

**CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY -  
MARINE ENGINEER OFFICER**

EXAMINATIONS ADMINISTERED BY THE  
**SCOTTISH QUALIFICATIONS AUTHORITY**  
ON BEHALF OF  
**MARITIME AND COASTGUARD AGENCY**

**SECOND ENGINEER (UNLIMITED)**

**042-27 - ENGINEERING KNOWLEDGE - GENERAL**

**MONDAY, 09 December 2013**

**0915-1215 hrs**

Examination paper inserts:

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Notes for the guidance of candidates:

Candidates are required to obtain 50% of the total marks allocated to this paper to gain a pass <b>AND</b> also obtain a minimum 40% in Sections A, B and C of the paper.
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Materials to be supplied by examination centres:

Candidate's examination workbook
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## ENGINEERING KNOWLEDGE - GENERAL

Attempt TEN questions only as follows:

SIX questions from section A

TWO questions from section B

TWO questions from section C

Marks for each part question are shown in brackets

### Section A

1. With reference to shell and tube type coolers:
  - (a) sketch a longitudinal section through a cooler; (6)
  - (b) explain how expansion is catered for; (2)
  - (c) state, with reasons, the location of cavitation and erosion damage. (2)
  
2. (a) State the possible causes for EACH of the following auxiliary engine lubricating oil sample results:
  - (i) high acidity; (2)
  - (ii) high sediment content; (2)
  - (iii) water content; (2)
  - (iv) fuel dilution. (2)(b) Explain which of the results in part (a) would give greatest concern. (2)
  
3. State a typical shipboard machinery application for EACH of the following metals, explaining how their properties make them particularly suitable for the stated application:
  - (a) stainless steel; (2)
  - (b) grey cast iron; (2)
  - (c) manganese bronze; (2)
  - (d) aluminium; (2)
  - (e) titanium. (2)

4. With reference to engine room bilge systems:
- (a) state, with reasons, a type of pump used as an oily water separator supply pump; (2)
  - (b) state FOUR possible causes for an engine room bilge pump being unable to pick up suction from a bilge well; (4)
  - (c) describe how a hole in a bilge main pipe may be located. (4)
5. (a) Sketch a low heat source evaporator, labelling the component parts and indicating the directions of flow. (5)
- (b) Describe how the evaporator sketched in part (a) is started up and put on line to the domestic water tanks. (5)
6. With reference to a vapour compressor refrigeration system:
- (a) describe, with the aid of a sketch, the operation of a high pressure cut out device; (6)
  - (b) state FOUR possible faults that could cause the cut out to operate. (4)
7. (a) Sketch a bearing which carries the weight of the rudder stock. (5)
- (b) Describe how the bearing sketched in part (a) transmits the load to the hull. (2)
- (c) Explain why a rudder may tend to lift, stating how this tendency is countered. (3)
8. As Second Engineer Officer, write a fire drill scenario for a fire in the purifier room. (10)

Section B

9. With reference to a.c. induction motors:
- (a) state, with reasons, the type of fuses used for protection; (3)
  - (b) explain the effects of single phasing; (2)
  - (c) describe how thermistors can be used to protect the motor; (3)
  - (d) sketch a cross section of a thermistor. (2)
10. Describe, with the aid of a circuit diagram, a two speed induction motor with independent windings. (10)
11. Explain the operating principle of the Automatic Voltage Regulator (AVR) shown in the figure. (10)

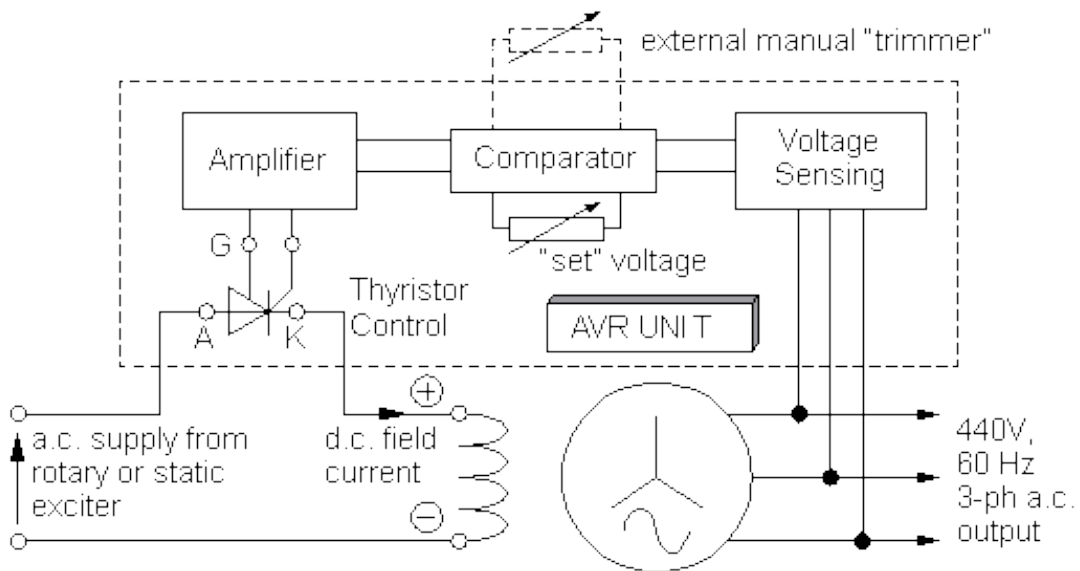


Fig Q11

## Section C

12. (a) State why ships' accommodation spaces require to be ventilated even when they are air conditioned. (3)
- (b) Sketch a mushroom ventilator as fitted on an accommodation structure. (5)
- (c) Describe the routine maintenance carried out on the ventilator sketched in part (b). (2)
13. Describe the stresses a ship is subjected to when in a dry-dock, stating how these stresses are resisted. (10)
14. (a) Describe how EACH of the following defects on a solid propeller may be repaired whilst in dry dock:
- (i) bent blades; (3)
  - (ii) damaged blade tips; (3)
  - (iii) pieces of missing blade. (3)
- (b) State the authority who would oversee the repairs of the propeller. (1)

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**SECOND ENGINEER (UNLIMITED)**

**042-27 - ENGINEERING KNOWLEDGE - GENERAL**

**MONDAY, 14 October 2013**

**0915-1215 hrs**

Examination paper inserts:

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Notes for the guidance of candidates:

Candidates are required to obtain 50% of the total marks allocated to this paper to gain a pass <b>AND</b> also obtain a minimum 40% in Sections A, B and C of the paper.
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## ENGINEERING KNOWLEDGE - GENERAL

Attempt TEN questions only as follows:

SIX questions from section A

TWO questions from section B

TWO questions from section C

Marks for each part question are shown in brackets

### Section A

1. State, with reasons, the materials used in EACH of the following components of a centrifugal pump for sea water circulating duties:
  - (a) casing; (2)
  - (b) impeller; (2)
  - (c) shaft; (2)
  - (d) wear rings; (2)
  - (e) mechanical seal. (2)
  
2. Describe, with the aid of a sketch, the operation of a system for remote indication of the level of water in an auxiliary boiler. (10)
  
3.
  - (a) Sketch a single cylinder, double acting reciprocating pump, labelling the component parts. (6)
  - (b) State how pressure fluctuations are dampened. (1)
  - (c) State, with reasons, the duties that the pump sketched in part (a) is particularly suited. (3)
  
4. When on deep sea passage, as Second Engineer Officer, on entering the engine room you are met with the following scenario: a strong smell of sewage effluent; sewage treatment plant showing high level alarm; aft bilge well in high alarm; sewage discharge pump running but amperes reading low.  
  
State the actions to be taken and maintenance required to restore the plant to correct working order. (10)
  
5.
  - (a) Sketch a stern tube lubricating oil system. (5)
  - (b) Explain why some vessels require more than one stern tube header tank. (2)
  - (c) Describe the arrangement which prevents both oil loss and sea water ingress, at the tailshaft. (3)

6. (a) Describe a method of ship stabilisation that employs a passive tank system. (4)
- (b) State THREE advantages and THREE disadvantages of the system described in part (a). (6)
7. (a) Sketch a cross section through a room solenoid valve used in a provisions refrigerating plant. (5)
- (b) Describe the operation of the valve sketched in part (a) making reference to the cold room temperature. (3)
- (c) Explain how solenoid valves affect the operation of a refrigeration compressor. (2)
8. Describe, with the aid of a sketch, an explosimeter for the detection of combustible gas. (10)

## Section B

9. (a) Sketch a section through an a.c. induction motor. (5)
- (b) Describe the construction of the motor sketched in part (a). (5)
10. With reference to the protection of High Voltage electric a.c. motors:
- (a) state the type of fuse that is fitted and how it prevents single phasing; (3)
- (b) describe the operation of EACH of the following direct temperature sensors:
- (i) resistance temperature device; (3)
- (ii) thermistor. (4)
11. (a) Sketch a circuit that allows both trickle charging and fast charging of lead-acid batteries. (6)
- (b) State, with reasons, why trickle charge and fast charge provision is necessary. (2)
- (c) Explain why lead-acid batteries may have to be taken off charge in hot climates. (2)

## Section C

12. (a) Sketch a midship section of a ship, labelling EACH of the following:
- camber
  - bilge radius
  - bilge keel
  - flat of bottom
  - rise of floor
- (5)
- (b) State FIVE terms used to describe the conditions that relate to the distortion a hull undergoes, stating in EACH case, the stresses involved. (5)
13. (a) Sketch a sea chest suitable for the connection of a main sea water inlet valve, labelling all of the fittings. (5)
- (b) Explain why a bilge injection valve is incorporated into the main sea water system, describing how it is tested. (4)
- (c) Compare the valve diameters of the bilge and main injection valves. (1)
14. With reference to ship's lifeboats:
- (a) sketch a main brake; (5)
- (b) state the safety features incorporated in the brake should the operator:
- (i) let go of the brake handle completely during lowering; (1)
  - (ii) attempt to lower the lifeboat too quickly; (1)
- (c) state the maximum rate of descent when launching; (1)
- (d) explain how the lifeboat is protected from falling back into the water if the power fails when hoisting the boat. (2)

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**SECOND ENGINEER (UNLIMITED)**

**042-27 - ENGINEERING KNOWLEDGE - GENERAL**

**MONDAY, 15 July 2013**

**0915-1215 hrs**

Examination paper inserts:

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Notes for the guidance of candidates:

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## ENGINEERING KNOWLEDGE - GENERAL

Attempt TEN questions only as follows:

SIX questions from section A

TWO questions from section B

TWO questions from section C

Marks for each part question are shown in brackets

### Section A

1. With reference to hydraulically loaded bolts.
  - (a) state FOUR applications; (4)
  - (b) state FOUR advantages; (4)
  - (c) explain why regular maintenance of hydraulic tension equipment is essential. (2)
  
2. With reference to plate type heat exchangers:
  - (a) sketch a sectional view of the flow in both fluid systems, labelling all major components and showing the direction; (6)
  - (b) state TWO reasons for plate relief patterns: (2)
  - (c) state the FOUR advantages of a plate cooler compared to shell and tube type. (2)
  
3.
  - (a) State why it is essential to sterilise fresh water for potable use on board ship. (1)
  - (b) State why re-mineralisation of potable water is carried out.. (1)
  - (c) Describe, with the aid of a sketch, a method of fresh water purification employing the use of silver ions. (6)
  - (d) State ONE advantage and ONE disadvantage of ultraviolet radiation sterilisation for fresh water. (2)
  
4. With reference to routine testing of equipment, explain how EACH of the following is tested to ensure it operates at the correct set point:
  - (a) stand-by facility for sea water cooling water pump; (2)
  - (b) high jacket water temperature alarm for generator; (2)
  - (c) auxiliary boiler flame failure; (2)
  - (d) differential pressure across fuel filter; (2)
  - (e) control air pressure low alarm. (2)

5. (a) Sketch a multi bottle CO<sub>2</sub> flooding system suitable for a main machinery space. (5)
- (b) Describe the procedure for releasing the CO<sub>2</sub> into the engine room. (5)
6. (a) Sketch a fully automatic provision refrigeration system incorporating a number of cold rooms. (5)
- (b) Explain the sequence of events from demand for refrigerating effect in a room until the room has reached the desired temperature. (5)
7. Describe, with the aid of a sketch, the operation of a rotary vane steering gear with constant delivery pumps. (10)
8. (a) Explain, with the aid of a sketch, the operation of a centrifuge for removing water and particles from lubrication oil. (8)
- (b) Explain the main differences when the centrifuge is used as a clarifier. (2)



## Section B

9. With reference to electrical switchgear:
- (a) explain why it is necessary to keep electrical contactors clean and closed with a firm contact pressure; (5)
  - (b) describe the functions of auxiliary contacts; (3)
  - (c) state how contacts are kept free from oxide formation. (2)
10. Explain, with the aid of a circuit diagram, the operation of ships navigating lights. (10)
11. (a) Explain the term *power factor*. (2)
- (b) Explain why it may be desirable to change the *power factor*. (2)
- (c) Explain how a synchronous motor may be used to assist in power factor correction. (6)

## Section C

12. (a) Explain the purpose of *cofferdams*. (3)
- (b) State TWO locations where *cofferdams* may be found. (2)
- (c) State the precautions prior to entry into a *cofferdam*. (5)
13. With reference to ship construction, describe EACH of the following, stating where EACH may be located:
- (a) duct keel; (3)
- (b) bilge keel; (2)
- (c) flare; (2)
- (d) camber. (3)
14. (a) Sketch a bearing which carries the weight of the rudder stock. (5)
- (b) Describe how the bearing sketched in part (a) transmits the load to the hull. (2)
- (c) Explain why a rudder may tend to lift, stating how this tendency is countered. (3)

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**SECOND ENGINEER (UNLIMITED)**

**042-27 - ENGINEERING KNOWLEDGE - GENERAL**

**MONDAY, 25 March 2013**

**0915-1215 hrs**

Examination paper inserts:

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Notes for the guidance of candidates:

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## ENGINEERING KNOWLEDGE - GENERAL

Attempt TEN questions only as follows:

SIX questions from section A

TWO questions from section B

TWO questions from section C

Marks for each part question are shown in brackets

### Section A

1. State a typical shipboard machinery application for EACH of the following metals, explaining how their properties make them particularly suitable for the stated application:
  - (a) stainless steel; (2)
  - (b) grey cast iron; (2)
  - (c) manganese bronze; (2)
  - (d) aluminium; (2)
  - (e) titanium. (2)
  
2.
  - (a) Sketch an engine room fresh water central cooling system, indicating the water temperatures at salient points on the system. (6)
  - (b) State FOUR advantages of the system sketched in part (a) compared to one which is totally sea water cooled. (4)
  
3.
  - (a) Sketch a tunnel type transverse bow thruster driven by a constant speed electric motor. (6)
  - (b) Describe the thruster sketched in part (a), stating how the direction and strength of thrust are varied. (4)
  
4.
  - (a) Sketch a hydraulically tensioned shaft coupling bolt which incorporates a tapered sleeve fitted between the bolt and the coupling holes. (4)
  - (b) Describe how the bolt assembly sketched in part (a) is fitted. (3)
  - (c) State the advantages of this type of arrangement compared to conventional bolt assemblies. (3)

5. (a) State the possible causes for EACH of the following auxiliary engine lubricating oil sample results:
- (i) high acidity; (2)
  - (ii) high sediment content; (2)
  - (iii) water content; (2)
  - (iv) fuel dilution. (2)
- (b) Explain which of the results in part (a) would give greatest concern. (2)
6. (a) Sketch a fully automatic provisions refrigeration system incorporating a number of cold spaces. (5)
- (b) Explain the sequence of events from a demand for refrigerating effect until all cold rooms have fully cooled down. (5)
7. With reference to the protection of mild steel main sea water cooling pipelines:
- (a) sketch an arrangement where impressed current anodes are fitted in the main sea chests to prevent corrosion and fouling; (4)
  - (b) describe how the system sketched in part (a) gives protection to steel pipework, stating the materials used; (4)
  - (c) explain why welding or hot work should not be carried out on sea water main lines. (2)
8. (a) Sketch a typical ship's firemain system. (5)
- (b) Describe the routine maintenance carried out on the system sketched in part (a) to ensure that it is at readiness for emergency situations. (5)

## Section B

9. (a) Sketch a standby emergency battery circuit which is charged by a. c. supply. (5)
- (b) List the safety precautions to be observed during the routine maintenance of acid or alkaline batteries. (5)
10. (a) Sketch a direct on line starter suitable for a three phase induction motor. (8)
- (b) Explain why the starter sketched in part (a) is limited to moderately sized motors. (2)
11. With reference to the protection of electrical power circuits:
- (a) explain *preferential tripping*, describing how it is achieved; (5)
- (b) explain *discrimination*, describing how it is achieved. (5)

## Section C

12. (a) State why ships' accommodation spaces require to be ventilated even when they are air conditioned. (3)
- (b) Sketch a mushroom ventilator as fitted on an accommodation structure. (5)
- (c) Describe the routine maintenance carried out on the ventilator sketched in part (b). (2)
13. With reference to the construction of refrigerated spaces: (2)
- (a) state suitable materials used for insulating the spaces; (2)
- (b) state the properties that an insulating material should possess; (3)
- (c) sketch a section through a wall of a cold storage space detailing how the insulation is attached to the ship's structure. (5)
14. As Second Engineer Officer, explain to a new crew member how to pass safely through a hydraulically operated watertight door. (10)