

Name: _____

Alpha: _____

SY486K

Final Exam

Spring AY2023

May 08, 2023

Open Slides, Notes, and Internet (no AI).

Please copy, verbatim, the honor pledge in the box and sign your name on the line below.

“The Naval Service I am a part of is bound by honor and integrity. I will not compromise our values by giving or receiving unauthorized help on this exam.”

1. **What is the primary purpose of the study?**

2. **Who are the participants in the study?**

3. **What are the key findings of the study?**

4. **How were the results of the study used to inform policy or practice?**

5. **What are the limitations of the study?**

For all the short answer (5 point) questions looking for 1-3 sentences approx. 50-200 words

Question 1 (5 pts)

Explain in your own words how and why modern commercial vessels are using sail technology. How much efficiency or savings is typically attained?

Question 2 (5 pts)

Describe the difference between high-pressure (HP) and low-pressure (LP) sections of a steam turbine engine.

Which one typically comes first and why?

Question 3 (5 pts)

Why are AC generators typically used in shipboard electrical systems?

Question 4 (7 pts)

Match the following electrical components to their definition:

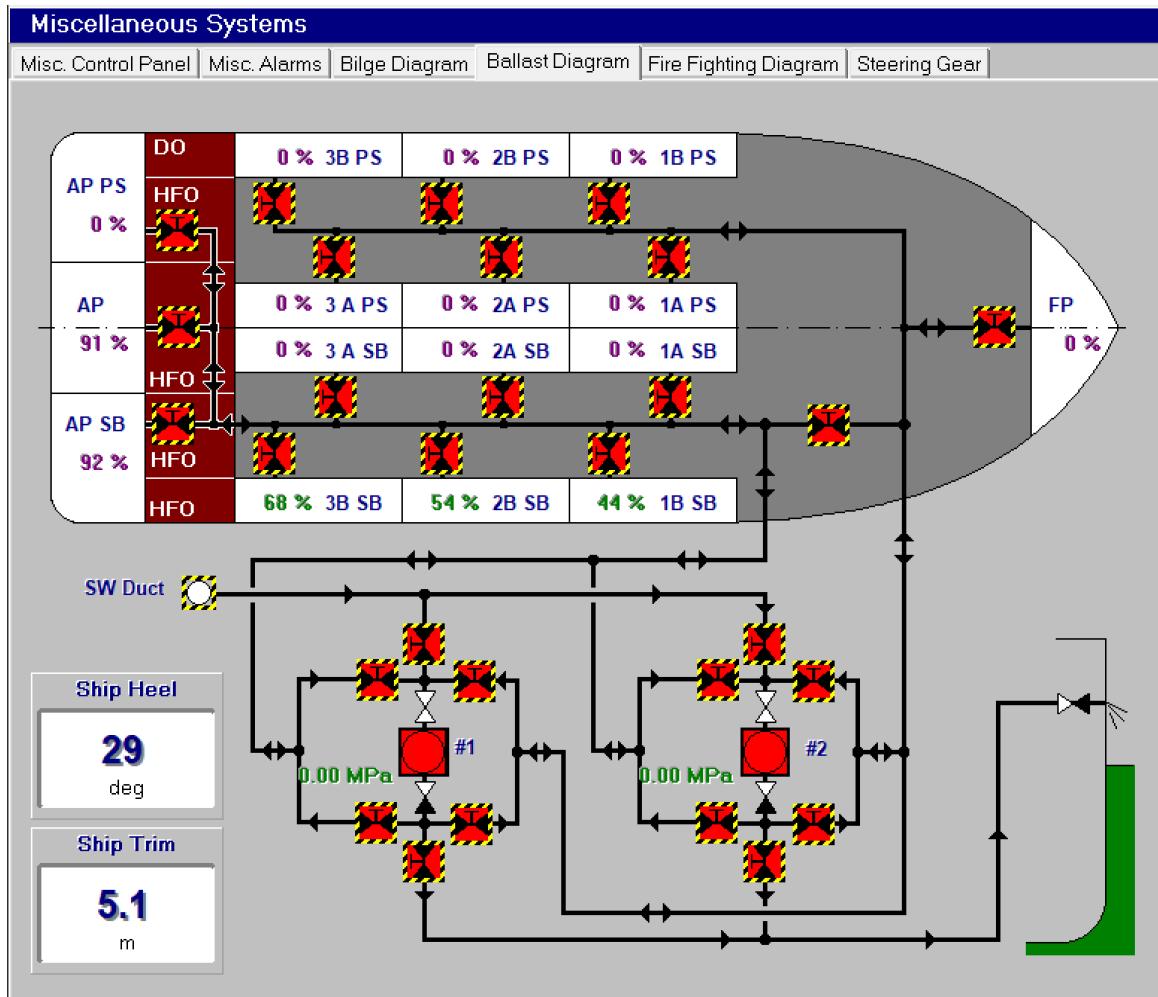
- Fuse
- Load
- Transformer
- Busbar
- Circuit Breaker
- Switchboard
- Syncro-phaser
- A machine that transfers electricity from one circuit to another at a different voltage level
- An auto shut down device which activates during an abnormality in the electrical circuit
- The hub of the ship's electrical system distributing power all over the ship
- A device used to estimate the magnitude and phase angle of voltage or current
- The power demand of the electrical system under specific operating conditions of the ship
- A piece of wire which can carry a stated current; above this value it will melt
- A copper plate used to conduct the high voltages of electricity coming in from the generators

Question 5 (5 pts)

Describe the process by which Blackwater is typically treated onboard a ship that has over 1000 people on board.

Question 6 (6 pts)

Describe the process that would be required to right this ship to level (0° heel and trim). What pumps and values would need to be manipulated?



Question 7 (10 pts)



Do some open source research, imagine you are hired to do a penetration test on a Maersk Container ship, similar to the one shown above, to see if their bridge systems could be compromised. Describe what systems they use and if there are any known vulnerabilities. (include links to some of the sources you used).

Looking for several sentences approx. 200-500 words.

Question 8 (6 pts)



Describe what kinds of sensors would be required for an autonomous cargo ship, like the MV Yara Birkeland shown above, to operate safely in sea lanes.

Question 9 (5 pts)

Describe what makes a PLC different from a regular computer or an embedded IoT system.

Question 10 (9 pts)

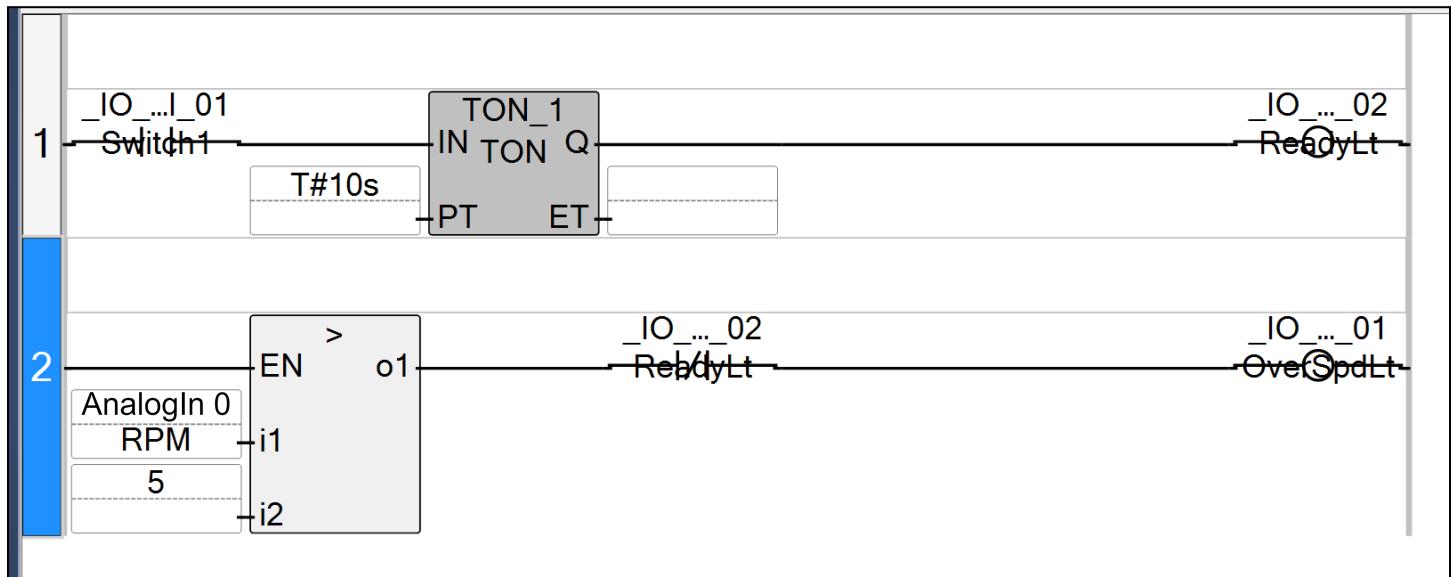
Draw the ladder logic diagram that will implement the following function given three inputs: I0, I1, I2 and three outputs: O4, O5, O6, such that:

- O4 is only high when I0 is high and either I1 or I2 are also high
- O5 is only high when two of the three inputs are high
- O6 is high when both I0 and I2 are low

I0	I1	I2	O4	O5	O6
0	0	0	0	0	1
0	0	1	0	0	0
0	1	0	0	0	1
0	1	1	0	1	0
1	0	0	0	0	0
1	0	1	1	1	0
1	1	0	1	1	0
1	1	1	1	0	0

Question 11 (8 pts)

Describe what the following ladder logic program is doing. Be specific in terms of the inputs and outputs.



Question 12 (6 pts)

Decode the following Modbus message and describe in plain english what it means.

0x13 0x06 0x00 0x04 0x00 0x06 0x4B 0x7B

Question 13 (6 pts)

Write a Modbus message to read the status of the first six discrete inputs from a peripheral with ID =3. Write it as bytes using Hex notation (eg. 0xXY). Include the appropriate size for the CRC, but you don't have to calculate that actual values just use 0xCC. (2 points Extra Credit if you have the correct CRC value)

Question 14 (6 pts)

Given the message you created in the previous question, fill out the following parameter tables assuming that the micro820 Controller will communicate with the micro820 Peripheral over Modbus RTU over RS-485. You can assume that the Peripheral PLC has its Modbus memory mapped correctly. Give values for the **five boxes** in the table below.

Name	Alias	Data Type	Value
> WriteCoils		MSG_MOD...	
WriteCancel		BOOL	
▽ LocalWriteParam		MODBUSL...	
> LocalWriteParam.Channel		UINT	
> LocalWriteParam.TriggerType		USINT	1
> LocalWriteParam.Cmd		USINT	
> LocalWriteParam.ElementCnt		UINT	
▽ TargetWriteParam		MODBUST...	
> TargetWriteParam.Addr		UDINT	
> TargetWriteParam.Node		USINT	

Question 15 (10 pts)

The [2013 Tommy Morris paper](#) describes how Modbus message insertion or modification can be used to attack Industrial Control Systems. Pick two of the attacks we replicated during Lab 9 and describe why the Modbus protocol is vulnerable to these types of attacks. What could possibly be changed with the protocol or its use in a system to avoid these attacks?

Looking for several sentences approx. 200-500 words.