overview: SQA Advanced Certificate & Diploma in Electrical Engineering**

| **Qualification** | **SCQF Level** | **Credit Points** | **Duration** |
| --- | --- | --- | --- |
| Advanced Certificate | 7 | 96 | 1 year |
| Advanced Diploma | 8 | 240 | 2 years |

These qualifications are designed to equip learners with both theoretical knowledge and practical skills across core and specialist areas in electrical engineering. They support progression to employment, HNDs, or degree-level study.

**📦 Scope: Modular Unit Domains**

**🔹 Core Domains (Certificate Level)**

* Electrical Principles
* DC and AC Principles
* Electrical Installation Skills
* Three-Phase Induction Motors
* Power Electronics
* Control Systems
* Engineering Mathematics 2 & 3
* Electrical Safety
* Programmable Logic Controllers

**🔹 Advanced Domains (Diploma Level)**

* Electrical Motor Drive Systems
* Synchronous Machines
* Electrical Systems in Hazardous Environments
* Electrical Installation Design (Computer Aided)
* Switchgear and Protection
* Power Supply Circuits
* Industrial Plant Maintenance
* High-Level Engineering Software
* Quality Management
* Advanced Mathematics (4 & 5)

**🧩 Visual Basic Code: Modular Unit Tracker**

This VBA module allows learners or instructors to track unit completion, SCQF level, and credit mapping across the Certificate and Diploma structure.

vb

' Module: SQA\_ElectricalEngineering\_Tracker

' Purpose: Track unit completion, SCQF level, and credit mapping for Advanced Certificate and Diploma

Option Explicit

Type UnitModule

Title As String

SCQFLevel As Integer

Credits As Integer

Completed As Boolean

End Type

Dim modules() As UnitModule

Sub InitializeModules()

ReDim modules(1 To 5)

modules(1).Title = "DC and AC Principles"

modules(1).SCQFLevel = 7

modules(1).Credits = 8

modules(1).Completed = False

modules(2).Title = "Electrical Installation Skills"

modules(2).SCQFLevel = 7

modules(2).Credits = 8

modules(2).Completed = False

modules(3).Title = "Programmable Logic Controllers"

modules(3).SCQFLevel = 7

modules(3).Credits = 8

modules(3).Completed = False

modules(4).Title = "Electrical Motor Drive Systems"

modules(4).SCQFLevel = 8

modules(4).Credits = 16

modules(4).Completed = False

modules(5).Title = "Engineering Mathematics 4"

modules(5).SCQFLevel = 8

modules(5).Credits = 16

modules(5).Completed = False

End Sub

Sub DisplayProgress()

Dim i As Integer, output As String

output = "📘 SQA Electrical Engineering Progress Tracker:" & vbCrLf

For i = 1 To UBound(modules)

output = output & vbCrLf & "Unit: " & modules(i).Title & vbCrLf & \_

"Level: SCQF " & modules(i).SCQFLevel & " | Credits: " & modules(i).Credits & vbCrLf & \_

"Status: " & IIf(modules(i).Completed, "✅ Completed", "❌ Incomplete") & vbCrLf

Next i

MsgBox output, vbInformation, "Unit Completion Overview"

End Sub

Sub MarkUnitComplete(unitTitle As String)

Dim i As Integer

For i = 1 To UBound(modules)

If modules(i).Title = unitTitle Then

modules(i).Completed = True

MsgBox "Marked '" & unitTitle & "' as complete.", vbInformation

Exit Sub

End If

Next i

MsgBox "Unit not found: " & unitTitle, vbExclamation

End Sub

**🔧 Use Cases**

* ✅ Track learner progress across Certificate and Diploma units
* 📊 Generate audit-ready dashboards for SCQF credit mapping
* 🧮 Integrate with credential-linked record books and public service submissions
* 🌍 Support bilingual export and modular curriculum synthesis

Would you like this extended to include export to Excel, integration with your credential dashboards, or mapped to your digital certificate inspection logic?

**You said**

overview scope visual visual basic code SQA Advanced Unit Specification General information for centres Unit title: Transmission Lines and Complex Waves Unit code: HT1H 48 Unit purpose: This Unit is designed to enable candidates to understand the basic principles and concepts of transmission lines and complex waves. It will provide candidates with the opportunity to develop knowledge and skills to determine electrical quantities associated with transmission lines and secondly, to solve simple electrical series and parallel circuits when a complex waveform is applied. On completion of this Unit the candidate should be able to: 1. Evaluate the characteristics of transmission lines. 2. Evaluate the performance of a transmission line with a matched termination. 3. Evaluate the performance of a transmission line with various terminations. 4. Solve network response problems when complex waves are applied. Credit value: 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8\*) \*SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates. Recommended prior knowledge and skills: Candidates should have a good knowledge and understanding of electrical principles. This may be evidenced by possession of the SQA Advanced Units Single Phase A.C. Circuits and Electrical Network and Resonance. Preferably candidates will have achieved the SQA Advanced Unit Mathematics for Engineering 1: Electronics and Electrical. Core skills: There may be opportunities to gather evidence towards Core Skills in this Unit, although there is no automatic certification of Core Skills or Core Skills components. Context for delivery: There may be opportunities to gather evidence towards Core Skills in this Unit, although there is no automatic certification of Core Skills or Core Skills components. SQA Advanced Unit Specification SQA Advanced Unit (HT1H 48): Transmission Lines and Complex Waves 2 Assessment: The assessments for Outcomes 1, 2, 3 and 4 should be combined into one assessment paper. This paper should be taken by candidates at one single assessment event that should last two hours. The assessment could be composed of a suitable balance of short answer, restricted response and structured questions. It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass this Unit. Assessment should be conducted under controlled supervised conditions. Candidates will be permitted to use a supplied formulae sheet and a scientific calculator. SQA Advanced Unit Specification SQA Advanced Unit (HT1H 48): Transmission Lines and Complex Waves 3 SQA Advanced Unit Specification: Statement of standards Unit title: Transmission Lines and Complex Waves Unit code: HT1H 48 The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory. Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion. Outcome 1 Evaluate the characteristics of transmission lines Knowledge and/or skills ♦ Describe and classify different types of transmission line ♦ Calculation of primary parameters ♦ Calculation of secondary parameters Evidence requirements Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that they can correctly answer questions based on the items shown above. In any assessment of this Outcome two out of three knowledge and/or skills items should be sampled and the sample must include the third item. In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of two out of three knowledge and/or skills items should be sampled. A candidate’s response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to: ♦ describe and classify two types of transmission line ♦ calculate inductance and capacitance for two types of transmission line ♦ perform calculations to determine each of the following secondary parameters; Zo , γ , α, β and ν Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed book conditions and as such, candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be allowed to use a supplied formulae sheet and a scientific calculator during the assessment. SQA Advanced Unit Specification SQA Advanced Unit (HT1H 48): Transmission Lines and Complex Waves 4 Assessment guidelines Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions. The assessment of this Outcome should be combined with Outcomes 2, 3 and 4 to form a single assessment paper, details of which are given under Outcome 4. Outcome 2 Evaluate the performance of a transmission line with a matched termination Knowledge and/or skills ♦ Calculation of phasor voltages and currents at various points ♦ Calculation of dissipated power at the receiving end Evidence requirements Evidence for all the knowledge and/or skills in this Outcome must be provided. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate

**Copilot said**

Here’s a scoped overview, modular description, and Visual Basic code framework tailored to the SQA Advanced Unit HT1H 48: Transmission Lines and Complex Waves. This supports credential-linked tracking, logigramme mapping, and audit-ready documentation aligned with SCQF Level 8.

**🧠 Overview: Transmission Lines and Complex Waves**

| **Unit Code** | **HT1H 48** |
| --- | --- |
| **SCQF Level** | 8 |
| **Credit Value** | 1 SQA Credit (8 SCQF points) |
| **Assessment Format** | Combined paper (Outcomes 1–4), 2 hours, supervised, closed-book |
| **Tools Allowed** | Formulae sheet, scientific calculator |
| **Recommended Prior Knowledge** | Single Phase AC Circuits, Electrical Network and Resonance, Mathematics for Engineering 1 |

**📦 Scope: Modular Outcome Breakdown**

**🔹 Outcome 1: Characteristics of Transmission Lines**

* Describe and classify transmission line types
* Calculate primary parameters (e.g. inductance, capacitance)
* Calculate secondary parameters: characteristic impedance Z0Z\_0, propagation constant γ\gamma, attenuation α\alpha, phase constant β\beta, velocity ν\nu

**🔹 Outcome 2: Matched Termination Performance**

* Calculate phasor voltages and currents at various points
* Calculate dissipated power at the receiving end

**🔹 Outcome 3: Various Terminations**

* Evaluate reflection coefficient and standing wave ratio
* Calculate voltage and current distributions
* Analyze mismatched load effects

**🔹 Outcome 4: Network Response to Complex Waves**

* Solve series and parallel circuit responses to complex waveforms
* Apply phasor and time-domain analysis
* Interpret waveform behavior in reactive networks

**🧩 Visual Basic Code: Outcome Tracker & Parameter Calculator**

This VBA module supports tracking learner progress across outcomes and calculating key transmission line parameters.

vb

' Module: TransmissionLines\_Tracker

' Purpose: Track outcome completion and calculate transmission line parameters

Option Explicit

Type Outcome

Title As String

Completed As Boolean

End Type

Dim outcomes(1 To 4) As Outcome

Sub InitializeOutcomes()

outcomes(1).Title = "Evaluate characteristics of transmission lines"

outcomes(2).Title = "Evaluate performance with matched termination"

outcomes(3).Title = "Evaluate performance with various terminations"

outcomes(4).Title = "Solve network response with complex waves"

End Sub

Sub DisplayProgress()

Dim i As Integer, output As String

output = "📘 Transmission Lines and Complex Waves Progress:" & vbCrLf

For i = 1 To 4

output = output & vbCrLf & "Outcome " & i & ": " & outcomes(i).Title & vbCrLf & \_

"Status: " & IIf(outcomes(i).Completed, "✅ Completed", "❌ Incomplete") & vbCrLf

Next i

MsgBox output, vbInformation, "Outcome Tracker"

End Sub

Sub MarkOutcomeComplete(index As Integer)

If index >= 1 And index <= 4 Then

outcomes(index).Completed = True

MsgBox "Marked Outcome " & index & " as complete.", vbInformation

Else

MsgBox "Invalid outcome index.", vbExclamation

End If

End Sub

Function CalculateCharacteristicImpedance(L As Double, C As Double) As Double

' Z0 = sqrt(L/C)

CalculateCharacteristicImpedance = Sqr(L / C)

End Function

Function CalculateVelocity(L As Double, C As Double) As Double

' v = 1 / sqrt(L\*C)

CalculateVelocity = 1 / Sqr(L \* C)

End Function

Sub ShowParameterCalculations()

Dim L As Double, C As Double

L = InputBox("Enter inductance per unit length (H/m):")

C = InputBox("Enter capacitance per unit length (F/m):")

Dim Z0 As Double, v As Double

Z0 = CalculateCharacteristicImpedance(L, C)

v = CalculateVelocity(L, C)

MsgBox "Calculated Parameters:" & vbCrLf & \_

"Characteristic Impedance (Z0): " & Format(Z0, "0.00") & " Ω" & vbCrLf & \_

"Velocity of Propagation (v): " & Format(v, "0.00") & " m/s", vbInformation

End Sub

**🔧 Use Cases**

* ✅ Track learner progress across outcomes
* 📊 Calculate and visualize transmission line parameters
* 🧮 Integrate with SCQF credit mapping and modular record books
* 🌍 Support bilingual export and registry assurance
* 🧠 Scaffold logigramme logic for waveform analysis and termination scenarios

Would you like this extended to include graphical dashboards, export logic, or integration with your credential-linked frameworks and public service submission templates?

**You said**

scope over view visual basic code SQA Advanced Unit specification General information Unit title: Engineering Mathematics 5 (SCQF level 8) Unit code: HT1N 48 Superclass: RB Publication date: August 2017 Source: Scottish Qualifications Authority Version: 01 Uo solve linear system equations. Knowledge and/or Skills ♦ Eigenvalues and Eigenvectors ♦ Eigenvalue related problems Evidence Requirements for this Unit A sampling approach will be used in the assessment of the Knowledge and/or Skills in this Unit. Learners will need to provide written and/or recorded oral evidence to demonstrate their Knowledge and/or Skills across all Outcomes by showing they can: Outcome 1 Provide evide alongside the Assessment Support Pack developed for this Unit will provide clear indication of the standard expected in this Unit. Outcome 1 (6 hours) Solve second order, constant coefficient differential equations. ♦ Introduce the general form of a constant coefficient, second order linear differential equation as follows: ( ) 2 2 d y dy a b cy f x dx dx + + = where a, b, c are constants ♦ Provide examples of second order differential equations from engineering SQA Advanced Unit Specification HT1N 48, Engineering Mathematics 5 (SCQF level 8) 7 ♦ Explain that solving a second order linear differential equation involves the following three stages: — Finding the complementary function, ycf — Finding a particular integral, ypi — Determining the general solution by adding together the complementary function and the particular integral (y = ycf + ypi) and applying initial conditions where known ♦ Explain the difference between homogeneous and non-homogenous in the context of second order differential equations ♦ Introduce the auxiliary equation (characteristic equation) and explain that when finding roots of the auxiliary equation there are three cases we need to consider ♦ Explain that to find the complementary function one is finding the solution to the equation 2 2 0 d y dy a b cy dx dx + + = ♦ Find the complementary functions of second order differential equations using solutions of the form y=ekx ♦ Explore the various forms a complementary function can take ♦ Explain that the particular integral is any function which satisfies the following equation ( ) 2 2 d y dy a b cy f x dx dx + + = ♦ Explain that for special classes of f x( ) we can use the Method of Undetermined Coefficients to find the particular integral ♦ Find the general solution of second order differential equations including applying initial conditions Outcome 2 (5 hours) Solve mathematical problems using partial differentiation. ♦ Introduce partial differentiation as the process of differentiating functions of two or more variables ♦ Identify the notation used in partial differentiation ♦ For any function f x y ( , ) differentiate with respect to x treating all terms in y as constant ♦ For any function f x y ( , ) differentiate with respect to y treating all terms in x as constant ♦ Undertake partial differentiation involving the use of the chain, product or quotient rules ♦ Introduce higher order partial derivatives ♦ Demonstrate the way in which to determine higher order derivatives ♦ Introduce examples of partial differential equations (solutions not required) which occur in engineering ♦ Explain and demonstrate the way in which to find the location and nature of a stationary point for a function of the form z f x y = ( , ) SQA Advanced Unit Specification HT1N 48, Engineering Mathematics 5 (SCQF level 8) 8 Outcome 3 (5 hours) Solve mathematical problems using double integration techniques. ♦ Explain that double integration involves integrating a function f x y ( , ) as follows: ( , ) R dy f y x dx ∫∫ where R is the region of integration in the x – y plane ♦ Explain that the process of double integration normally comprises the following three stages: — Work out the limits of integration if these are not known — Determine the inner integral assuming terms in x are constant — Determine the outer integral ♦ Perform double integration where the limits are known and where they have to be determined ♦ Demonstrate that changing the order of integration can sometimes make double integration easier or possible to perform ♦ Demonstrate the way in which double integration may be performed by transforming variables from the rectangular domain to the polar domain ♦ Use double integration to determine the volume or surface areas of objects or the length of a curve Outcome 4 (6 hours) Solve differential equations using Laplace Transforms. ♦ Explain that the Laplace transform method is an integral transform method in which a linear constant coefficient differential equations is transformed into an algebraic equation. The corresponding algebraic equation is then solved and the transform reversed to find the solution of the differential equation. ♦ Introduce the Laplace Transform of f t() as: ( ) e ( ) 0 st F s f t dt ∞ − = ∫ (non-assessable) ♦ Determine one or two simple Laplace Transforms using the above equation ♦ Direct learners to tables of Laplace Transforms and Inverse Laplace Transforms ♦ Demonstrate techniques for finding the inverse of functions of F s( ) using completing the square and partial fractions ♦ Introduce the first and second shift theorems ♦ Demonstrate the application of the two theorems ♦ Introduce the Dirac Delta function (simple treatment only) — provide engineering analogies (eg a power supply spike or a hammer striking an object) SQA Advanced Unit Specification HT1N 48, Engineering Mathematics 5 (SCQF level 8) 9 ♦ State the Laplace transform of the Dirac Delta function as L t a ( ( )) e δ − = −as ♦ Solve differential equations involving the use of the Dirac Delta function ♦ Solve first and second order differential equations with initial conditions using Laplace Transforms ♦ Solve systems of linear differential equations using Laplace Transforms if time permits Outcome 5 (6 hours) Use eigenvalues and eigenvectors to solve linear system equations ♦ Introduce the idea of a trivial and non-trivial solution in the context of matrix theory ♦ Define the concept of an eigenvalue (in terms of, for example, the characteristic equation A− = λ 0 ) ♦ Determine eigenvalues for 2 × 2 and 3 × 3 matrices ♦ Introduce the concept of eigenvectors as the non-trivial solutions X of the equation AX X = λ ♦ Find the eigenvectors for 2 × 2 and 3 × 3 matrices ♦ Solve eigenvalue/eigenvector problems (eg diagonalisation matrices/transformation matrices) Guidance on approaches to delivery of this Unit

**Copilot said**

Here’s a scoped overview, structured description, and Visual Basic code module tailored to the SQA Advanced Unit HT1N 48: Engineering Mathematics 5 (SCQF Level 8). This supports modular tracking, outcome-based learning, and audit-ready documentation for credential-linked portfolios.

**🧠 Overview: Engineering Mathematics 5 (SCQF Level 8)**

| **Unit Code** | **HT1N 48** |
| --- | --- |
| **SCQF Level** | 8 |
| **Credit Value** | 1 SQA Credit (8 SCQF points) |
| **Superclass** | RB |
| **Assessment** | Sampling-based, written/oral evidence, supervised conditions |
| **Recommended Prior Knowledge** | Engineering Mathematics 1–4, Differential Equations, Matrix Algebra |

**📦 Scope: Modular Outcome Breakdown**

| **Outcome** | **Title** | **Key Topics** |
| --- | --- | --- |
| 1 | Second Order Differential Equations | Complementary function, particular integral, auxiliary equation, homogeneous/non-homogeneous |
| 2 | Partial Differentiation | Chain/product/quotient rules, higher-order derivatives, stationary points |
| 3 | Double Integration | Area, volume, polar coordinates, order of integration |
| 4 | Laplace Transforms | Inverse transforms, shift theorems, Dirac delta, solving ODEs |
| 5 | Eigenvalues & Eigenvectors | Characteristic equation, diagonalisation, matrix transformations |

**🧩 Visual Basic Code: Outcome Tracker & Laplace/Eigenvalue Calculator**

This VBA module supports tracking learner progress across outcomes and includes sample functions for Laplace transforms and eigenvalue problems.

vb

' Module: EngMath5\_Tracker

' Purpose: Track outcome progress and support Laplace/eigenvalue calculations

Option Explicit

Type MathOutcome

Title As String

Completed As Boolean

End Type

Dim outcomes(1 To 5) As MathOutcome

Sub InitializeOutcomes()

outcomes(1).Title = "Second Order Differential Equations"

outcomes(2).Title = "Partial Differentiation"

outcomes(3).Title = "Double Integration"

outcomes(4).Title = "Laplace Transforms"

outcomes(5).Title = "Eigenvalues and Eigenvectors"

End Sub

Sub DisplayProgress()

Dim i As Integer, output As String

output = "📘 Engineering Mathematics 5 Progress:" & vbCrLf

For i = 1 To 5

output = output & vbCrLf & "Outcome " & i & ": " & outcomes(i).Title & vbCrLf & \_

"Status: " & IIf(outcomes(i).Completed, "✅ Completed", "❌ Incomplete") & vbCrLf

Next i

MsgBox output, vbInformation, "Outcome Tracker"

End Sub

Sub MarkOutcomeComplete(index As Integer)

If index >= 1 And index <= 5 Then

outcomes(index).Completed = True

MsgBox "Marked Outcome " & index & " as complete.", vbInformation

Else

MsgBox "Invalid outcome index.", vbExclamation

End If

End Sub

Function LaplaceTransform\_Exp(a As Double, s As Double) As Double

' L{e^(at)} = 1 / (s - a)

If s = a Then

LaplaceTransform\_Exp = CVErr(xlErrDiv0)

Else

LaplaceTransform\_Exp = 1 / (s - a)

End If

End Function

Function Eigenvalue2x2(a As Double, b As Double, c As Double, d As Double) As String

' Characteristic equation: λ² - (a+d)λ + (ad - bc) = 0

Dim trace As Double, det As Double, disc As Double

trace = a + d

det = a \* d - b \* c

disc = trace ^ 2 - 4 \* det

If disc < 0 Then

Eigenvalue2x2 = "Complex roots"

Else

Dim lambda1 As Double, lambda2 As Double

lambda1 = (trace + Sqr(disc)) / 2

lambda2 = (trace - Sqr(disc)) / 2

Eigenvalue2x2 = "λ₁ = " & Format(lambda1, "0.00") & ", λ₂ = " & Format(lambda2, "0.00")

End If

End Function

**🔧 Use Cases**

* ✅ Track learner progress across all five outcomes
* 🧠 Support Laplace transform and eigenvalue calculations
* 📊 Integrate with SCQF credit dashboards and modular record books
* 🌍 Enable bilingual export and credential-linked audit sheets
* 🧮 Scaffold logigramme logic for engineering mathematics scenarios

Would you like this extended to include symbolic differentiation, matrix diagonalisation, or export to Excel for credential-linked dashboards?

**You said**

scope overview visual basic © National Qualications 2025 X823/77/11 AH Engineering Science FRIDAY, 16 MAY 1:00 PM – 3:30 PM Total marks — 75 You may refer to the Advanced Higher Engineering Science Data Booklet. SECTION 1 — 35 marks Attempt ALL questions. SECTION 2 — 40 marks Attempt ALL questions. Write your answers clearly in the answer booklet provided. In the answer booklet, you must clearly identify the question number you are attempting. For questions 1 (a), 2, 4 (a), 10 (c) and 10 (d), write your answers clearly in the worksheets provided in the answer booklet. Show all working and units where appropriate. The number of significant figures expressed in a final answer should be equivalent to the least significant data value given in the question. Answers that have two more figures or one less figure than this will be accepted. Use blue or black ink. Sketches, diagrams and graphs may be drawn in pencil. Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper. B/SQA [BLANK PAGE] DO NOT WRITE ON THIS PAGE page 02 page 03 MARKS SECTION 1 — 35 marks Attempt ALL questions 1. A capital project is divided into several phases, A to I. The precedents for each phase and the planned duration of each phase are detailed in the precedence table below. Phase Stage Precedent Duration (months) Feasibility A -- 4 Planning B A 4 Procurement C A 8 Recruitment D B, C 2 Groundwork E B, C 9 Utilities F D, E 7 Main build G E 5 Commissioning H G 3 Handover I F, H 1 (a) Using the precedence table and the worksheet for question 1 (a): (i) complete the activity network diagram by adding precedence arrows to stages D to G (ii) add the latest finish time, the latest start time, and the float for each of stages D to G (iii) identify the critical path. Project Management includes five main process groups, one of which is the Project Planning phase. This may involve the following steps: • estimate budget • estimate resources required • anticipate risks on time. (b) Explain what a Project Manager would do in one of these steps. [Turn over 1 3 1 2 page 04 MARKS 2. A simply supported beam is loaded with two point loads and a uniformly distributed load, as shown below. 30.0 kNm−1 20.0 kN 20.0 kN 0.60 m 1.20 m A B 1.20 m On the worksheet for question 2, draw the shear force diagram for the beam under the applied loads. 3. Traditional power stations are designed solely to produce work (to generate electricity). A Combined Heat and Power (CHP) plant is designed to provide useful work and heat. The energy audit for a CHP plant is shown below. The overall efficiency of the plant is 82%, and the ratio of useful heating power to useful electrical power is 5:3. input power from fuel 305 MW CHP plant wasted power useful electrical power useful heating power Calculate the efficiency of the CHP plant for electricity generation. 5 3 page 05 MARKS 4. A simplified electricity supply line diagram is shown below. large industrial customers domestic customers A C D B (a) Identify the electricity supply line components that symbols A, B, C and D represent by placing each letter next to the correct component in the table on the worksheet for question 4 (a). (b) Describe the function of: (i) a busbar (ii) a circuit breaker. [Turn over 2 1 1 page 06 MARKS 5. A student builds a 4-bit digital to analogue convertor (DAC). The circuit is shown below. Vout +Vcc −Vcc +Vcc −Vcc R3 R2 R1 R0 16 kΩ 15 kΩ 15 kΩ + − + − 0 V LSB digital inputs MSB Circuit specifications: Logic 1 = 5.0 V Logic 0 = 0 V Vout = +10.0 V when digital input is 1111LSB (a) State the purpose of the inverting amplifier within the DAC circuit. (b) State the number of different digital input combinations that this configuration of DAC will accept. (c) Calculate required resistor values R0, R1, R2 and R3. 1 1 3 page 07 MARKS 6. A student is testing a Wien bridge oscillator. The circuit is shown below. R1 680 Ω 20 kΩ 680 Ω Vout +Vcc −Vcc + − 0 V 5.6 μF 5.6 μF The 680 Ω resistors have a 1% tolerance and the 5.6 µF capacitors have a 5% tolerance. (a) Calculate the highest possible frequency at which this circuit would be expected to oscillate when tested. (b) State the value of R1 that will produce and maintain a stable amplitude sine wave. The student tested their circuit but selected an incorrect value for R1. The output waveform the circuit produced is shown below. time Vout (c) State whether too large or too small a value of R1 has been used. [Turn over 2 1 1 page 08 MARKS 7. A 102 kg person stands in the middle of a paddleboard. The board is 2.5 m long and is made from polystyrene, with a Young’s Modulus of 3.25 GN m−2. To determine deflection, the board can be modelled as two rectangular cross-section cantilever beams with a uniformly distributed load (UDL) applied due to the water buoyancy force, acting symmetrically about a central point load to balance the person’s weight. ω Nm−1 W L L1 2 (a) Calculate the magnitude of the UDL, ω Nm−1, required to balance the weight, W, of the person. The board is assumed to have a constant rectangular cross-section of breadth 690 mm and thickness 75 mm. (b) Calculate the deflection of the free end of the board in relation to its centre. 1 3 page 09 MARKS 8. A stair lift carries a person between two floors (floor 1 and floor 2) of a house. During the design of a microcontroller-based control system for this stair lift, a student needs to produce an 8-bit variable, called ‘flag’, containing the logical state of the five input switches connected to pins 2–6 of the data port. Pins 7, 1 and 0 are used as outputs and should be set to zero in the variable ‘flag’. INPUT PORT OUTPUT 7 Emergency 6 Call floor 1 5 Call floor 2 4 Floor 1 limit switch 3 Floor 2 limit switch 2 1 0 The student sets the PORT register to the binary value 11111111, so that the required value of ‘flag’ becomes binary value 01111100. The student tests three commands that perform bitwise logic between two registers: PBASIC (1) flag = PORTB | %01111100 (bitwise OR) (2) flag = PORTB & %01111100 (bitwise AND) (3) flag = PORTB ^ %01111100 (bitwise XOR) ARDUINO (1) flag = PORTD | 0b01111100 (bitwise OR) (2) flag = PORTD & 0b01111100 (bitwise AND) (3) flag = PORTD ^ 0b01111100 (bitwise XOR) Note that 00110000 | 01010000 gives the result 01110000, where numbers are binary. Determine which of the three commands should be used, stating the binary value of ‘flag’ that results in each case. [Turn over 3 page 10 SECTION 2 — 40 marks Attempt ALL questions 9. An image of an industrial tumble dryer is shown below. An electric motor rotates the drum in either direction via a belt drive, as shown below. bearing A bearing B drum motor belt driven pulley drive pulley The diagram below shows the external forces acting on the shaft that connects the driven pulley to the drum. The two forces at the left-hand end represent the tensions in the belt when running and the vertical force at the right-hand end represents the weight of the drum when fully-loaded. 66.9 N at 32° all dimensions in mm angles measured relative to the horizontal plane 334.5 N at 56° bearing A bearing B 305 N z x y 41 82 227 page 11 MARKS 9. (continued) (a) Calculate the magnitude of the reaction at bearing B, shown opposite. A diagram of the belt drive geometry is shown below. The pulley diameter and the belt contact angle for each pulley are given. all dimensions in mm drive pulley driven pulley Ø400.0 Ø50.0 204° 156° The slack side of the belt has a tension of 66.9 N, the tight side of the belt has a tension of 334.5 N and the driven pulley turns at a constant speed of 175 revs min−1. (b) Calculate the power delivered by the motor to the drive pulley. The ratio of tensions of the belt such that there is no slip, is given by the equation max μθ min F e F ≤ where: F is tension (N) μ is the coefficient of friction between the belt and the pulley θ is the contact angle between the belt and the pulley, in radians (2π radians = 360°). (c) Show that the belt does not slip when the coefficient of friction is 0.80. [Turn over 5 2 2 page 12 MARKS 9. (continued) The diagram below shows a pulse-width modulation (PWM) signal used to test the MOSFET-based drive circuitry for the drum motor. The current through the MOSFET increases slightly between it turning on and turning off. Both the frequency and duty cycle (the ratio of the ‘on’ time to the period of each pulse) are constant. time (microseconds, μs) IOFF = 1.2 A ON = 1.0 AI 0 20 40 60 80 100 120 140 160 180 200 220 The power dissipated by the signal when the MOSFET is conducting is given by the formula 2 2 C DS(on) ON ON OFF OFF 1 P = × D × R × (I + I × I + I ) 3 where: D is the duty cycle RDS(on) = 0.15 Ω for the MOSFET. Data for the MOSFET switching characteristics are shown in the diagram below. time (nanoseconds, ns) ION = 1.0 A VOFF = 110 V TON = 40 ns time (nanoseconds, ns) IOFF = 1.2 A VOFF = 110 V TOFF = 45 ns The power dissipated as the MOSFET switches on and as it switches off is given by the formula SW OFF ON ON OFF OFF 1 P = × f × V × (T × I + T × I ) 2 where: f is the PWM frequency. (d) Determine the total power dissipation in the MOSFET. 3 current, I (A) page 13 MARKS 9. (continued) The electronic control circuitry in the tumble dryer is designed to work from a 9 V DC supply derived from a 230 V AC supply. (e) (i) Identify two electrical devices specified by the design engineer in order to produce the AC to DC conversion. (ii) Describe the function of each device. A sensor produces a pattern of electrical pulses which are counted to determine the drum motor speed. The noise on the pulses is removed using the Schmitt trigger circuit shown below. Vout Vin 9.0 V 0 V 6.2

**Copilot said**

Here’s a scoped overview, structured description, and Visual Basic code module tailored to the 2025 Advanced Higher Engineering Science exam (X823/77/11). This framework supports modular tracking, logigramme logic, and credential-linked audit documentation.

**🧠 Overview: AH Engineering Science 2025**

| **Exam Code** | **X823/77/11** |
| --- | --- |
| **Level** | Advanced Higher |
| **Subject** | Engineering Science |
| **Date** | Friday, 16 May 2025 |
| **Time** | 1:00 PM – 3:30 PM |
| **Total Marks** | 75 |
| **Sections** | Section 1 (35 marks), Section 2 (40 marks) |
| **Resources** | Data Booklet allowed |
| **Format** | Answer booklet + worksheets for Q1(a), Q2, Q4(a), Q10(c), Q10(d) |

**📦 Scope: Modular Breakdown by Section**

**🔹 Section 1 — Core Engineering Applications**

| **Q#** | **Topic** | **Skills Assessed** |
| --- | --- | --- |
| 1 | Project Management | Network diagrams, float, critical path, planning steps |
| 2 | Structural Analysis | Shear force diagram for beam with UDL and point loads |
| 3 | Energy Systems | CHP efficiency calculation (electrical vs thermal) |
| 4 | Electrical Supply | Component ID, busbar and circuit breaker functions |
| 5 | DAC Circuit | Amplifier role, binary input combinations, resistor calculations |
| 6 | Wien Oscillator | Frequency tolerance, R1 value, waveform diagnosis |
| 7 | Structural Deflection | UDL calculation, cantilever beam deflection |
| 8 | Microcontroller Logic | Bitwise operations (OR, AND, XOR), binary flag manipulation |

**🔹 Section 2 — Advanced Systems & Control**

| **Q#** | **Topic** | **Skills Assessed** |
| --- | --- | --- |
| 9 | Mechanical Systems | Bearing reaction, belt drive power, PWM dissipation, AC–DC conversion, Schmitt trigger |
| 10 | Crane Arm Design | Ixx calculation, stress ratio, bending moment diagram, amplifier Q-point, servo control logic, ADC resolution, duty cycle |

**🧩 Visual Basic Code: Modular Tracker & Engineering Calculator**

This VBA module supports tracking progress across questions and includes sample functions for key calculations.

vb

' Module: AH\_EngScience2025\_Tracker

' Purpose: Track question progress and support engineering calculations

Option Explicit

Type ExamQuestion

Title As String

Section As String

Completed As Boolean

End Type

Dim questions(1 To 10) As ExamQuestion

Sub InitializeQuestions()

questions(1).Title = "Project Management"

questions(2).Title = "Shear Force Diagram"

questions(3).Title = "CHP Efficiency"

questions(4).Title = "Electrical Supply Line"

questions(5).Title = "DAC Circuit"

questions(6).Title = "Wien Oscillator"

questions(7).Title = "Paddleboard Deflection"

questions(8).Title = "Microcontroller Logic"

questions(9).Title = "Tumble Dryer System"

questions(10).Title = "Crane Arm Design"

Dim i As Integer

For i = 1 To 10

If i <= 8 Then

questions(i).Section = "Section 1"

Else

questions(i).Section = "Section 2"

End If

questions(i).Completed = False

Next i

End Sub

Sub DisplayProgress()

Dim i As Integer, output As String

output = "📘 AH Engineering Science 2025 Progress:" & vbCrLf

For i = 1 To 10

output = output & vbCrLf & "Q" & i & ": " & questions(i).Title & " (" & questions(i).Section & ")" & vbCrLf & \_

"Status: " & IIf(questions(i).Completed, "✅ Completed", "❌ Incomplete") & vbCrLf

Next i

MsgBox output, vbInformation, "Exam Tracker"

End Sub

Sub MarkQuestionComplete(index As Integer)

If index >= 1 And index <= 10 Then

questions(index).Completed = True

MsgBox "Marked Question " & index & " as complete.", vbInformation

Else

MsgBox "Invalid question index.", vbExclamation

End If

End Sub

Function CalculateCHPEfficiency(usefulElectricalMW As Double, inputMW As Double) As Double

CalculateCHPEfficiency = (usefulElectricalMW / inputMW) \* 100

End Function

Function CalculateMOSFETPower(DutyCycle As Double, Rds As Double, ION As Double, IOFF As Double) As Double

' P = (1/3) × D × R × (ION² + ION×IOFF + IOFF²)

CalculateMOSFETPower = (1 / 3) \* DutyCycle \* Rds \* (ION ^ 2 + ION \* IOFF + IOFF ^ 2)

End Function

**🔧 Use Cases**

* ✅ Track learner progress across all exam questions
* 🧮 Calculate CHP efficiency and MOSFET power dissipation
* 📊 Integrate with credential-linked dashboards and modular record books
* 🌍 Enable bilingual export and public service submission templates
* 🧠 Scaffold logigramme logic for project management and control systems

Would you like this extended to include graphical dashboards, export to Excel, or integration with your credential-linked frameworks?

**You said**

over view scpee code visual basic + − R2 R1 The op-amp output saturates at 7.5 V and 0 V. The required upper threshold voltage is 5.2 V, and the lower threshold voltage is 2.7 V. (f) Calculate, using nodal analysis, the required values for R1 and R2. [Turn over 1 2 5 page 14 10. A telescopic boom arm crane is shown below. Two hydraulic cylinders move part B relative to part A and part C relative to part B. part A part B part C A simplified model for the arm comprises three parts of equal length, each being hollow rectangular box-section, and where the part on the right fits inside the part to its immediate left. This means that the arm can fully retract or extend by a factor of three. part A part B part C Sectional diagrams of fully extended and fully retracted positions for the simplified model are shown below. part A part B part C 1.000 m 1.000 m 1.000 m part A part B part C 1.000 m page 15 MARKS 10. (continued) part A part B part C 200 180 160 end elevation of simplified model The table shown below summarises the data for each arm part. All dimensions are accurate to the nearest mm. Part A Part B Part C Units Height 400 360 320 mm Breadth 200 180 160 mm Length 1.000 1.000 1.000 m Ixx 262.9 180.8 × 106 mm4 Mass 121.6 108.8 96.0 kg The arm is a cantilever, built-in at the left-hand end of part A. (a) Calculate the second moment of area (Ixx) value for part A. (b) Determine the ratio of the maximum stresses in the arm due to self‑weight when the arm is in its fully extended position and when it is in its fully retracted position. [Turn over 2 6 400 360 320 page 16 MARKS 10. (continued) The following free-body diagram is used to analyse bending moments in part A when the crane arm is fully extended and bearing its maximum load. Fs and Ms represent the shear force and bending moment at the built-in support point for part A. Ms Fs 0.85 m 320 kN 344 kN 0.15 m (c) Draw the bending moment diagram for this free-body diagram on the worksheet for question 10 (c). 3 page 17 MARKS 10. (continued) The crane has an audible alarm to warn when loads being lifted are too heavy. A student is developing a stage for an audio amplifier circuit. The circuit diagram is shown below. R1 Vin Vout R2 8.25 kΩ 16.0 V 0 V The quiescent point (Q-point) is selected to give a drain-source voltage value (VDS) of 9.00 V. (d) Draw the load line for the circuit on the worksheet for question 10 (d) and hence, or otherwise, identify the value of the drain current, ID, and gate-source voltage, VGS, at the quiescent point (Q-point). Design rule: The combined resistance of R1 in parallel with R2 is 85.0 kΩ. All resistors in the circuit have a tolerance of 1%, so their values have 3 significant figures. (e) Calculate suitable values for R1 and R2. [Turn over 2 3 page 18 MARKS 10. (continued) The following extract from a program is used to generate pulses to a servomotor within the control system for the telescopic boom arm actuators. A rotational potentiometer supplies a voltage input to an analogue port of the microcontroller. ARDUINO PBASIC void setup() { PinMode(6,OUTPUT); } unsigned int pos = 0; void loop() { symbol pos = w1 let pos = 0 main: pos=analogRead(A0); readadc10 C.1, pos pos = pos + 750; digitalWrite(6,HIGH); delayMicroseconds(pos); digitalWrite(6,LOW); pos = 2000 − pos; delayMicroseconds (pos); delay(18); } pos = pos + 750 high B.6 pausemicro (pos) low B.6 pos = 2000 − pos pausemicro (pos) pause(18) goto main In either language, the analogue to digital conversion has 10-bit resolution when an analogue input is sampled. (f) State the maximum and minimum values that the variable ‘pos’ could hold immediately after the line highlighted in the program executes. 1 page 19 MARKS 10. (continued) For a 40 ms time interval, the input voltage is a constant 1.225 V. The analogue to digital converter (ADC) produces its maximum value when the input voltage reaches 5.0 V. (g) Calculate the frequency and duty cycle of the pulses produced at pin 6 during this 40 ms time interval. (Duty cycle is the ratio of the ‘on’ time to the period of each pulse, normally expressed as a percentage.) ARDUINO Syntax delayMicroseconds (microseconds) Parameters microseconds — is a variable/ constant (0–65535) which specifies the number of microseconds to pause. Example delayMicroseconds(500) //Wait 500 μs PBASIC Syntax PAUSEMICRO (microseconds) Parameters microseconds — is a variable/constant (0–65535) which specifies the number of microseconds to pause. Example pausemicro(500)  ‘Wait 500 μs [END OF QUESTION PAPER] 3 page 20 [BLANK PAGE] DO NOT WRITE ON THIS PAGE Acknowledgement of copyright Question 9 Dmitry Kalinovsky/shutterstock.com

**Copilot said**

Here’s a scoped overview, structured breakdown, and Visual Basic code module tailored to Question 10 of the 2025 Advanced Higher Engineering Science exam (X823/77/11). This supports modular tracking, nodal analysis, and circuit design logic for audit-ready documentation and engineering simulation.

**🧠 Overview: Question 10 – Telescopic Boom Arm Crane & Amplifier Circuit**

| **Question** | **10** |
| --- | --- |
| **Topic Areas** | Structural Mechanics, Bending Moment, Audio Amplifier Design, Pulse Width Modulation |
| **Total Marks** | 20 |
| **Key Skills** |  |

* Calculate second moment of area (Ixx)
* Compare stress in extended vs retracted configurations
* Draw bending moment diagram
* Apply nodal analysis to op-amp threshold circuit
* Design resistor network for amplifier Q-point
* Analyze ADC resolution and PWM duty cycle

**📦 Scope: Modular Breakdown**

| **Part** | **Topic** | **Skills Assessed** |
| --- | --- | --- |
| (a) | Ixx Calculation | Use geometric properties to compute second moment of area |
| (b) | Stress Ratio | Compare max stress in extended vs retracted boom |
| (c) | Bending Moment | Interpret free-body diagram and draw moment distribution |
| (d) | Load Line & Q-Point | Use VDS and resistor values to find ID and VGS |
| (e) | Resistor Design | Solve for R1 and R2 given parallel resistance constraint |
| (f) | ADC Resolution | Determine min/max values of pos after analog read |
| (g) | PWM Analysis | Calculate frequency and duty cycle from ADC input |

**🧩 Visual Basic Code: Nodal Analysis & PWM Calculator**

This VBA module supports:

* Calculating R1 and R2 for a Schmitt trigger using nodal analysis
* Determining PWM frequency and duty cycle from ADC input

vb

' Module: Q10\_BoomArm\_Amplifier\_PWM

' Purpose: Solve nodal analysis for R1/R2 and calculate PWM duty cycle

Option Explicit

' Calculate R1 and R2 for Schmitt trigger thresholds

Function CalculateResistorRatio(VsatHigh As Double, VsatLow As Double, VthHigh As Double, VthLow As Double) As String

' Using nodal analysis:

' Vth = Vsat \* (R2 / (R1 + R2)) => R2/R1 = Vth / (Vsat - Vth)

Dim ratioHigh As Double, ratioLow As Double

ratioHigh = VthHigh / (VsatHigh - VthHigh)

ratioLow = VthLow / (VsatLow - VthLow)

CalculateResistorRatio = "R2/R1 for Vth+ = " & Format(ratioHigh, "0.00") & vbCrLf & \_

"R2/R1 for Vth− = " & Format(ratioLow, "0.00")

End Function

' Calculate R1 and R2 given parallel resistance and one known resistor

Function CalculateResistorPair(Rparallel As Double, Rknown As Double) As Double

' Rparallel = (R1 \* R2) / (R1 + R2)

' Solve for R2 given R1

CalculateResistorPair = (Rparallel \* Rknown) / (Rknown - Rparallel)

End Function

' Calculate PWM duty cycle and frequency

Function CalculatePWM(pos As Integer, totalTime\_us As Double) As String

Dim onTime As Double, offTime As Double, period\_us As Double

onTime = pos

offTime = 2000 - pos

period\_us = onTime + offTime

Dim freq As Double, duty As Double

freq = 1000000 / period\_us

duty = (onTime / period\_us) \* 100

CalculatePWM = "Frequency: " & Format(freq, "0.00") & " Hz" & vbCrLf & \_

"Duty Cycle: " & Format(duty, "0.0") & "%"

End Function

**🔧 Example Usage**

vb

Sub RunQ10Calculations()

' Part (f) - Resistor ratio for Schmitt trigger

MsgBox CalculateResistorRatio(7.5, 0, 5.2, 2.7)

' Part (e) - R1 = 8.25kΩ, find R2 for parallel = 85kΩ

Dim R2 As Double

R2 = CalculateResistorPair(85000, 8250)

MsgBox "R2 = " & Format(R2 / 1000, "0.00") & " kΩ"

' Part (g) - PWM from ADC input

MsgBox CalculatePWM(1044, 40000) ' pos = 1044 μs, total = 40 ms

End Sub

Would you like this extended to include graphical plotting of the load line, bending moment diagrams, or export to a credential-linked engineering dashboard?

**You said**

scope over view visual basic code National Qualifications 2024 2024 Engineering Science Advanced Higher Question Paper Finalised Marking Instructions © Scottish Qualifications Authority 2024 These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments. The information in this document may be reproduced in support of SQA qualifications only on a noncommercial basis. If it is reproduced, SQA must be clearly acknowledged as the source. If it is to be reproduced for any other purpose, written permission must be obtained from permissions@sqa.org.uk. © General marking principles for Advanced Higher Engineering Science Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates’ responses. (a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions. (b) If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader. (c) Where a candidate makes an error at an early stage in a multi-stage calculation, award marks for correct follow-on working in subsequent stages. Do not award marks if the error significantly reduces the complexity of the remaining stages. Apply the same principle in questions which require several stages of non-mathematical reasoning. (d) SQA presents all units of measurement in a consistent way, using negative indices where required (for example ms−1 ). Candidates can respond using this format, or solidus format (m/s), or words (metres per second), or any combination of these (for example metres/second). (e) For numerical questions, candidates should round their answers to an appropriate number of significant figures. However, award marks if their answer has up to two figures more or one figure less than the expected answer. (f) Unless a numerical question specifically requires candidates to show evidence of their working, award full marks for a correct final answer (including unit) on its own. (g) Award marks where a labelled diagram or sketch conveys clearly and correctly the response required by the question. (h) Award marks regardless of spelling if the meaning is unambiguous. (i) Candidates can answer programming questions in any appropriate programming language. Award marks where the intention of the coding is clear, even where there are minor syntax errors. (j) For ‘Explain’ questions, only award marks where the candidate goes beyond a description, for example by giving a reason, or relating cause to effect, or providing a relationship between two aspects. (k) Where separate space is provided for rough working and a final answer, only award marks for the final answer. Ignore all rough working. page 02 page 03 Marking instructions for each question Section 1 Question Expected response Max mark Additional guidance 1. (a) (i) 3 1 mark - any two out of E, F, G and H added correctly without float. 1 mark - remaining two out of E,F,G and H added correctly without float. 1 mark - Float added correctly for E and G. page 04 Question Expected response Max mark Additional guidance 1. (a) (ii) B, D, F, H 1 1 mark - critical path correct (potential for FTE from a(i)). If float is applied to stage F (incorrectly) on the Gantt chart, but the correct critical path is given, award this mark. (b) (i) A direct cost is a cost that can be controlled by the project manager and assigned entirely to the project alone and not to other parts of the organisation’s costs. An on-cost is a cost that arises because of legislation, and that cannot be controlled by the project manager. 2 1 mark for each description. (ii) Direct costs: • Construction materials • Travel expenses of engineers and technicians. On-costs: • Preliminary site work (to ensure compliance with Health & Safety legislation) • Employer National Insurance contributions • Engineering, technical and construction worker salaries. 1 1 mark for correct identification. page 05 Question Expected response Max mark Additional guidance 2. 2 2 Fuel cell A 0.84 0.56 0.47 (2 s.f.)(47%) Fuel cell B 0.75 0.65 0.49 (2 s.f.)(49%) overall C H H C overall overall overall overall η η η η η η η = × − − = × = = × = Fuel cell B has the higher overall efficiency. 3 1 mark - extract efficiencies from diagram and convert to decimal. 1 mark - correct value of efficiency for both fuel cells. 1 mark - correct answer. page 06 Question Expected response Max mark Additional guidance 3. (a) Base demand is the minimum level of demand on the national grid over a period, for example, a week or a month, whereas peak demand is the maximum power required during the same interval. 1 Clear difference between the two types of demand is given, related to a period. (b) Nuclear power, coal power 1 Accept gas. (c) The function of the step-up transformer is to increase the voltage and reduce the current produced at the power station to transmit power along the powerlines. To allow this power to be usable at the end of the powerline, this power is stepped down to the required voltage, for example 230V for home consumers. Without step-up and step-down transformers, the current would produce high heat loss in the transmission powerlines reducing the distance the electricity can be distributed efficiently (this would mean an increase in the number of power stations required in the UK). 2 1 mark - description of what each transformer does. 1 mark - reason given for requiring low transmission current, so high transmission voltage. (d) 2 1 mark - calculate power loss. 1 mark - calculate efficiency. 2 8 3 3 3 1000 40 1.68 10 550 45 985.6 10 kW 17 0.9452... 17 985.6 10 0.95, 95% (2 s.f.) − − − = × × × × × = × = = = + × = out in P P P η P η page 07 Question Expected response Max mark Additional guidance 4. (a) 0 (24 1.6 0.8) 4.1 3.2 4.8 0 3.6666...... = 3.67 kN(3 s.f.) 0 4.1 (24 1.6) 0 30.633..... = 30.6 kN(3 s.f.) = × × − × − × = = = + + − × = = ∑ ∑ A B B V A B A M R R F R R R 4 1 mark - calculate reactions (units not required). 1 mark - reactions on shear force diagram correct and point load on shear force diagram correct. 1 mark - slope in region of UDL (0 1.6) ≤ ≤ x . 1 mark - constant shear force for and . (b) The point would mean the shear force is zero and this equates to a maximum or minimum magnitude of bending moment. From the bending moment a maximum stress level in the beam can be determined and this will tell the engineer whether the beam will fail under loading. OR The engineer will determine the maximum bending moment using these positions. Knowing the safe working stress for the beam material, the engineer will be able to determine a safe cross-section for the beam. 2 1 mark - identify that it gives the potential position of maximum magnitude of bending moment. 1 mark - link bending moment to the determination of stress levels, and whether the beam is a safe design. (1.6 3.2) ≤ < x (3.2 4.8) ≤ < x page 08 Question Expected response Max mark Additional guidance 5. 0 0 9.0 0 0 (\*) 30 50 150 45 5 3 3 0 150 150 150 9 3 45 3 15 ...(1) 0 0 9.0 100 − − = − − − − − = − − − − = − − − − = − − = − = + − = − − − + − = − + AB BC BD A B B D B C AB BC BD B B B C B B B C B C B C AC BC CD A C B C C D AC BC CD C B I I I V V V V V V R R R V V V V V V V V V V V V I I I V V V V V V R R R V V 0 0 (\*\*) 50 60 27 3 6 6 5 0 300 300 300 6 14 27 ...(2) 2 (1) to (2) (6 2 ) ( 6 14 ) =(30)+(27) 12 57 4.75 for in (1) 3 − − − = − − + − = − + = × − + − + = = − C C C B C C B C B C B C C C C B V V V V V V V V Add V V V V V V substitute V V 4.75 15 6.583 6.6 V, 4.8 V (2 s.f.) = = = = B B C V V V 5 1 mark(\*) - correct application of KCL and Ohm’s law to node B. Alternative 1 mark(\*\*) - correct application of KCL and Ohm’s law to node C. Alternative 1 mark - begin to solve simultaneous equations correctly (equations do not need to be correct but both must include terms for VB and VC). 1 mark - correct value for VC. 1 mark - correct value for VB (FTE from fourth mark possible). A B C D A B C D A B C D A B C D 0 0 9.0 0 0 (\*) 30 50 150 45 5 3 3 0 150 150 150 9 3 45 3 15 ...(1) + + = − − + + = − − − + + = − − + − = − − = − = AB CB DB A B D B C B AB BC BD B B C B B B C B B C B C I I I V V V V V V R R R V V V V V V V V V V V V 0 0 9.0 0 0 (\*\*) 100 50 60 27 3 6 6 5 0 300 300 300 6 14 27 ...(2) + + = − − − + + = − − − + + = − − + − = − + = AC BC DC A C B C D C AC BC CD C B C C C B C C B C I I I V V V V V V R R R V V V V V V V V V V page 09 Question Expected response Max mark Additional guidance 6. 3 2 2 3 3 2 2 3 4 6 3 3 2 3 2 3 3 3 6 2 6 1 1 m 1 100 10 10 mm 1 m 10 10 19 00 100 1 10 100 100 1 10 ) 104.16 10 64 15 196 10 104.16 10 12 (1 0.3 104.16 10 12 (1 6 10 15 mm 10 ( ) kN m N mm N mm N mm t N r mm p E δ Z Z t − − − − − − − = × × × ⎡ ⎤ ⎢ ⎥ ⎣ ⎦ × = = − × = × × × = × = × = = × × × = × × × − × × = = × 2 3 3 0.3 196 10 17.97... 18 (2 s.f.) ) t t mm = × = OR 2 3 3 2 9 2 2 2 2 4 3 3 3 3 3 2 3 9 3 3 9 196 m 100 10 196 10 15 10 100 10 104.16 10 64 15 10 196 10 104.16 10 12 (1 0.3 104.16 10 12 ( 196 10 10 mm 1 1 m 1 mm 196 10 1.0 m m 1.0 ) kN m N m Z N m N m Z t t N r p E δ − − − − − − = × × × ⎡ ⎤ ⎢ ⎥ ⎣ ⎦ = × = = = = = = × × × × × × = × × = × × − × × × × = × 9 2 3 3 3 1 0.3 196 10 17.97 10 ... 18 10 (2 s.f.) ) t t m − = × − × − = × 4 Solution using mm as unit of length.

**Copilot said**

Here’s a scoped overview, structured description, and Visual Basic code module tailored to the 2024 Advanced Higher Engineering Science Finalised Marking Instructions. This framework supports modular assessment tracking, marking logic simulation, and credential-linked audit documentation.

**🧠 Overview: AH Engineering Science 2024 Marking Instructions**

| **Level** | **Advanced Higher** |
| --- | --- |
| **Subject** | Engineering Science |
| **Year** | 2024 |
| **Total Marks** | 75 |
| **Sections** | Section 1 (35 marks), Section 2 (40 marks) |
| **Marking Principles** |  |

* Positive marking only
* Follow-on credit allowed for multi-stage errors
* Accept multiple formats for units and syntax
* Diagrams and sketches earn marks if clearly correct
* Programming answers accepted in any language
* Final answer space prioritized over rough work

**📦 Scope: Modular Breakdown of Marking Logic**

| **Question** | **Topic** | **Max Marks** | **Marking Focus** |
| --- | --- | --- | --- |
| 1 | Project Management | 6 | Network diagram, float, critical path, cost types |
| 2 | Fuel Cell Efficiency | 3 | Diagram extraction, decimal conversion, comparison |
| 3 | Power Systems | 6 | Demand types, transformer function, power loss |
| 4 | Beam Analysis | 6 | Reaction forces, shear force diagram, bending moment |
| 5 | Nodal Analysis | 5 | KCL, Ohm’s Law, simultaneous equations |
| 6 | Structural Deflection | 4 | Young’s modulus, deflection formula, unit conversion |

**🧩 Visual Basic Code: Modular Marking Simulator**

This VBA module simulates marking logic for selected questions, applying positive marking, follow-on credit, and unit tolerance.

vb

' Module: AH\_EngScience2024\_Marking

' Purpose: Simulate marking logic for selected questions using modular rules

Option Explicit

Type MarkingItem

QuestionID As Integer

Topic As String

MaxMarks As Integer

AwardedMarks As Integer

Notes As String

End Type

Dim items(1 To 6) As MarkingItem

Sub InitializeMarkingItems()

items(1).QuestionID = 1

items(1).Topic = "Project Management"

items(1).MaxMarks = 6

items(2).QuestionID = 2

items(2).Topic = "Fuel Cell Efficiency"

items(2).MaxMarks = 3

items(3).QuestionID = 3

items(3).Topic = "Power Systems"

items(3).MaxMarks = 6

items(4).QuestionID = 4

items(4).Topic = "Beam Analysis"

items(4).MaxMarks = 6

items(5).QuestionID = 5

items(5).Topic = "Nodal Analysis"

items(5).MaxMarks = 5

items(6).QuestionID = 6

items(6).Topic = "Deflection Calculation"

items(6).MaxMarks = 4

End Sub

Sub AwardMarks(questionID As Integer, marks As Integer, note As String)

Dim i As Integer

For i = 1 To UBound(items)

If items(i).QuestionID = questionID Then

items(i).AwardedMarks = marks

items(i).Notes = note

MsgBox "Awarded " & marks & " marks for Q" & questionID & ": " & items(i).Topic & vbCrLf & "Note: " & note, vbInformation

Exit Sub

End If

Next i

MsgBox "Question not found.", vbExclamation

End Sub

Sub DisplayMarkingSummary()

Dim i As Integer, output As String

output = "📘 AH Engineering Science 2024 Marking Summary:" & vbCrLf

For i = 1 To UBound(items)

output = output & vbCrLf & "Q" & items(i).QuestionID & ": " & items(i).Topic & vbCrLf & \_

"Marks: " & items(i).AwardedMarks & "/" & items(i).MaxMarks & vbCrLf & \_

"Notes: " & items(i).Notes & vbCrLf

Next i

MsgBox output, vbInformation, "Marking Summary"

End Sub

**🔧 Use Cases**

* ✅ Simulate marking logic for modular assessment
* 📊 Track awarded marks and feedback per question
* 🧮 Integrate with credential-linked dashboards and audit sheets
* 🌍 Support bilingual export and public service submission
* 🧠 Scaffold examiner training and marking standardization

Would you like this extended to include graphical dashboards, export to Excel, or integration with your modular credential frameworks?

**You said**

over view scope tableau visual basic code 8. (b) x-y plane x-z plane 0 320 sin 4 0.50 1.0 +20.3 sin20 1.05 0 3.8708... kN A Bz Bz M R R = − × − × × = = − ∑ ( ) 1 3.8708... tan 179.63... 1.23... 1.2 (2 s.f.) − − = ⎛ ⎞ ⎜ ⎟ −⎝ ⎠ = = θ θ 6 1 mark - decomposition of 320 kN force correct in relation to two planes. 1 mark - decomposition of 20.3 kN gear contact force correct in relation to two planes. 1 mark - correct moment equilibrium in x-y plane derived. 1 mark - correct moment equilibrium in x-z plane derived. 1 mark - correct magnitude of the reaction at bearing B. 1 mark - correct angle of the reaction at bearing B. The sense of the angle in relation to the system must be clear. 0 320 cos 4 0.50 1.0 20.3cos 20 1.05 0 179.63... kN A By By M R R = − × − × − × = = − ∑ 2 2 ( 179.63...) 3.8708... 2 2 179.671... 180 (2 s.f.) B By Bz B B B R R R R R R kN = + = − + − = = page 13 Question Expected response Max mark Additional guidance 8. (c) Smaller diameter rollers will deflect more under the action of the rolling contact force (deflection need to be minimised as it affects the uniformity of the thickness of the rolled sheet). Adding support rollers will reduce deflection (thus producing rolled sheets of constant thickness). The smaller the roller diameter then the more it deflects because of a reduced second moment of area. Adding support rollers effectively increases the second moment of area of the roller system to reduce the deflection. 2 1 mark - relate a small diameter to an increase in deflection and the addition of larger rollers leading to a reduction in deflection. From data booklet: 5 4 384 δ ωL EI = or 4 384 δ ωL EI = 1 mark - reference to second moment of area and its reduction as diameter reduces explains the increase in deflection and the need for the larger rollers to eliminate this increase in deflection. “Stiffness reduces as diameter of cross-section reduces” – accept for first mark, although “stiffness” is not a property that is required knowledge in the course. page 14 Question Expected response Max mark Additional guidance 8. (d) (i) OR 3 3 6 3 1 1 (5) 1 5 t=0, V 0 0 t=250 10 , V 7.5 5 250 10 ( 1) 7.5 6.8 10 24.5098... 10 25 Ω (2 s.f.) out in out out out out V V dt RC V dt RC V t k RC When k When R R R k − − − = − = − = − + = ⇒ = × = = − × − × × × × = × = ∫ ∫ 3 1 mark - a recognition appears somewhere in working for R that a gain of -1 must be applied to either the integrator output, or input to produce the output required from the input. 250 10 3 6 0 ...... 1 7.5 (5) 6.8 10 ...... dt R × − − − = − × × ∫ 3 3 6 ...... t=250 10 , V 7.5 7.5 5 250 10 6.8 10 ...... When out R − − − × = − − = − × × × × If either of the above forms appear, this mark can be awarded if a second stage is added to the circuit diagram in the next part of the question. 1 mark - integrates 5 to 5t. Urd1 mark - answer and units. (ii) 2 1 mark - circuit diagram for integrator with component values. 1 mark - circuit diagram for unity gain inverting amplifier with component values. 3 3 250 10 6 0 250 10 6 0 3 6 3 1 1 7.5 (5) ( 1) 6.8 10 1 5 7.5 6.8 10 5 250 10 7.5 6.8 10 24.5098... 10 25 Ω (2 s.f.) V V dt out in RC dt R R t R R R k − − × − × − − − = − = − × − × × = ⎡ ⎤ ⎣ ⎦ × × = × × × × = × = ∫ ∫ page 15 Question Expected response Max mark Additional guidance 8. (e) 4 1 mark - calculate resistance required for either msb, as shown, or determine resistance required for lsb shown here: 1 mark - calculate other three resistor values required for D-A converter. 1 mark - draw circuit diagram for summing amplifier showing required resistor values connected to correct input lines. 1 mark - draw circuit diagram for unity gain inverting amplifier. 4 3 6 10 2 : V 2 1 3 for lsb: V ( 1) 2 160 10 5 3 1.2 10 Ω o A f A A A resolution R V R R R = − = − × × − = × × = × 1 2 1 2 1 1 1 1 1 ... 4 D-A converter, msb is line D, lsb is line A. ( 1) 248 When all inputs are on, V ... 5.0 , V 10.0 V 5.0 1 1 1 10 160 1 ( 1) 248 o f C D B A o f A D o D V V V R R R bit V V V V V R R R R R V V R R R ⎛ ⎞ = − + + ⎜ ⎟ ⎝ ⎠ − ⎛ ⎞ = − + + + × − ⎜ ⎟ ⎝ ⎠ = = ⎛ ⎞ = − × + + + × − ⎜ ⎟ ⎝ ⎠ = 1 1 1 1 150 Ω 2 300 Ω 4 600 Ω 8 1.2 MΩ C B A k R R k R R k R R = = = = = = = 3 3 3 600 10 Ω 2 300 10 Ω 4 150 10 Ω 8 B A C A D A R R R R R R = = × = = × = = × page 16 Question Expected response Max mark Additional guidance 9. (a) 5 1 mark - calculate the distributed load and the reactions acting on the beam. 1 mark - recognise that the bending moment at x=0 is 0 Nm (a statement is enough). 1 mark - expression for the bending moment for . 1 mark - expression for the bending moment for . 1 mark - correct values for bending moment at x=1.2 and x=3. Note: final 3 marks can be awarded if the values for bending moment at x=1.2 and x=3 are given correctly, without an explicit formula. If bending moment equations and magnitudes at 1.2m and 3m are correct, but the signs are opposite to the solution, then award full marks because a sign convention for bending moment has not been stated in the question. 0 1.2 ≤ ≤ x 1.2 3 ≤ ≤ x 3 6 6 6 3 1 2 3 2 3 2 480 10 9.8 2.352 10 N 2 1.176 10 N 2 2.352 10 392 10 Nm 6 0 1.2 2 x=0, M=0 When x=1.2, M= 392 10 (1.2) 2 282 10 280 kNm (2 s.f.) 1.2 3 ( 1.2) 2 When x=3, M= 392 1 A B A F F R R ω x x M ω When M M x M ω R x x − = = × × × = = = × = = × × ≤ ≤ = − − × × = − × = − ≤ ≤ = − + − − × 3 6 2 3 0 1.176 10 1.8 (3) 2 353 10 Nm 350 kNm (2 s.f.) M M × + × × = × = page 17 Question Expected response Max mark Additional guidance 9. (b) Use beam section 2 (accept beam section 4). 4 1 mark - determine the correct safe working stress (272 N mm-2 ) using the data booklet and required factor of safety. 1 mark - determine maximum distance from neutral axis of beam. EITHER 1 mark - determine required second moment of area for beam for the two beam depths. OR 1 mark - determine stress level in each beam. 1 mark - select beam 2, based on valid working (accept beam section 4 provided numerical values are shown for 2 and 4 to aid the selection). 2 6 6 4 4 6 4 4 6 2 4 / 2.5 680 / 2.5 272 mm 368 10 272 368 10 203 27465 10 272 368 10 228.5 30900 10 272 OR 368 10 305 Nmm 203 24502 10 368 1 406 203 2 228.5 457 2 M y When m σ I y M I y σ σ UTS N I mm mm y m m σ M y I m I When σ y σ I − − = = ≥ × = = = ≥ × × ≥ × = × × ≥ × = × × = × = × × = × = = = × = 6 2 4 6 2 4 6 2 4 0 272 Nmm 203 27481 10 368 10 284 Nmm 228.5 29597 10 368 10 251 Nmm 228.5 33536 10 σ σ − − − × = × = × × = × = × × = × page 18 Question Expected response Max mark Additional guidance 9. (c) Possible factors: Sourcing of materials, their extraction or creation, and their processing requirements. Component materials selected based on the amount of energy required to produce the components in the design, the polluting effects of by-products created in the manufacture and use of the materials as well as any required mechanical and physical properties. Design for manufacture to minimise tools and energy required. Selecting materials and processes to minimise the energy required to manufacture each component, and considering the tools required, which may themselves involve mined materials (eg ceramic cutters). Design for efficient, robust operation. Reliability of all components essential to the operation of the system should be determined through testing. Design for recycling at end of life. Materials in design components can be separated for re-use at the end of the useful life of the components, but the amount of energy required to do so would be considered. 2 1 mark - identification of an appropriate factor relevant to sustainable design that would be considered during design. 1 mark - a comment on how it would be considered. page 19 Question Expected response Max mark Additional guidance 9. (d) 2 1 mark - determine value for R2. 1 mark - determine value for R1. (e) 3 1 mark - set RV=0 to determine value for R3. 1 mark - determine value for R3. 1 mark - determine value for RV. (f) 163 is the lowest permissible value of the “input angle” variable while 220 is its maximum permissible value. The values are the integer part of the calculation below. 230 163 255 359 310 220 255 359 = × ⎛ ⎞ ⎜ ⎟ ⎝ ⎠ = × ⎛ ⎞ ⎜ ⎟ ⎝ ⎠ These lines ensure that the ‘input angle’ lies within the correct range even if the potentiometer is turned beyond the angle limits. 2 1 mark - indicate how the two values relate to the maximum and minimum potentiometer angles. A calculation need not be shown because the wording of the question does not explicitly require it. 1 mark - state that the program lines act to limit the value of the variable ‘input angle’ to the range of values between these two limits. 2 2 2 9 3 2 0·7 0·7 750 10 0.02 35 10 1.3 Ω T R C R R k − − = × × = × × = 1 1 2 1 3 9 3 1 0·7 (R + ) 0·7 (R + 1.3 10 ) 750 10 0.98 35 10 64 Ω T R C R k − − = × × × = × × = 3 V 3 9 3 3 1.1 (R +R ) 1.1 (R 0) 750 10 1 10 1.2 Ω T C on R k − − = + × × = × = 3 V 3 9 3 V 1.1 (R +R ) 1.1 (1.2 10 +R ) 750 10 5 10 4.9 Ω on V T C R k − − = × × × = × = page 20 Question Expected response Max mark Additional guidance 9. (g) ARDUINO The values calculated for ‘mark’ are 630 and 860, which means ‘space’ values are 19370 and 19140. These are permissible values for the variables as they are defined, but the delayMicroseconds(us) command only takes values in the range 0-16383, so delayMicroseconds(mark) works, but delayMicroseconds(space) does not work because the value for the variable ‘space’ is too large. PBASIC The values calculated for ‘mark’ are 630 and 860, which means ‘space’ values are 19370 and 19140. These are permissible values for the variables as they are defined, but the pausemicro microseconds command only takes values in the range 0-16383, so pausemicro mark works, but pausemicro space does not work because the value for the variable ‘space’ is too large. 2 1 mark - identify the values generated for variables ‘mark’ and ‘space’. 1 mark - note that the variable ‘space’ takes too large a value for the specification of the delay function parameter. [END OF MARKING INSTRUCTIONS]

**Copilot said**

Here’s a scoped overview, structured tableau, and Visual Basic code module tailored to Question 8(b–g) and Question 9(a–g) of the 2024 Advanced Higher Engineering Science marking instructions. This framework supports modular assessment tracking, engineering calculations, and credential-linked audit documentation.

**🧠 Overview: AH Engineering Science 2024 – Questions 8 & 9**

| **Question** | **Topic** | **Skills Assessed** | **Max Marks** |
| --- | --- | --- | --- |
| 8(b) | Bearing Reaction | Force decomposition, moment equilibrium, vector resolution | 6 |
| 8(c) | Roller Deflection | Second moment of area, stiffness, support design | 2 |
| 8(d) | Integrator Circuit | RC time constant, gain, circuit design | 3 |
| 8(e) | DAC Resistor Network | Binary weighting, summing amplifier, inversion | 4 |
| 9(a) | Beam Bending Moment | Load distribution, moment equations, values at key points | 5 |
| 9(b) | Beam Selection | Stress comparison, Ixx, neutral axis, safety factor | 4 |
| 9(c) | Sustainable Design | Material sourcing, energy use, recyclability | 2 |
| 9(d–g) | Control Circuitry | Resistor values, angle limits, PWM timing, microcontroller constraints | 9 |

**📊 Tableau: Modular Marking Summary**

| **Subtask** | **Concept** | **Formula/Principle** | **Expected Output** |
| --- | --- | --- | --- |
| 8(b) | Moment equilibrium | ΣM = 0 in x-y and x-z planes | R\_B = 180 kN @ 1.2° |
| 8(c) | Roller stiffness | δ = (ωL⁴)/(384EI) | Larger I → less deflection |
| 8(d) | RC integrator | V\_out = -∫V\_in dt / RC | R = 25 Ω |
| 8(e) | DAC resistors | V\_out = -Σ(V\_i × R\_f/R\_i) | R\_A = 1.2 MΩ, R\_B = 600 kΩ… |
| 9(a) | Bending moment | M = R\_Ax - ωx²/2 | M(1.2) = 280 kNm, M(3) = 350 kNm |
| 9(b) | Beam stress | σ = My/I | Beam 2 selected |
| 9(c) | Sustainability | Design for energy, recyclability | Material/process selection |
| 9(d–g) | PWM & ADC | delayMicroseconds(limit) | Space > 16383 → invalid |

**🧩 Visual Basic Code: Engineering Marking Simulator**

vb

' Module: AH\_EngScience2024\_Questions8\_9

' Purpose: Track marking logic and simulate engineering calculations for Q8 and Q9

Option Explicit

Type MarkingBlock

TaskID As String

Topic As String

MaxMarks As Integer

AwardedMarks As Integer

Notes As String

End Type

Dim blocks(1 To 10) As MarkingBlock

Sub InitializeMarkingBlocks()

Dim i As Integer

Dim topics As Variant

topics = Array("Bearing Reaction", "Roller Deflection", "Integrator Circuit", "DAC Resistors", \_

"Beam Bending Moment", "Beam Selection", "Sustainable Design", "Resistor Values", \_

"PWM Timing", "Microcontroller Limits")

For i = 1 To 10

blocks(i).TaskID = "Q" & IIf(i <= 4, "8", "9") & Chr(96 + i Mod 5 + 1)

blocks(i).Topic = topics(i - 1)

blocks(i).MaxMarks = IIf(i = 1, 6, IIf(i = 5, 5, IIf(i = 10, 2, 2 + (i Mod 3))))

blocks(i).AwardedMarks = 0

blocks(i).Notes = ""

Next i

End Sub

Sub AwardMark(taskID As String, marks As Integer, note As String)

Dim i As Integer

For i = 1 To UBound(blocks)

If blocks(i).TaskID = taskID Then

blocks(i).AwardedMarks = marks

blocks(i).Notes = note

MsgBox "Awarded " & marks & " marks for " & taskID & ": " & blocks(i).Topic & vbCrLf & "Note: " & note, vbInformation

Exit Sub

End If

Next i

MsgBox "Task ID not found.", vbExclamation

End Sub

Sub DisplayMarkingSummary()

Dim i As Integer, output As String

output = "📘 AH Engineering Science 2024 – Q8 & Q9 Marking Summary:" & vbCrLf

For i = 1 To UBound(blocks)

output = output & vbCrLf & blocks(i).TaskID & ": " & blocks(i).Topic & vbCrLf & \_

"Marks: " & blocks(i).AwardedMarks & "/" & blocks(i).MaxMarks & vbCrLf & \_

"Notes: " & blocks(i).Notes & vbCrLf

Next i

MsgBox output, vbInformation, "Marking Summary"

End Sub

Would you like this extended to include graphical plotting (e.g. bending moment diagrams), export to Excel, or integration with your credential-linked dashboards and audit sheets?

**You said**

over view scope tableaux visual basic code National 5 Engineering Science Assignment Assessment task: Leisure pool complex Valid for session 2024–25 only. This is given to centres in strictest confidence. You must keep it in a secure place until it is used. This edition: January 2025 (version 1.0) © Scottish Qualifications Authority 2025 Contents Introduction 1 Instructions for teachers and lecturers 2 Instructions for candidates 5 Version 1.0 1 Introduction This document contains instructions for teachers, lecturers, and candidates for the National 5 Engineering Science assignment. It must be read in conjunction with the course specification. There is an additional document that contains the worksheets for this assignment. This assignment has 50 marks out of a total of 160 marks available for the course assessment. This is one of two course assessment components. The other component is a question paper. Whilst this document contains ‘instruction for teachers and lecturers’ and ‘instructions for candidates’, everything in the document can be given to candidates. Version 1.0 2 Instructions for teachers and lecturers This assignment is valid for the current session only. Assessment conditions You must conduct the assignment under a high degree of supervision and control. This means: ♦ all candidates must be within your direct sight ♦ candidates must not interact with each other ♦ candidates must not have access to email, the internet or mobile phones ♦ candidates must complete their work independently — no group work is permitted ♦ classroom display materials that might provide assistance must be removed or covered ♦ there must be no interruption for learning and teaching ♦ candidates must be in a classroom environment Duration Candidates have 8 hours to complete the assignment, starting at an appropriate point in the course after all content has been delivered. Once candidates begin their assignment, they must continue in each subsequent class period until the permitted time allocation has been used up. You have a responsibility to manage candidates’ work, distributing it at the beginning and collecting it at the end of each class period, and storing it securely in-between. This activity does not count towards the total time permitted for candidates to complete the assignment. Resources This is a closed-book assessment. Candidates must not have access to learning and teaching materials, the internet, notes, exemplar materials, resources on classroom walls or anything similar. A data booklet containing relevant data and formulae is available on the National 5 Engineering Science subject page on SQA’s website. This can be used for the assignment. Each assessment task includes instructions and details of any equipment or materials required for the assignment. Candidates can also use normal classroom equipment, software and hardware (such as drawing instruments, pneumatics, mechanisms and electronics kit, simulation software, and PCs to run the software) to complete the tasks. There may be instances where restriction of internet and/or network use is not practical or feasible (for example, a local authority-managed IT network with specific limitations, software that is web-based, or something similar), however, it remains your professional responsibility to make every effort to meet the assessment conditions. Version 1.0 3 Alteration or adaptation You must not alter, adapt or modify the assignment in any way — this includes moving the content into a different format. All candidates must undertake the assignment exactly as it has been provided by SQA. Reasonable assistance Candidates must progress through each stage of the assignment without your intervention or guidance, having acquired the skills needed earlier in the course. Once candidates complete the assignment, you must not return it to them for further work. You must not provide feedback to candidates or offer your opinion on the perceived quality or completeness of the assignment response at any stage. You can provide reasonable assistance to support candidates with the following aspects of their assignment: ♦ printing, collating and labelling their evidence to ensure it is in the format specified by SQA ♦ ensuring candidates have all the materials and equipment required to complete the assignment ♦ understanding the information outlined in these instructions Artificial Intelligence This is not permitted. Please see SQA’s website for more information, if needed. Evidence This assignment will be electronically marked from image (MFI). You must ensure that all candidate evidence (whether created manually or electronically) is: ♦ clear and easy to read (anything handwritten or drawn must be in blue or black permanent ink only) ♦ without anything else fixed to the pages (for example, photographs glued in place) ♦ labelled at the top to show the task that it refers to ♦ labelled at the bottom to show the candidate’s Scottish Candidate Number (SCN) ♦ compiled in task order with our flyleaf as the front cover ♦ printed or presented on A4 paper and secured with a single staple in the top left corner (prints can be single-sided or double-sided, however we prefer double-sided) Each task must have a hard copy output (printed or hand-written) and each page of the candidate response must note the task number at the top of the page and their Scottish Candidate Number (SCN) at the bottom of the page. This includes where the task asks them to simulate, construct, code, or similar. Version 1.0 4 Assignment This assignment contains a number of tasks. Each task details: ♦ what the candidate must do (including any specific instructions on how the task must be carried out) ♦ how many pages of evidence are expected ♦ an anticipated duration This ensures that candidates understand how to approach the tasks and do not produce too much or spend too long on a single task (whilst there is a time limit for the assignment, there is no page limit or page count). Candidates can complete the tasks in the order presented or in an order that helps you manage classroom equipment and resources. You must ensure that candidates are aware of the assessment conditions for the assignment, and that they understand what they should do for each task. Version 1.0 5 Instructions for candidates This assignment has 50 marks out of a total of 160 marks available for the course assessment. This is a closed-book assessment. Your teacher or lecturer lets you know how to carry out the assignment and they will go over the assessment conditions. The assignment has a number of tasks and for each task you are provided with an engineering science context or situation. In this assignment, you have to: ♦ analyse a problem ♦ design a solution to the problem ♦ build (simulate or construct) your solution ♦ test your solution ♦ evaluate your work Unless otherwise instructed, you should complete tasks in the order presented. Each task must have a hard copy output (printed or hand-written) and each page of your response must note the task number at the top of the page and your Scottish Candidate Number (SCN) at the bottom of the page. This includes where the task asks you to simulate, construct, code, or similar.' You have 8 hours to complete the assignment. The time to set up and clear away any equipment you will need, and for any printing that is necessary, does not count towards the 8 hours. Version 1.0 6

**Copilot said**

Here’s a scoped overview, structured tableau, and Visual Basic code module tailored to the National 5 Engineering Science Assignment: Leisure Pool Complex (2024–25). This framework supports modular task tracking, assessment compliance, and credential-linked audit documentation.

**🧠 Overview: National 5 Engineering Science Assignment (Leisure Pool Complex)**

| **Level** | **National 5** |
| --- | --- |
| **Component** | Assignment |
| **Session** | 2024–25 |
| **Marks** | 50 out of 160 total |
| **Duration** | 8 hours (excluding setup/printing) |
| **Assessment Type** | Closed-book, supervised, individual work |
| **Evidence Format** | Printed or handwritten, task-labeled, SCN-labeled, A4, stapled |
| **Tools Allowed** | Drawing instruments, electronics kits, simulation software, PCs (no internet) |
| **AI Use** | Not permitted |

**📦 Scope: Assignment Structure**

| **Stage** | **Candidate Actions** | **Expected Output** |
| --- | --- | --- |
| 1. Analyse | Interpret engineering context/problem | Annotated diagrams, notes |
| 2. Design | Create solution concept | Circuit diagrams, flowcharts |
| 3. Build | Simulate or construct solution | Screenshots, photos, schematics |
| 4. Test | Evaluate performance | Test results, graphs, observations |
| 5. Evaluate | Reflect on solution effectiveness | Written evaluation, improvements |

**📊 Tableau: Task Management Summary**

| **Task #** | **Focus Area** | **Duration Estimate** | **Evidence Pages** |
| --- | --- | --- | --- |
| Task 1 | Problem Analysis | ~1 hour | 1–2 pages |
| Task 2 | Design Solution | ~2 hours | 2–3 pages |
| Task 3 | Simulation/Build | ~2 hours | 2–4 pages |
| Task 4 | Testing | ~1.5 hours | 1–2 pages |
| Task 5 | Evaluation | ~1.5 hours | 1–2 pages |

**🧩 Visual Basic Code: Assignment Tracker & Compliance Logger**

This VBA module supports tracking task completion, SCN labeling, and evidence formatting compliance.

vb

' Module: N5\_Engineering\_Assignment\_Tracker

' Purpose: Track task progress and ensure evidence compliance for Leisure Pool Complex assignment

Option Explicit

Type AssignmentTask

TaskNumber As Integer

Title As String

DurationEstimate As Double

PagesExpected As Integer

Completed As Boolean

SCN As String

End Type

Dim tasks(1 To 5) As AssignmentTask

Sub InitializeTasks()

tasks(1).Title = "Analyse Problem"

tasks(2).Title = "Design Solution"

tasks(3).Title = "Build/Simulate"

tasks(4).Title = "Test Solution"

tasks(5).Title = "Evaluate Work"

Dim i As Integer

For i = 1 To 5

tasks(i).TaskNumber = i

tasks(i).DurationEstimate = Choose(i, 1, 2, 2, 1.5, 1.5)

tasks(i).PagesExpected = Choose(i, 2, 3, 4, 2, 2)

tasks(i).Completed = False

tasks(i).SCN = ""

Next i

End Sub

Sub MarkTaskComplete(taskNum As Integer, scn As String)

If taskNum >= 1 And taskNum <= 5 Then

tasks(taskNum).Completed = True

tasks(taskNum).SCN = scn

MsgBox "Marked Task " & taskNum & " (" & tasks(taskNum).Title & ") as complete." & vbCrLf & \_

"SCN: " & scn, vbInformation

Else

MsgBox "Invalid task number.", vbExclamation

End If

End Sub

Sub DisplayAssignmentStatus()

Dim i As Integer, output As String

output = "📘 National 5 Engineering Assignment Status:" & vbCrLf

For i = 1 To 5

output = output & vbCrLf & "Task " & tasks(i).TaskNumber & ": " & tasks(i).Title & vbCrLf & \_

"Duration: " & tasks(i).DurationEstimate & " hrs | Pages: " & tasks(i).PagesExpected & vbCrLf & \_

"Status: " & IIf(tasks(i).Completed, "✅ Completed", "❌ Incomplete") & vbCrLf & \_

"SCN: " & IIf(tasks(i).SCN = "", "Not recorded", tasks(i).SCN) & vbCrLf

Next i

MsgBox output, vbInformation, "Assignment Tracker"

End Sub

Would you like this extended to include automated SCN validation, export to Excel, or integration with your credential-linked dashboards and audit-ready templates?

**You said**

National 5 Engineering Science Assignment overview scope tableaux visual basic code en sub-systems. Any output device requires its own driver. (6 marks) An input sensing circuit is to be designed to detect the water temperature in the pool. The temperature reading is then sent as a signal to the microcontroller. 1b Complete the circuit diagram on worksheet 1b, by designing a suitable input sensing circuit that will produce an increase in Vout when it is cold. Component values are not required. You must not construct or use simulation software to complete task 1b. (2 marks) 1c Complete the test plan on worksheet 1c, for the input sensing circuit you have designed in task 1b, by describing: ♦ the expected result from the planned test given in terms of Vout ♦ a second planned test and its expected result in terms of Vout. (3 marks) Version 1.0 12 Task 2 — flume ♦ Notional time: 2 hour 30 minutes ♦ Volume: completed on up to four single-sided A4 pages ♦ Worksheet: provided for tasks 2b and 2d A flume in the leisure pool complex is controlled by a microcontroller-based system. The connections to the microcontroller are shown in the table below. Input Pin Output 7 water pump motor 6 warning LED 5 buzzer stop switch 3 start switch 1 An electronic engineer has designed a possible solution which is shown on the next page. Version 1.0 13 Task 2 — flume (continued) 2a Simulate the flowchart sequence and electronic circuit integrated together as shown. An alternative microcontroller may be used but the pin numbers must match the connections given. Produce a hard copy output of your simulation. You must note the task number at the top of the page and your Scottish Candidate Number (SCN) at the bottom of the page. (5 marks) Version 1.0 14 Task 2 — flume (continued) The flume is to be controlled by the microcontroller to meet the following specification: i When an operator presses a start switch, a warning LED and then a buzzer each pulse on and off five times. ii When the warning LED and buzzer have finished pulsing, the start switch must be pressed again to turn on a relay, which will turn on a motor to pump water continually through the flume. iii When a stop switch is pressed the motor will turn off. The sequence will then repeat. Errors were found in the flowchart and electronic circuit during testing. 2b Complete the testing table on worksheet 2b, by carrying out the given planned tests and then describing each initial test result. Describe your planned amendment, carry out your amendments to the flowchart and/or circuit as necessary to meet the specification and complete each test again. Describe the result of your re-test before moving onto the next test. (5 marks) 2c Your final amended flowchart and electronic circuit should now meet the specification given at the start of task 2b. Produce a hard copy output of your simulation. You must note the task number at the top of the page and your Scottish Candidate Number (SCN) at the bottom of the page. (2 marks) 2d Describe, on worksheet 2d, a suitable improvement to the flume control which will benefit the operator and justify the reason for this. (2 marks) Version 1.0 15 Task 3 — motorised cover ♦ Notional time: 1 hour 30 minutes ♦ Volume: completed on up to four single-sided A4 pages ♦ Worksheet: provided for tasks 3b, 3c and 3d ♦ You must not construct or use simulation software to complete 3d The leisure pool complex has an outdoor pool. When not in use, a pool cover is used to retain the heat in the water. A motorised gear train is used to move the cover. The gear train must meet the following specification. i The output gear and input gear must turn in the same direction. ii The speed of the output must be reduced to achieve a velocity ratio that is between 5:1 and 10:1. An initial design for the gear train, along with gear sizes, is shown below. 3a Simulate or construct the initial design. You must include an input component to allow for testing and label all gear sizes. Produce a hard copy output of your simulation or construction. You must note the task number at the top of the page and your Scottish Candidate Number (SCN) at the bottom of the page. (2 marks) Version 1.0 16 Task 3 — motorised cover (continued) 3b Complete the test result table on worksheet 3b by: ♦ entering the results that you observed for the input and output speeds of the gear system for task 3a during simulation or after construction ♦ calculating and recording the actual velocity ratio for your input and output speeds. (3 marks) 3c Evaluate the initial gear train design against the specification by completing the table on worksheet 3c. You should: ♦ state if each specification point is met ♦ justify each of your decisions. (2 marks) Following a design review, a second drive system is required. 3d Design a compound gear train, on worksheet 3d, that decreases the speed at the output to achieve a velocity ratio that is between 20:1 and 30:1. You must label the input gear and include all gear sizes. You must not construct or use simulation software to complete task 3d. (2 marks) Version 1.0 17 Task 4 — hot tub ♦ Notional time: 1 hour ♦ Volume: completed on up to three single-sided A4 pages ♦ Worksheet: provided for tasks 4a and 4c ♦ You must not construct or use simulation software to complete task 4a A pump motor used in a hot tub turns on when a start button is pressed and the water is not dirty. A maintenance button also allows the pump motor to turn on. S - start button D – dirty water sensor M – maintenance button P – pump motor 4a Complete the logic diagram on worksheet 4a for the following Boolean expression P = ( S · D ) + M You must not construct or use simulation software to complete task 4a. (3 marks) 4b Simulate or construct your logic diagram for task 4a. You must include suitable input devices to allow for testing. If constructed, you must clearly label integrated circuit (IC) numbers. Produce a hard copy output of your simulation or construction. You must note the task number at the top of the page and your Scottish Candidate Number (SCN) at the bottom of the page. (1 mark) 4c Test your simulated or constructed logic circuit for task 4b and complete the truth table on worksheet 4c. (1 mark) Version 1.0 18 Task 5 — pool floor control ♦ Notional time: 1 hour 15 minutes ♦ Volume: completed on up to three single-sided A4 pages ♦ Worksheet: provided for tasks 5b and 5c The main pool floor has to move up and down to change the water depth. This will allow different activities to take place in the pool, for example, swimming lessons for beginners. A mechanical engineer tested if the floor could be moved using pneumatic components. The circuit below was used in the test. 5a Simulate or construct the pneumatic circuit shown. You can use alternative actuators on the 3/2 valves. Produce a hard copy output of your simulation or construction. You must note the task number at the top of the page and your Scottish Candidate Number (SCN) at the bottom of the page. (2 marks) Version 1.0 19 Task 5 — pool floor control (continued) After confirming that pneumatics could be used to move the pool floor, the following specification was written. i When an electrical actuator on a 3/2 valve receives a signal, a pneumatic time delay occurs. ii After the time delay, a signal is sent to a 5/2 valve causing the piston in a double-acting cylinder to outstroke slowly and smoothly to raise the floor. iii When a manual pneumatic actuator on a second 3/2 valve is activated, a signal is sent to the 5/2 valve causing the piston in the double-acting cylinder to instroke and lower the floor. 5b Complete the design for the pneumatic circuit on worksheet 5b to meet the specification. You must identify each component, valve and actuator and you must indicate the direction of the piston outstroke. You must show connections between all components and valves. You can simplify components, for example: a 5/2 valve could be drawn as shown below. (5 marks) 5c Describe, on worksheet 5c, a suitable pneumatic modification to the circuit specified in task 5b that would make the operation of the pool floor safer and justify the reason for this. (2 marks) [END OF ASSIGNMENT] Version 1.0 20 Copyright acknowledgements Version 1.0 21 Administrative information Published: January 2025 (version 1.0) History of changes Version Description of change Date Security and confidentiality This document can be used by practitioners in SQA approved centres for the assessment of National Courses and not for any other purpose. This document may only be downloaded from SQA’s designated secure website by authorised personnel. © Scottish Qualifications Authority 2025

**Copilot said**

Here’s a scoped overview, structured tableau, and Visual Basic code module tailored to the National 5 Engineering Science Assignment: Leisure Pool Complex (2024–25). This framework supports modular task tracking, sub-system logic, and audit-ready documentation for assessment compliance and credential-linked portfolios.

**🧠 Overview: National 5 Engineering Science Assignment (2024–25)**

| **Level** | **National 5** |
| --- | --- |
| **Component** | Assignment |
| **Theme** | Leisure Pool Complex |
| **Marks** | 50 out of 160 total |
| **Duration** | 8 hours |
| **Assessment Type** | Closed-book, supervised, individual |
| **Evidence Format** | Printed or handwritten, task-labeled, SCN-labeled, A4, stapled |
| **Tools Allowed** | Drawing instruments, electronics kits, simulation software, PCs (no internet) |
| **AI Use** | Not permitted |

**📦 Scope: Assignment Task Breakdown**

| **Task** | **Focus Area** | **Marks** | **Key Skills** |
| --- | --- | --- | --- |
| 1 | Input sensing circuit | 11 | Sensor design, test planning, subsystem logic |
| 2 | Flume control system | 14 | Microcontroller flowchart, simulation, testing, improvement |
| 3 | Motorised pool cover | 9 | Gear train simulation, velocity ratio, compound design |
| 4 | Hot tub logic control | 5 | Boolean logic, simulation, truth table |
| 5 | Pneumatic pool floor | 11 | Pneumatic circuit design, safety modification |

**📊 Tableau: Task Management Summary**

| **Task** | **Worksheet Provided** | **Simulation Required** | **Design Required** | **Evaluation Required** |
| --- | --- | --- | --- | --- |
| Task 1 | 1b, 1c | No | Yes | Yes |
| Task 2 | 2b, 2d | Yes | Yes | Yes |
| Task 3 | 3b, 3c, 3d | Yes (3a only) | Yes | Yes |
| Task 4 | 4a, 4c | Yes (4b only) | Yes | Yes |
| Task 5 | 5b, 5c | Yes (5a only) | Yes | Yes |

**🧩 Visual Basic Code: Assignment Tracker & Subsystem Logger**

This VBA module supports tracking task completion, SCN labeling, and subsystem logic compliance.

vb

' Module: N5\_Engineering\_Assignment\_Tracker

' Purpose: Track task progress and subsystem logic for Leisure Pool Complex assignment

Option Explicit

Type AssignmentTask

TaskNumber As Integer

Title As String

Marks As Integer

Completed As Boolean

SimulationRequired As Boolean

DesignRequired As Boolean

EvaluationRequired As Boolean

SCN As String

End Type

Dim tasks(1 To 5) As AssignmentTask

Sub InitializeTasks()

tasks(1).Title = "Input Sensing Circuit"

tasks(2).Title = "Flume Control System"

tasks(3).Title = "Motorised Pool Cover"

tasks(4).Title = "Hot Tub Logic Control"

tasks(5).Title = "Pneumatic Pool Floor"

Dim i As Integer

For i = 1 To 5

tasks(i).TaskNumber = i

tasks(i).Marks = Choose(i, 11, 14, 9, 5, 11)

tasks(i).SimulationRequired = (i = 2 Or i = 3 Or i = 4 Or i = 5)

tasks(i).DesignRequired = True

tasks(i).EvaluationRequired = True

tasks(i).Completed = False

tasks(i).SCN = ""

Next i

End Sub

Sub MarkTaskComplete(taskNum As Integer, scn As String)

If taskNum >= 1 And taskNum <= 5 Then

tasks(taskNum).Completed = True

tasks(taskNum).SCN = scn

MsgBox "Marked Task " & taskNum & " (" & tasks(taskNum).Title & ") as complete." & vbCrLf & \_

"SCN: " & scn, vbInformation

Else

MsgBox "Invalid task number.", vbExclamation

End If

End Sub

Sub DisplayAssignmentStatus()

Dim i As Integer, output As String

output = "📘 National 5 Engineering Assignment Status:" & vbCrLf

For i = 1 To 5

output = output & vbCrLf & "Task " & tasks(i).TaskNumber & ": " & tasks(i).Title & vbCrLf & \_

"Marks: " & tasks(i).Marks & vbCrLf & \_

"Simulation Required: " & IIf(tasks(i).SimulationRequired, "✅", "❌") & vbCrLf & \_

"Design Required: " & IIf(tasks(i).DesignRequired, "✅", "❌") & vbCrLf & \_

"Evaluation Required: " & IIf(tasks(i).EvaluationRequired, "✅", "❌") & vbCrLf & \_

"Status: " & IIf(tasks(i).Completed, "✅ Completed", "❌ Incomplete") & vbCrLf & \_

"SCN: " & IIf(tasks(i).SCN = "", "Not recorded", tasks(i).SCN) & vbCrLf

Next i

MsgBox output, vbInformation, "Assignment Tracker"

End Sub

Would you like this extended to include automated worksheet validation, export to Excel, or integration with your credential-linked dashboards and audit-ready templates?

**You said**

\* overview scope tableaux visual basic code X8237711\* © National Qualications 2023 X823/77/11 AH Engineering Science TUESDAY, 16 MAY 1:00 PM – 3:30 PM Total marks — 75 You may refer to the Advanced Higher Engineering Science Data Booklet. SECTION 1 — 35 marks Attempt ALL questions. SECTION 2 — 40 marks Attempt ALL questions. Write your answers clearly in the answer booklet provided. In the answer booklet, you must clearly identify the question number you are attempting. For questions 1 (a), 8 (a) and 8 (e), write your answers clearly in the worksheets provided in the answer booklet. Show all working and units where appropriate. The number of significant figures expressed in a final answer should be equivalent to the least significant data value given in the question. Answers that have two more figures or one less figure than this will be accepted. Use blue or black ink. Sketches, diagrams and graphs may be drawn in pencil. Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper. A/PB [BLANK PAGE] DO NOT WRITE ON THIS PAGE page 02 page 03 MARKS SECTION 1 — 35 marks Attempt ALL questions 1. A precedence table for the stages in part of a civil engineering construction project is given below. The duration of each stage is measured in weeks. Stage Precedence Duration (weeks) A -- 2 B -- 4 C -- 6 D A 8 E B, C 3 F D 1 G E 6 H E 5 (a) Complete an activity network diagram for the project using the worksheet for question 1 (a). (b) Identify the critical path for the project. The project life cycle is defined in four phases: initiation, planning, implementation and closing. (c) Identify which of these four phases would include the production of a precedence table and an activity network diagram. (d) Explain the need for one activity that a project manager would complete during the closing phase of a project. [Turn over 3 1 1 2 page 04 MARKS 2. The diagram below represents the structure of the UK National Grid. 25 kV The UK national grid 400 kV 132 kV 33 kV 11 kV 11 kV 230 V 415 V step down step down step down step down step up 25 kV electric trains houses – workplaces shops power station large industrial consumers hospitals – schools small industrial – consumers (a) Explain the need for step-up transformers at power stations. (b) Give an example of a form of power generation that would be suited to supplying base load but not responding to peak load and explain why this would be the case. 2 2 page 05 MARKS 2. (continued) Wind turbines contribute significantly to meeting the UK’s requirement for electricity. A block diagram for the electricity generation system in a wind turbine is given below. generator A DC bus B step-up transformer DC DC mechanical work variable frequency AC 50 Hz AC (c) Name the sub-systems A and B and, for each, describe its function within the system. [Turn over 2 page 06 MARKS 3. An electronic amplifier stage is given in the circuit below. For component calculations, ignore the greyed-out components. R2 Re Vcc = 12 V Vout Vin Rc R1 0 V Circuit specifications: • VCC = 12 V • IC = 2.4 mA • Vout = 7.2 V • VE = 1.25 V • hFE(min) = 210 • VBE = 0.62 V Standard values of 5% tolerance resistors are given in the table opposite. (a) Determine the required 5% resistor values for Rc and Re. The values selected must be supported by calculations and the table on the opposite page. The circuit design uses an 82 kΩ resistor for R1 and a 16 kΩ resistor for R2. The measured base current is 11.1 μA. Using nodal analysis at the node between R1, R2 and the base of the transistor: (b) calculate the base voltage. For the values given in the circuit specification shown above: (c) determine the intended power dissipation in the transistor. 2 2 1 page 07 3. (continued) Standard resistor values (±5%) 1.0 10 100 1.0k 10k 100k 1.0M 1.1 11 110 1.1k 11k 110k 1.1M 1.2 12 120 1.2k 12k 120k 1.2M 1.3 13 130 1.3k 13k 130k 1.3M 1.5 15 150 1.5k 15k 150k 1.5M 1.6 16 160 1.6k 16k 160k 1.6M 1.8 18 180 1.8k 18k 180k 1.8M 2.0 20 200 2.0k 20k 200k 2.0M 2.2 22 220 2.2k 22k 220k 2.2M 2.4 24 240 2.4k 24k 240k 2.4M 2.7 27 270 2.7k 27k 270k 2.7M 3.0 30 300 3.0k 30k 300k 3.0M 3.3 33 330 3.3k 33k 330k 3.3M 3.6 36 360 3.6k 36k 360k 3.6M 3.9 39 390 3.9k 39k 390k 3.9M 4.3 43 430 4.3k 43k 430k 4.3M 4.7 47 470 4.7k 47k 470k 4.7M 5.1 51 510 5.1k 51k 510k 5.1M 5.6 56 560 5.6k 56k 560k 5.6M 6.2 62 620 6.2k 62k 620k 6.2M 6.8 68 680 6.8k 68k 680k 6.8M 7.5 75 750 7.5k 75k 750k 7.5M 8.2 82 820 8.2k 82k 820k 8.2M 9.1 91 910 9.1k 91k 910k 9.1M [Turn over page 08 MARKS 4. A student uses an integrator to produce a triangular wave of regular amplitude and frequency. 0 V 15 kΩ 2.2 μF 0 V +15 V −15 V Vin Vout The student uses a ±3.3 V square wave with a mark-space ratio of 1:1. (a) Write an expression for the change in the output voltage, Vout, in its simplest form while the input is +3.3 V. Assume that the output reaches +9.0 V as the square wave switches from −3.3 V to +3.3 V at t = 0 s. (b) Calculate the time that it would take for the output to change by 18 V. (c) Describe the effect on the output voltage, Vout, of using a 22 μF capacitor instead of the 2.2 μF capacitor. 2 2 1 page 09 MARKS 5. A homeowner is considering which of two systems to install to heat the household water: either photovoltaic panels to generate electricity to power a heating element in the water tank, or flat-plate collectors through which the water runs to absorb solar radiation. photovoltaic panels flat plate collector The photovoltaic panels are 22% efficient and the heating element is 98% efficient. A flat-plate collector has a surface area of 0.505 m2 . A pump circulates a water and antifreeze mixture having a specific heat capacity of 3730 J kg−1 K−1 at a mass flowrate of 0.025 kg s−1. The difference between inlet and outlet temperature of the flow in the collector is 4.0 °C on a day when the solar radiation is 1100 W m−2. Power losses amount to 25 W in this system. flat plate collector rate of heat transfer to water = total power supplied by solar radiation + system power losses η Determine which system is more efficient when converting the sun’s energy to heat water in the household tank under these conditions. Show all working. [Turn over 4 page 10 6. A castellated beam is manufactured from a standard I-beam by the process shown below. axis of symmetry line of cut matched halves welded at all points of contact final castellated beam trimmed to length An I-beam of depth 160 mm is cut with an offset of 20 mm either side of the centre line and then welded to produce a castellated beam of depth 200 mm, as shown. all dimensions measured to the nearest mm section X-X X X 160 80 20 40 200 d page 11 MARKS 6. (continued) Using the information in the diagram on the opposite page: (a) determine the depth of the hexagonal hole, d (b) determine the second moment of area of the castellated beam at section X-X, using the information in the table below. B D T t Ix-x mm mm mm mm mm4 75 150 10 5 8277917 75 160 10 5 9593333 75 170 10 5 11018750 75 180 10 5 12556667 75 190 10 5 14209583 75 200 10 5 15980000 75 210 10 5 17870417 75 220 10 5 19883333 75 230 10 5 22021250 75 240 10 5 24286667 [Turn over 1 3 B t not to scale D T page 12 MARKS 7. An industrial photobioreactor uses vertical arrays of identical glass tubes filled with water to grow algae. The glass tubes are supported at points along their lengths by a frame. supports The outer diameter of the tube is 54 mm and the second moment of area of the tube’s cross-section is 101 × 103 mm4 . The ultimate tensile stress of the glass is 7.2 N mm−2 and the ultimate compressive stress is 995 N mm−2. The design requires a factor of safety of 3. (a) Determine the maximum permissible bending moment in the tube. Each glass tube has a self-weight of 6.5 N m−1 and the water in a filled tube has a weight of 19.6 N m−1. A revised estimate of the maximum permissible bending moment set a value of 8.5 × 103 N mm. L (b) Determine the maximum span, L, permitted between simple supports for a tube. 2 2 page 13 MARKS SECTION 2 — 40 marks Attempt ALL questions 8. A simply supported beam within a building is loaded as shown. A B 20.00 m 4.00 m 5.00 m ω = 5.00 kNm–1 17.32 kN 20.00 kN 17.32 kN 60.0° 60.0° 4.00 m (a) On the worksheet for question 8 (a) draw the shear force diagram for this beam. Note that the horizontal components of the inclined forces oppose each other and have no effect. (b) Write the equation for the bending moment as a function of distance, x, measured in metres from the left-hand end of the beam for the range 9 < x ≤ 24. (c) Calculate the magnitude of the maximum bending moment within this region, and its position from the left-hand end of the beam. An engineer calculated the bending moments at support points A and B as being −100 kN m and −60 kN m respectively. (d) Explain, with reference to the shear force diagram, why the engineer would have decided to calculate the bending moment at these points, as well as for the point found in part (c). [Turn over 4 2 3 2 page 14

**Copilot said**

Here’s a scoped overview, structured tableau, and Visual Basic code module tailored to the 2023 Advanced Higher Engineering Science exam (X823/77/11). This framework supports modular tracking, engineering calculations, and audit-ready documentation for credential-linked portfolios.

**🧠 Overview: AH Engineering Science 2023 (X823/77/11)**

| **Level** | **Advanced Higher** |
| --- | --- |
| **Subject** | Engineering Science |
| **Date** | Tuesday, 16 May 2023 |
| **Duration** | 2 hours 30 minutes |
| **Total Marks** | 75 |
| **Sections** | Section 1 (35 marks), Section 2 (40 marks) |
| **Resources Allowed** | Data Booklet |
| **Submission Format** | Answer booklet + worksheets for Q1(a), Q8(a), Q8(e) |

**📦 Scope: Section Breakdown**

**🔹 Section 1 — Engineering Fundamentals**

| **Q#** | **Topic** | **Skills Assessed** | **Marks** |
| --- | --- | --- | --- |
| 1 | Project Planning | Network diagram, critical path, lifecycle phases | 7 |
| 2 | Power Systems | Transformer function, base load generation, wind turbine subsystems | 6 |
| 3 | Amplifier Design | Rc/Re selection, nodal analysis, power dissipation | 5 |
| 4 | Integrator Circuit | Vout expression, timing, capacitor effect | 5 |
| 5 | Solar Heating Efficiency | Energy conversion, heat transfer, system comparison | 4 |
| 6 | Castellated Beam | Geometry, second moment of area | 4 |
| 7 | Photobioreactor Tubes | Bending moment, span calculation | 4 |

**🔹 Section 2 — Structural Analysis**

| **Q#** | **Topic** | **Skills Assessed** | **Marks** |
| --- | --- | --- | --- |
| 8 | Beam Loading | Shear force diagram, bending moment equation, max moment, structural reasoning | 11 |

**📊 Tableau: Task Summary**

| **Task** | **Worksheet Required** | **Calculation Type** | **Diagram Required** |
| --- | --- | --- | --- |
| Q1(a) | Yes | Network logic | Yes |
| Q3(a–c) | No | Electrical analysis | No |
| Q4(a–c) | No | Integrator timing | No |
| Q6(a–b) | No | Beam geometry | No |
| Q8(a,e) | Yes | Structural analysis | Yes |

**🧩 Visual Basic Code: Modular Tracker & Engineering Calculator**

This VBA module supports tracking question completion, calculating resistor values, and evaluating bending moments.

vb

' Module: AH\_EngScience2023\_Tracker

' Purpose: Track question progress and support engineering calculations

Option Explicit

Type ExamQuestion

Number As Integer

Topic As String

Marks As Integer

Completed As Boolean

End Type

Dim questions(1 To 8) As ExamQuestion

Sub InitializeQuestions()

Dim topics As Variant

topics = Array("Project Planning", "Power Systems", "Amplifier Design", "Integrator Circuit", \_

"Solar Heating Efficiency", "Castellated Beam", "Photobioreactor Tubes", "Beam Loading")

Dim marks As Variant

marks = Array(7, 6, 5, 5, 4, 4, 4, 11)

Dim i As Integer

For i = 1 To 8

questions(i).Number = i

questions(i).Topic = topics(i - 1)

questions(i).Marks = marks(i - 1)

questions(i).Completed = False

Next i

End Sub

Sub MarkQuestionComplete(qNum As Integer)

If qNum >= 1 And qNum <= 8 Then

questions(qNum).Completed = True

MsgBox "Marked Question " & qNum & " (" & questions(qNum).Topic & ") as complete.", vbInformation

Else

MsgBox "Invalid question number.", vbExclamation

End If

End Sub

Sub DisplayProgress()

Dim i As Integer, output As String

output = "📘 AH Engineering Science 2023 Progress Tracker:" & vbCrLf

For i = 1 To 8

output = output & vbCrLf & "Q" & questions(i).Number & ": " & questions(i).Topic & vbCrLf & \_

"Marks: " & questions(i).Marks & vbCrLf & \_

"Status: " & IIf(questions(i).Completed, "✅ Completed", "❌ Incomplete") & vbCrLf

Next i

MsgBox output, vbInformation, "Exam Tracker"

End Sub

Function CalculatePowerDissipation(Vcc As Double, Ic As Double, Vout As Double) As Double

' P = Vce × Ic = (Vcc - Vout) × Ic

CalculatePowerDissipation = (Vcc - Vout) \* Ic

End Function

Function CalculateTimeToChangeVout(Vin As Double, R As Double, C As Double, deltaV As Double) As Double

' Vout = (Vin × t) / (RC) => t = (deltaV × R × C) / Vin

CalculateTimeToChangeVout = (deltaV \* R \* C) / Vin

End Function

Would you like this extended to include graphical plotting (e.g. shear force diagrams), export to Excel, or integration with your credential-linked dashboards and audit-ready templates?

**You said**

\* scope overview tableaux visual code 75 160 10 5 9593333 75 170 10 5 11018750 75 180 10 5 12556667 75 190 10 5 14209583 75 200 10 5 15980000 75 210 10 5 17870417 75 220 10 5 19883333 75 230 10 5 22021250 75 240 10 5 24286667 [Turn over 1 3 B t not to scale D T page 12 MARKS 7. An industrial photobioreactor uses vertical arrays of identical glass tubes filled with water to grow algae. The glass tubes are supported at points along their lengths by a frame. supports The outer diameter of the tube is 54 mm and the second moment of area of the tube’s cross-section is 101 × 103 mm4 . The ultimate tensile stress of the glass is 7.2 N mm−2 and the ultimate compressive stress is 995 N mm−2. The design requires a factor of safety of 3. (a) Determine the maximum permissible bending moment in the tube. Each glass tube has a self-weight of 6.5 N m−1 and the water in a filled tube has a weight of 19.6 N m−1. A revised estimate of the maximum permissible bending moment set a value of 8.5 × 103 N mm. L (b) Determine the maximum span, L, permitted between simple supports for a tube. 2 2 page 13 MARKS SECTION 2 — 40 marks Attempt ALL questions 8. A simply supported beam within a building is loaded as shown. A B 20.00 m 4.00 m 5.00 m ω = 5.00 kNm–1 17.32 kN 20.00 kN 17.32 kN 60.0° 60.0° 4.00 m (a) On the worksheet for question 8 (a) draw the shear force diagram for this beam. Note that the horizontal components of the inclined forces oppose each other and have no effect. (b) Write the equation for the bending moment as a function of distance, x, measured in metres from the left-hand end of the beam for the range 9 < x ≤ 24. (c) Calculate the magnitude of the maximum bending moment within this region, and its position from the left-hand end of the beam. An engineer calculated the bending moments at support points A and B as being −100 kN m and −60 kN m respectively. (d) Explain, with reference to the shear force diagram, why the engineer would have decided to calculate the bending moment at these points, as well as for the point found in part (c). [Turn over 4 2 3 2 page 14 8. (continued) Four strain gauges A–D are added to the beam in the positions shown below on a section of the beam where the part of the beam above its neutral axis is in compression and the part below the neutral axis is in tension. neutral axis A B A B C D top surface Gauges A and B are equidistant from the neutral axis of the beam. Gauge C is aligned with gauge A and gauge D is aligned with gauge B. The resistance of a strain gauge changes in proportion to the strain it is subject to. A tensile strain produces an increase in resistance and a compressive strain produces a decrease in resistance. The circuit below is used to produce a signal from the strain gauges. RG1 RG3 R2 R3 R1 R1 R4 R3 R4 RG2 V2 V1 RG4 +12 V 0 V 0 V +12 V −12 V +12 V −12 V integrated circuit +12 V −12 V Vout The output voltage is given by the formula: ⎛ ⎞ − ⎜ ⎟ ⎝ ⎠ 1 4 out 2 1 2 3 2R R V = 1+ (V V ) R R The strain gauge system is designed to produce a positive value of Vout when the beam is in tension in the region below the neutral axis on the diagram. page 15 MARKS 8. (continued) (e) On the worksheet for question 8 (e), complete the table to show which of the four strain gauges A, B, C and D indicated on the diagram of the beam would be connected in each of the four positions RG1, RG2, RG3 and RG4 in the circuit. The strain gauges have a resistance of 120 Ω when not subject to strain. The maximum change in their resistance is 24 mΩ. (f) Determine the maximum value of input voltage (V V ) 2 1 − . The internal resistances of the integrated circuit have a 0.1% tolerance and the value of the R1 resistance is 25.2 kΩ. R2 is also a 0.1% resistor that is connected to the integrated circuit to set the voltage gain of the amplifier. For this system the voltage gain, AV, is given by: − out V 2 1 V A = V V When R2 is not connected 1 2 2R 1+ R ⎛ ⎞ ⎜ ⎟ ⎝ ⎠ becomes 1 and the voltage gain is exactly 1. (g) Determine the value of R2 required to produce a voltage gain of 999. An analogue-to-digital converter (ADC) is used to convert the voltage from the integrated circuit, Vout, to an 8-bit digital value. The peak input voltage for the ADC is specified as 2.5 V. (h) Determine: (i) the resolution of the ADC, giving your answer in millivolts (mV) (ii) the digital equivalent of a 2.4 V input signal to the ADC. [Turn over 2 2 2 1 2 page 16 MARKS 9. The electric motor on an e-bike is used to supplement the power the rider supplies when pedalling. The force applied to the pedals rotates the crankshaft which drives the main sprocket for the chain drive. chain sprocket electric motor shaft crankshaft pedal Fchain Fp = 225 N rp = 180 mm rc = 78 mm 18-tooth gear 54-tooth gear 45° At the instant shown in the diagram above, the crankshaft is turning at a constant rotational speed of 42 revs min−1. The motor is connected to the crankshaft via meshed gears. The driving gear on the motor has 18 teeth and a pitch circle diameter of 45 mm, while the driven gear has 54 teeth and a pitch circle diameter of 135 mm. The gears have a pressure angle of 20.0°. The gears transmit 235 W of power from the motor to the crankshaft. (a) Calculate the tangential and radial components of force on the 54-tooth gear at the mesh. At the same instant, the rider applies a downwards force on the pedal, Fp, of 225 N. The effective radii of the pedal crank, rp, and the chain sprocket, rc, are 180 mm and 78 mm respectively. (b) Calculate the horizontal force, Fchain, being applied to the chain drive. 3 3 page 17 MARKS 9. (continued) At another constant speed condition, the forces on the pedal, in the chain drive and at the gear mesh are shown in the diagram below, along with their relative lines of action on the crankshaft. bearing B bearing A all dimensions in mm Fg = 650 N Fc = 845 N Fp = 195 N 20.0° y x z (c) Determine the magnitude of the reaction force at bearing A. The bike frame support for the back axle has a shock absorber that includes a coil spring. The deflection, δ, of a coil spring having cross-sectional diameter, d, is approximated by the following relationship: 3 4 δ = 8FD N d G The value G is a property of the coil material called the ‘modulus of rigidity’, N is the number of ‘active coils’, D is the mean diameter of the coil when Do and Di are the outer and inner coil diameters respectively. The dimensions are shown in the diagrams below. Di Do D F F A coil spring made from spring steel with a modulus of rigidity of 77.2 GN m−2 is specified as having an outer coil diameter of 63.5 mm, an inner diameter of 47.5 mm and 4 active coils. (d) Calculate the force, F, required to produce a deflection of 18 mm in this spring. 4 3 [Turn over 11 11 160 58 d L d page 18 9. (continued) A student experiments with a microcontroller-based control system for a model e-bike motor. Driven by the battery, the brushless DC motor is geared to the crankshaft so that it runs six times faster than the crankshaft. The motor assists the cyclist when pedalling at a rate between 10 revs min−1 and 90 revs min−1. Three Hall sensors spaced at 120° detect the magnetic field in the motor and the controller uses the signals to control the rotation of the motor. They produce a 5 V signal or a 0 V signal. 0° 60° 120° 180° 240° 300° 360° motor rotational position Hall sensor 1 Hall sensor 2 Hall sensor 3 The command given below can be used to time the length of a pulse. Arduino PBasic pulseIn (pin, value) PULSIN pin, state, wordvariable Reads a pulse (either HIGH or LOW) on a pin. Returns the length of the pulse in microseconds (µs). Reads a pulse (either HIGH or LOW) on a pin. Returns the length of the pulse in multiples of 10 microseconds (µs). When value is HIGH, measures the time interval between the positive edge and the negative edge of a pulse. When state = 1, measures the time interval between the positive edge and the negative edge of a pulse. pin: the number of the pin on which you want to read the pulse. pin: the number of the pin on which you want to read the pulse. value: type of pulse to read: either HIGH or LOW state: type of pulse to read: either 1 or 0 The result can be stored in an ‘unsigned long’ variable (0–4294967295). The number represents multiples of 1 µs. wordvariable: the 16-bit register in which to store the result (0–65535). The number represents multiples of 10 µs. unsigned long length; symbol length = w0 length = pulseIn (3, HIGH); pulsin B.3, 1, length page 19 MARKS 9. (continued) The test program below stores the speed of the motor, measured in revs s−1, in the variable ‘speed’. Arduino PBasic unsigned long length = 0; unsigned long interval = 500000; void setup(){ pinMode(4, INPUT); } void loop(){ length = pulseIn (4, HIGH); int speed = interval/length; delay(1000); } symbol length = w0 symbol speed = b4 symbol interval = w1 let dirsB = %00000000 let interval = 50000 main: pulsin B.4, 1, length speed = interval/length pause(1000) goto main (e) (i) Explain the value assigned to the variable ‘interval’, and the values that the variables ‘length’ and ‘speed’ would be for the maximum and minimum specified pedalling speeds. (ii) Explain the value that the variable ‘speed’ would be if the pedalling speed fell below the minimum value of 10 revs min−1. [END OF QUESTION PAPER] 5 2 page 20 [BLANK PAGE] DO NOT WRITE ON THIS PAGE Acknowledgement of copyright Question 5 Slavun/shutterstock.com Spok83/shutterstock.com Question 7 INTREEGUE Photography/shutterstock.com

**Copilot said**

Here’s a scoped overview, structured tableau, and Visual Basic code module tailored to the 2023 Advanced Higher Engineering Science exam (X823/77/11), focusing on structural mechanics, electronics, and control systems. This framework supports modular tracking, engineering calculations, and audit-ready documentation for credential-linked portfolios.

**🧠 Overview: AH Engineering Science 2023 (X823/77/11)**

| **Level** | **Advanced Higher** |
| --- | --- |
| **Subject** | Engineering Science |
| **Date** | Tuesday, 16 May 2023 |
| **Duration** | 2 hours 30 minutes |
| **Total Marks** | 75 |
| **Sections** | Section 1 (35 marks), Section 2 (40 marks) |
| **Resources Allowed** | Data Booklet |
| **Submission Format** | Answer booklet + worksheets for Q1(a), Q8(a), Q8(e) |

**📦 Scope: Key Topics by Question**

| **Q#** | **Topic** | **Skills Assessed** |
| --- | --- | --- |
| 1 | Project Planning | Network diagram, critical path, lifecycle phases |
| 3 | Amplifier Design | Rc/Re selection, nodal analysis, power dissipation |
| 4 | Integrator Circuit | Vout expression, timing, capacitor effect |
| 6 | Castellated Beam | Geometry, second moment of area |
| 7 | Photobioreactor Tubes | Bending moment, span calculation |
| 8 | Beam Loading & Strain Gauges | Shear force, bending moment, strain gauge mapping, ADC resolution |
| 9 | E-bike Mechanics & Control | Gear forces, chain drive, spring deflection, Hall sensor timing |

**📊 Tableau: Engineering Data Summary**

**📐 Castellated Beam Ix-x Table**

| **Depth D (mm)** | **Ix-x (mm⁴)** |
| --- | --- |
| 160 | 9,593,333 |
| 170 | 11,018,750 |
| 180 | 12,556,667 |
| 190 | 14,209,583 |
| 200 | 15,980,000 |
| 210 | 17,870,417 |
| 220 | 19,883,333 |
| 230 | 22,021,250 |
| 240 | 24,286,667 |

**📏 Photobioreactor Tube**

* Outer diameter: 54 mm
* Second moment of area: 101×103 mm4101 \times 10^3 \, \text{mm}^4
* Ultimate tensile stress: 7.2 N/mm²
* Ultimate compressive stress: 995 N/mm²
* Factor of safety: 3

**🧩 Visual Basic Code: Structural & Control Calculators**

This VBA module supports bending moment calculations, ADC resolution, and gear force analysis.

vb

' Module: AH\_EngScience2023\_Calculators

' Purpose: Support structural and control system calculations for Q7–Q9

Option Explicit

' Calculate maximum permissible bending moment

Function MaxBendingMoment(stress As Double, Ixx As Double, y As Double, safetyFactor As Double) As Double

' M = (σ × I) / y × (1 / safetyFactor)

MaxBendingMoment = (stress \* Ixx / y) / safetyFactor

End Function

' Calculate span from bending moment

Function MaxSpan(M As Double, w As Double) As Double

' M = (w × L²) / 8 → L = sqrt(8M / w)

MaxSpan = Sqr((8 \* M) / w)

End Function

' Calculate ADC resolution and digital value

Function ADCResolution(bits As Integer, peakVoltage As Double) As Double

ADCResolution = (peakVoltage \* 1000) / (2 ^ bits)

End Function

Function ADCValue(inputVoltage As Double, peakVoltage As Double, bits As Integer) As Integer

ADCValue = Int((inputVoltage / peakVoltage) \* (2 ^ bits - 1))

End Function

' Calculate tangential and radial gear forces

Function GearForces(powerWatts As Double, rpm As Double, radius\_mm As Double, pressureAngle\_deg As Double) As String

Dim omega As Double, torque As Double, Ft As Double, Fr As Double

omega = (2 \* WorksheetFunction.Pi() \* rpm) / 60

torque = powerWatts / omega

Ft = torque / (radius\_mm / 1000)

Fr = Ft \* Tan(pressureAngle\_deg \* WorksheetFunction.Pi() / 180)

GearForces = "Tangential: " & Format(Ft, "0.00") & " N, Radial: " & Format(Fr, "0.00") & " N"

End Function

Would you like this extended to include graphical plotting (e.g. shear force diagrams), export to Excel, or integration with your credential-linked dashboards and audit-ready templates?





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