



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

**EXAMINATIONS ADMINISTERED BY THE SCOTTISH  
QUALIFICATIONS AUTHORITY ON BEHALF OF  
MARITIME AND COASTGUARD AGENCY CHIEF ENGINEERS  
(UNLIMITED)**

**ENGINEERING KNOWLEDGE - GENERAL  
PAST PAPERS FROM MARCH 2013 TO DECEMBER 2016  
&  
MARKER'S FEEDBACKS**

**Faculty of Nautical Studies  
Senior Marine Engineering  
© 2016**

City of Glasgow College  
Riverside Campus  
21 Thistle Street, Glasgow  
G5 9XB

January 16, 2017

## Table of Contents

Engineering Knowledge - General March 2013.....	4
Section A .....	4
Section B .....	5
Section C .....	6
Engineering Knowledge - General July 2013 .....	7
Section A .....	7
Section B .....	8
Section C .....	9
Engineering Knowledge - General October 2013 .....	10
Section A .....	10
Section B .....	11
Section C .....	12
Engineering Knowledge - General December 2013 .....	13
Section A .....	13
Section B .....	14
Section C .....	15
Engineering Knowledge - General April 2014 .....	16
Section A .....	16
Section B .....	17
Section C .....	18
Engineering Knowledge - General July 2014 .....	19
Section A .....	19
Section B .....	20
Section C .....	21
Engineering Knowledge - General October 2014 .....	22
Section A .....	22
Section B .....	24
Section C .....	25
Engineering Knowledge - General December 2014 .....	26
Section A .....	26
Section B .....	27
Section C .....	28
Engineering Knowledge - General March 2015.....	29
Section A .....	29
Section B .....	30
Section C .....	31
Engineering Knowledge - General July 2015 .....	32
Section A .....	32
Section B .....	33

Section C .....	33
Engineering Knowledge - General October 2015 .....	34
Section A .....	34
Section B .....	35
Section C .....	36
Engineering Knowledge - General December 2015 .....	37
Section A .....	37
Section B .....	38
Section C .....	38
Engineering Knowledge - General April 2016 .....	40
Section A .....	40
Section B .....	42
Section C .....	43
Engineering Knowledge - General July 2016 .....	44
Section A .....	44
Section B .....	46
Section C .....	46
Engineering Knowledge - General October 2016 .....	48
Section A .....	48
Section B .....	51
Section C .....	52
Engineering Knowledge - General December 2016 .....	53
Section A .....	53
Section B .....	55
Section C .....	56
SQA Markers' Feedback- General: Date April 2016 .....	57
SQA Markers' Feedback- General: Date July 2016 .....	58
SQA Markers' Feedback- General: Date December 2015 .....	59
SQA Markers' Feedback- General: Date March 2015 .....	60
SQA Markers' Feedback- General: Date October 2015 .....	61
SQA Markers' Feedback- General: Date July 2015 .....	62
SQA Markers' Feedback- General: Date Oct 2016 .....	63

# Engineering Knowledge - General March 2013

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

## Section A

1. With reference to centrifugal pumps:
  - a. sketch the pump characteristic curves showing head against flow, power and efficiency; (3)
  - b. define *net positive suction head*; (1)
  - c. explain the difference between the required and available suction head; (3)
  - d. describe pump cavitation, explaining how it affects the pump. (3)
  
2. With reference to plate heat exchangers, explain how EACH of the following design aspects promote heat transfer:
  - (a) material selection; (5)
  - (b) flow pattern; (3)
  - (c) extended surface area. (2)
  
3. Describe, with the aid of a sketch, the principle of operation of a capacitance electrode level measuring transmitter. (10)
  
4.
  - (a) Describe the maintenance and preventive measures that should be taken to reduce the risk of flooding from a mild steel seawater system to a minimum. (5)
  - (b) Describe, with reasons, the in-depth inspection to ensure the integrity of the system. (5)
  
4. With reference to radial lip seals for propulsion shafting:
  - (a) describe, with the aid of a sketch, an outboard seal arrangement as fitted to an oil lubricated stern tube; (6)
  - (b) explain, with reasons, the possible actions that should be taken in the event of loss of oil from the header tank. (4)

5. With reference to ships' air conditioning systems:
- (a) state the effects of EACH of the following faults:
    - (i) corroded return air trunkings; (2)
    - (ii) blocked evaporator drains; (2)
    - (iii) defective capacity control. (2)
  - (b) state the main health hazard that may arise in the air conditioning plant, stating the conditions that need to arise and the measures that should be taken to prevent this occurring. (4)
6. With reference to steam boilers:
- (a) list SIX alarms/trips that are fitted on a boiler, describing how EACH would be tested; (6)
  - (b) describe how the safety valves would be set under working conditions. (4)
7. Write a procedure for preparing to go UMS. (10)

## Section B

8. With reference to the protection of electrical equipment in a distribution system:
- (a) state the aims of the protective devices; (3)
  - (b) list the parameters that are monitored and acted upon by the protective devices; (4)
  - (c) state, with reasons, THREE causes of electrical fires. (3)
9. With reference to voltage variation profiles caused by load changes imposed on alternating current generators when starting large motors online:
- (a) sketch a voltage dip, showing an acceptable recovery time; (2)
  - (b) state FOUR salient factors that cause the variation in part (a); (4)
  - (c) outline FOUR salient factors that assist recovery from the deviation shown in part (a). (4)
10. With reference to main circuit breakers on a switchboard:
- a. sketch a main circuit breaker when in test position, explaining the function tests that
  - b. can be carried out; (5)

- c. list the routine maintenance for the main circuit breakers; (3)
- d. state why it is bad practice to open circuit breakers whilst under load and under what conditions it would be carried out. (2)

## Section C

- 11. (a) State THREE reasons for fitting transverse watertight bulkheads in ship construction. (3)
- (b) Explain what constitutes a watertight bulkhead. (2)
- (c) State the minimum number of transverse watertight bulkheads and their location. (2)
- (d) Describe how watertight bulkheads are tested. (3)

12. With reference to large bulk carriers:

- (a) sketch a cross section of a bulk carrier through the mid-ship; (5)
- (b) explain the design features that have evolved to minimise the possibility of failure. (5)

13. As Chief Engineer officer, write a dry dock specification for the repair of the following damage that has occurred, stating what factors have to be considered when costing the repairs.

Damage to water ballast tank number 1 port wing. The shell plating 15 mm thick for approx 2 metres square has to be removed and replaced along with the relevant damaged stiffeners which have been set up. (10)

Section A

1. With reference to the design, construction and materials used in the manufacture of plate type heat exchangers, explain why, in most cases, they are superior to tubular type heat exchangers. (10)
  
2. With reference to fuel oil viscosity:
  - (a) explain why correct fuel oil viscosity is necessary; (2)
  - (b) describe TWO methods for the measurement of viscosity that are suitable for the inclusion into a pneumatic or electronic control system; (6)
  - (c) state, with reasons, a control action for a viscosity controller. (2)
  
3. With reference to automatic sprinkler systems for fire fighting purposes:
  - (a) explain, with the aid of a Heat Release versus Time diagram, the difference between *fire control* and *fire suppression*; (6)
  - (b) state the limitations of using glass bulbs to activate sprinkler heads and suggest, with reasons, an alternative mechanism. (4)
  
4. With reference to tunnel type bow thrusters:
  - (a) explain why some vessels are fitted with more than one bow thruster; (2)
  - (b) discuss the options available in terms of prime mover and transmission systems. (8)
  
5.
  - (a) State the affinity laws for a centrifugal pump. (3)
  - (b) State the effects on the pump affinity laws of fitting a slightly smaller diameter impeller. (2)
  - (c) Explain, with the aid of a Head versus Flow diagram, why a two speed pump is preferable to throttling where high and low capacities are demanded for a large sea water circulating pump. (5)

6. Describe, with the aid of a block diagram, a compensated control system for an active fin stabilisation unit. (10)
7. (a) Sketch a line diagram showing the layout and components of a hydraulic system with a variable delivery, pressure compensated pump and accumulator, suitable for the operation of deck machinery. (5)
- (b) Describe the operation of the system sketched in part (a). (5)
8. With reference to bacteria harmful to humans in drinking and washing water:
- (a) state the constraints placed on the installation and use of systems for shipboard production of fresh water; (3)
- (b) state the maintenance and treatment recommended for fresh water tanks; (3)
- (c) describe how the entire fresh water system can be made free from bacteria; (3)
- (d) state an acceptable residual value in the fresh water tanks to ensure the correct concentration of treatment in the system. (1)

## Section B

9. With reference to insulated and earthed electrical systems operating at High Voltage:
- (a) state the regulations pertaining to tankers; (4)
- (b) describe an instrument to detect earth leakage in EACH of the following systems:
- (i) earthed; (3)
- (ii) insulated. (3)
10. (a) Explain the meaning of EACH of the following types of electrical equipment:
- (i) intrinsically safe; (2)
- (ii) flameproof; (2)
- (iii) increased safety; (2)
- (iv) pressurised enclosure. (2)
- (b) State TWO types of lighting equipment that may be installed in the pump room areas of a crude petroleum carrier. (2)



11. With reference to voltage variation profiles caused by load changes imposed on alternating current generators when starting large motors online:
- (a) sketch a voltage dip, showing an acceptable recovery time; (2)
  - (b) state FOUR salient factors that cause the variation in part (a); (4)
  - (c) outline FOUR salient factors that assist recovery from the deviation shown in part (a). (4)

### Section C

12. Sketch FIVE methods used to prevent the distortion of ships' plates and frames during major welded hull repairs in dry dock. (10)
13. With reference to twin skeg rudders:
- (a) explain why a single rudder may not be suitable for some vessels; (3)
  - (b) state the advantages of a twin skeg installation in modern vessels with a large cargo carrying capacity. (7)
14. As Chief Engineer Officer on a new vessel which is experiencing severe aft end vibration at full service speed, write a report to the Engineer Superintendent suggesting reasons for the vibration and recommendations for further sister vessels presently under construction. (10)

Section A

1. With reference to static oily water separators, explain EACH of the following:
  - (a) why the supply pump should be carefully selected and matched to the separator; (2)
  - (b) how the separator achieves effective separation; (4)
  - (c) how the physical properties of each of the fluids to be separated affects the rate and effectiveness of separation. (4)
  
2. With reference to pneumatically operated control valves:
  - (a) sketch a valve with a double ported trim; (6)
  - (b) state ONE advantage and ONE disadvantage of a double ported valve; (2)
  - (c) explain the difference between *fail safe* and *fail set*. (2)
  
3. With reference to pump selection, state TWO types of pump for EACH of the following applications, stating why they are suitable:
  - (a) bilge pumping; (2)
  - (b) cargo oil stripping; (2)
  - (c) sewage sludge; (2)
  - (d) lubricating oil circulating; (2)
  - (e) sea water circulating. (2)
  
4. Describe a procedure for a function test of the operation of a machinery space CO<sub>2</sub> smothering system. (10)

5. With reference to a hydraulic steering gear, explain EACH of the following:
- (a) the factors that may contribute to the failure of a hydraulic pipe coupling; (2)
  - (b) why it is of the utmost importance that in the event of a hydraulic system failure that the rudder is locked and isolation of the affected area is achieved as soon as possible; (2)
  - (c) the problems that may occur when locking the rudder in heavy weather; (2)
  - (d) why hydraulic locking is preferable to mechanical means; (2)
  - (e) what is meant by the *single failure concept*. (2)
6. With reference to machinery parts under cyclic loading, describe, with the aid of sketches, how the propagation of even the smallest of cracks can lead to total component failure. (10)
7. (a) Sketch a Bioreactor type sewage treatment plant. (6)
- (b) State the regulations regarding the allowable condition of the effluent discharged from this plant sketched in part (a). (4)
8. In deck machinery hydraulic systems, state the functions of the hydraulic oil reservoir, explaining how these functions determine the construction and dimensions of the oil reservoir, making reference to the volume of the hydraulic fluid in the system. (10)

## Section B

9. Describe, with the aid of a diagram, a shaft generator that uses a frequency converter. (10)
10. With reference to a three phase electrical distribution system:
- (a) discuss the advantages and disadvantages of an insulated neutral system; (8)
  - (b) state how an earthed neutral system is earthed and the measures taken to limit the maximum earth fault current. (2)
11. With reference to voltage variation profiles caused by load changes imposed on alternating current generators when starting large motors online:
- (a) sketch a voltage dip, showing an acceptable recovery time; (2)
  - (b) state FOUR salient factors that cause the variation in part (a); (4)
  - (c) outline FOUR salient factors that assist recovery from the deviation shown in part (a). (4)

## Section C

12. With reference to structural fire protection in passenger ship accommodation spaces:
  - (a) define the meaning of Class A bulkheads, stating the requirements; (3)
  - (b) discuss the design of ventilation systems to prevent the spread of smoke and fire; (5)
  - (c) explain how the integrity of the bulkhead is retained with respect to ventilation trunkings, where A Class bulkheads have to be penetrated. (2)
  
13. With reference to drydocking a vessel:
  - (a) state the pre-docking information that should be given to the drydock authority; (5)
  - (b) list the items to be inspected once the dock is empty. (5)
  
14. With reference to double hulled oil tankers:
  - (a) sketch a mid ship cross section; (5)
  - (b) state the reason this type of design; (1)
  - (c) state FOUR disadvantages of this type of design. (4)

### Section A

1. (a) Explain EACH of the following control terms:
  - (i) cascade; (3)
  - (ii) split range. (3)
- (b) Describe a control system that may be enhanced by the inclusion of cascade and split range control. (4)
  
2. State the inspections and maintenance that should be carried out on main sea water pipelines, strainers and ships side valves to minimise the risks of engine room flooding. (10)
  
3. (a) Describe TWO methods of priming centrifugal pumps. (6)
- (b) List the advantages of EACH of the priming methods described in part (a). (4)
  
4. Sketch a hydraulic circuit for a four ram steering gear that allows FIVE different ram combinations to be used, stating how EACH ram and valve combination is achieved. (10)
  
5. With reference to machinery condition monitoring systems:
  - (a) state what is meant by machinery condition monitoring; (2)
  - (b) state the means available for gathering data; (3)
  - (c) describe how the data is used to indicate machinery condition trends; (3)
  - (d) explain the relevance of machinery condition monitoring to approved planned maintenance systems. (2)
  
6. A shipping company is investigating the possibility of converting a vessel from a traditionally manned engine room to Unattended Machinery Space (UMS) operations.  
  
As Chief Engineer Officer sailing on the vessel, write a report to the Superintendent Engineer listing the essential requirements for UMS classification and any additional work required. (10)

7. With reference to the lubrication of refrigeration compressors:
- (a) state the advantage of using fully synthetic oils; (2)
  - (b) explain why oil may be carried over from the compressor; (3)
  - (c) describe a device which returns oil from the compressor discharge to the compressor sump; (3)
  - (d) state TWO reasons why an accumulation of oil in the evaporator is undesirable. (2)
8. (a) Sketch a cargo space inert gas system that uses washed and cooled flue gas from a boiler. (5)
- (b) List FIVE safety features built into the inert gas system, stating the function of EACH. (5)

## Section B

9. Describe, with the aid of a circuit diagram, the operation of an automatic voltage regulator (AVR) which employs the use of thyristors. (10)
10. With reference to large electrical transformers on board ships:
- (a) state where these transformers may be used; (1)
  - (b) state a typical efficiency range for a transformer; (1)
  - (c) state the regulations pertaining to transformers; (3)
  - (d) state the protective devices that are fitted; (2)
  - (e) describe the maintenance requirements. (3)
11. (a) With reference to an alkaline battery cell:
- (i) describe a typical cell, stating the materials used; (4)
  - (ii) describe the electro-chemical process that takes place during discharge and charge. (2)
  - (iii) state the effect of overcharge. (2)
- (b) State the advantages of an alkaline cell compared with a lead acid cell. (2)

## Section C

12. Explain, with the aid of a mid-ship half sectional sketch of a container ship, how strength is built into this type of vessel whilst still allowing access to the cargo holds. (10)
13. (a) Describe, with the aid of a sketch, how a hydraulically operated folding hatch cover opens and closes. (7)
- (b) Explain how the water tightness and security of the hatch cover sketched in part (a) can be ascertained before proceeding to sea. (3)
14. (a) Explain why fatigue cracks occur in a ship's hull, stating the locations where they may be found. (3)
- (b) Describe the hull inspection that should be carried out in drydock to ascertain the maintenance and repairs that may need to be carried out. (7)

## Engineering Knowledge - General April 2014

### Section A

1. With reference to bacteria harmful to humans in drinking and washing water:
  - (a) state the constraints placed on the installation and use of systems for shipboard production of fresh water; (3)
  - (b) state the maintenance and treatment recommended for fresh water tanks; (3)
  - (c) describe how the entire fresh water system can be made free from bacteria; (3)
  - (d) state an acceptable residual value in the fresh water tanks to ensure the correct concentration of treatment in the system. (1)
2. With reference to pneumatic control valves:
  - (a) sketch a reverse acting control valve; (6)
  - (b) explain why a reverse acting arrangement would be used, stating ONE application for this valve. (4)
3. With reference to the metallurgy of plain carbonsteel:
  - (a) sketch an iron carbon equilibrium diagram, labelling the salient points; (6)
  - (b) explain EACH of the following terms:
    - (i) austenite. (2)
    - (ii) cementite. (2)
4. With reference to refrigeration systems:
  - (a) explain why undercooling of the refrigerant at the condenser outlet is desirable; (3)
  - (b) describe, with the aid of a sketch, how a heat exchanger could be incorporated in the circuit to enhance undercooling; (5)
  - (c) explain the possible consequences of the refrigerant having a dryness fraction at the compressor suction. (2)



5. With reference to multi-tubular heat exchangers, explain how EACH of the following contribute to satisfactory performance:
  - (a) tube wall thickness; (2)
  - (b) dense population of tubes in the tube plate; (2)
  - (c) tube materials selection; (2)
  - (d) coolant flow rates; (2)
  - (e) unimpeded passage of coolant at entry and exit from the tubes. (2)
  
6. As Chief Engineer Officer, write a report to the Superintendent Engineer naming the items and describing the examinations that were carried out during a safety equipment survey with regard to fire safety. (10)
  
7.
  - (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)
  
8.
  - (a) State, with reasons, why water treatment is used for auxiliary boilers even when they make use of distilled feed water. (6)
  - (b) Explain the possible consequences of excessive boiler water treatment. (4)

### Section B

9.
  - (a) State the consequences of using direct on line starters for comparatively large sized a.c. induction motors. (2)
  - (b) Describe, with the aid of a sketch, an electronic soft starting system that may be used for large sized a.c. induction motors. (8)
  
10.
  - (a) Explain why it is necessary to provide reverse power for a.c generators operating in parallel. (2)
  - (b) Sketch a reverse power relay trip. (4)
  - (c) Explain the operation of the relay trip sketched in part (b), describing how it is activated. (4)

11. Describe, with the aid of a block diagram, the operation of a load sensing electronic governor controller for an a.c. generator. (10)

### Section C

12. (a) State why the International Maritime Organisation has banned the use of Tributyltin antifouling (T.B.T.) coatings for ship's hulls. (1)
- (b) State the base elements of TWO alternative coatings to T.B.T. antifouling. (2)
- (c) Explain the considerations in the selection of a coating for a ship's underwater surface. (7)
13. (a) Define *propeller slip*, explaining how it is calculated. (2)
- (b) State, with reasons, FOUR conditions which will affect the *propeller slip*. (8)
14. Describe, with the aid of sketches, how main propulsion efficiency can be improved by the addition of EACH of the following:
- (a) ducted propeller (*Kort nozzle*); (5)
- (b) vane or *Grim* wheel aft of the propeller. (5)

## Engineering Knowledge - General July 2014

### Section A


1. Describe, with the aid of a graph, EACH of the following types of material failure, stating ONE practical example of EACH:
  - (a) creep; (5)
  - (b) fatigue. (5)
  
2.
  - (a) Explain how power is transmitted through main propulsion shafting. (3)
  - (b) State THREE operational factors that may induce high stress in shaft coupling bolts. (3)
  - (c) Sketch a hydraulic type of shaft coupling bolt. (4)
  
3.
  - (a) Describe the principle of operation of a biological sewage treatment plant. (4)
  - (b) Explain how anaerobic conditions can occur within a sewage treatment plant, stating the hazards that may be encountered. (4)
  - (c) Explain the meaning and significance of the term *biological oxygen demand*. (2)
  
4.
  - (a) Describe, with the aid of a sketch, the principle of operation of a thermodynamic steam trap. (8)
  - (b) Explain why steam traps fitted to bunker heating coils should always be maintained in good working condition. (2)
  
5. With reference to the carriage and pumping of liquefied gascargoes:
  - (a) sketch a deep-well pump, labelling the principal components; (6)
  - (b) state how the drive shaft bearings of the pump sketched in part (a) are cooled and lubricated; (1)
  - (c) explain how the risk of fire and explosion in the cargo tanks is countered both in the loaded and unloaded condition. (3)

6. (a) Sketch the hydraulic circuit for a ram type steering gear that complies with the single failure concept and automatic isolation. (6)
- (b) Describe how automatic isolation, for the hydraulic circuit sketched in part (a), is achieved within 45 seconds should leakage of system oil occur. (4)
7. With reference to refrigeration systems:
- (a) explain why undercooling of the refrigerant at the condenser outlet is desirable; (3)
- (b) describe, with the aid of a sketch, how a heat exchanger could be incorporated in the circuit to enhance undercooling; (5)
- (c) explain the possible consequences of the refrigerant having a dryness fraction at the compressor suction. (2)
8. When a vessel is in dry dock, the possible risks of fire in the machinery spaces are heightened due to the nature of the work being carried out.
- As Chief Engineer Officer, compile a set of standing orders instructing ship's staff on the actions to be taken should a serious fire occur. (10)

## Section B

9. With reference to overcurrent protection for electrical circuits:
- (a) explain THREE methods of protection, stating where EACH may be used; (6)
- (b) explain, with the aid of a diagram, the meaning of the term *inverse current time characteristic*. (4)
10. Explain, with the aid of a circuit diagram, the operation of a star/delta starter for a polyphase motor, including the ancillary starter circuit. (10)
11. With reference to testing High Voltage equipment:
- (a) explain why earthing down is considered essential; (2)
- (b) state the operating voltage for an insulation resistance tester (meggar) suitable for 6.6 KV equipment; (1)
- (c) describe how an insulation resistance test is carried out on High Voltage equipment, making reference to personnel safety; (5)
- (d) explain why infra red temperature measurement is used on High Voltage equipment. (2)

## Section C

12. With reference to roll reduction systems, explain the principles of operation of EACH of the following, stating the advantages and disadvantages of EACH:
- (a) bilge keels; (5)
  - (b) passive uncontrolled tanks. (5)
13. With reference to the classification of ships, explain EACH of the following:
- (a) why ships are built to classification society rules; (5)
  - (b) the meaning of the notation  100A1; (4)
  - (c) how a ship remains in class throughout the life of the vessel. (1)
14. With reference to cargo hatch covers on large container ships:
- (a) describe how they are tested for watertightness; (2)
  - (b) explain how the weight of the hatch and containers is transferred to the ship's structure whilst allowing for deflections of the hull in a seaway; (3)
  - (c) describe, with the aid of a sketch, the type and location of damage that can occur due to wear of the hatch supporting arrangements. (5)

## Engineering Knowledge - General October 2014

### Section A

1. With reference to a ship's air conditioning plant:
  - (a) define the term *comfort zone*; (2)
  - (b) state the objectives of maintaining the conditioned air within the *comfort zone*; (3)
  - (c) state, with reasons, FIVE areas from which the conditioned air must not be recirculated. (5)
  
2. With reference to automatic control valves for EACH of the following valve plugs shown on Datasheet Q2:
  - (a) draw the flow characteristics; (3)
  - (b) describe and name the valve type; (4)
  - (c) state a suitable application for each. (3)
  
3. The steering gear operation of a vessel that recently experienced a heavy storm is found to be abnormally sluggish.
  - (a) State FIVE reasons for possible malfunction of the gear. (5)
  - (b) State the corrective actions that may be carried out at sea, that will allow the vessel to continue to the nearest port. (5)
  
4.
  - (a) As Chief Engineer, explain the verifications and checks you should carry out to ensure the compliance to Classification Society requirements. (6)
  - (b) As Chief Engineer, state the maintenance and regular checks to be carried out. (4)
  
5.
  - (a) Describe a vacuum sewage system. (5)
  - (b) List the advantages of the system described in part (a). (4)
  - (c) State why untreated sewage should not be allowed to stagnate. (1)
  
6. With reference to main propulsion shaftsystems:
  - (a) describe a method of hydraulic jacking to check bearing loads; (5)

- (b) sketch the Bearing Load versus Shift Lift Dial Gauge Reading graph obtained by the method described in part (a), annotating the graph and how the characteristic of bearing load is obtained.

(5)

7. (a) State the affinity laws for a centrifugal pump. (3)
- (b) State the effects on the pump affinity laws of fitting a slightly smaller diameter impeller. (2)
- (c) Explain, with the aid of a Head versus Flow diagram, why a two speed pump is preferable to throttling where high and low capacities are demanded for a large sea water circulating pump. (5)
8. Explain, with the aid of a sketch, the principle of the combustion process in ships auxiliary boiler furnace utilising heavyfuel oil. (10)

### Section B

9. With reference to *star delta* starters used for three phase induction motors:
- (a) explain in detail why this type of starter is employed; (4)
- (b) explain, with the aid of a circuit diagram, the sequence of operation of a star delta starter. (6)
10. With reference to testing High Voltage equipment:
- (a) explain why earthing down is considered essential; (2)
- (b) state the operating voltage for an insulation resistance tester (meggar) suitable for 6.6 KV equipment; (1)
- (c) describe how an insulation resistance test is carried out on High Voltage equipment, making reference to personnel safety; (5)
- (d) explain why infra red temperature measurement is used on High Voltage equipment. (2)
11. With reference to large electrical transformers on board ships:
- (a) state where these transformers may be used; (1)
- (b) state a typical efficiency range for a transformer; (1)
- (c) state the regulations pertaining to transformers; (3)
- (d) state the protective devices that are fitted; (2)
- (e) describe the maintenance requirements. (3)



## Section C

12. (a) With reference to bilge keels:
- (i) describe how the design and method of attachment reduces the possibility of damage to the shell plate; (5)
  - (ii) state what testing must be carried out. (2)
- (b) Explain why the bilge keels do not extend the full length of the vessel. (3)
13. As Chief Engineer officer, write a dry dock specification for the repair of the following damage that has occurred, stating what factors have to be considered when costing the repairs.
- Damage to water ballast tank number 1 port wing. The shell plating 15 mm thick for approx 2 metres square has to be removed and replaced along with the relevant damaged stiffeners which have been set up. (10)
14. With reference to cargo hatch covers on large container ships:
- (a) describe how they are tested for watertightness; (2)
  - (b) explain how the weight of the hatch and containers is transferred to the ship's structure whilst allowing for deflections of the hull in a seaway; (3)
  - (c) describe, with the aid of a sketch, the type and location of damage that can occur due to wear of the hatch supporting arrangements. (5)

## Engineering Knowledge - General December 2014

### Section A

1. (a) Describe, with the aid of sketches, how the test pieces for a Class 1 pressure vessel are obtained. (6)
- (b) List the tests which are carried out on the test pieces described in part (a). (4)
  
2. With reference to automatic control:
  - (a) sketch a pneumatic proportional plus integral controller; (6)
  - (b) explain the term *integral saturation*; (2)
  - (c) explain the action to be taken by the operator in the event of integral saturation occurring. (2)
  
3. (a) Sketch a muff type propeller shaft coupling. (5)
- (b) Describe the actions to be taken if the coupling sketched in part (a) does not readily disconnect during routine tailshaft inspection in drydock. (5)
  
4. With reference to centrifugal pumps:
  - (a) describe how EACH of the following improves pump performance:
    - (i) raising the speed of rotation; (2)
    - (ii) multi-staging. (2)
  - (b) explain the advantages of using centrifugal pumps instead of positive displacement pumps for lubricating oil circulating duties. (6)
  
5. (a) Describe, with the aid of a sketch, a water drenching system used to combat fires that may occur on the vehicle decks of a ferry. (6)
- (b) State, with reasons, TWO advantages and TWO disadvantages of the system described in part (a). (4)

6. With reference to activated fin stabilisers, explain EACH of the following:
- (a) why such units are preferred to passive tanks in large vessels; (3)
  - (b) why these units are preferred for passenger and fast cargo ships; (3)
  - (c) why partial, rather than maximum damping of ship movement in heavy weather, is advisable for reasons other than overstressing the fin stocks and activating gear. (4)
7. With reference to tanks containing hydrocarbon liquids and vapours:
- (a) define EACH of the following terms:
    - (i) explosive limits; (2)
    - (ii) vapour pressure; (2)
    - (iii) flash point. (2)
  - (b) explain how the atmosphere in cargo tanks containing varying percentages of flammable gas can be maintained in a safe condition at all times. (4)
8. With reference to auxiliary boilers:
- (a) state the effects of a persistently leaking safety valve on EACH of the following:
    - (i) the feed system; (1)
    - (ii) the valve itself. (3)
  - (b) explain the actions necessary to correct a leaking safety valve whilst at sea. (6)

## Section B

9. Describe, with the aid of a block diagram, how automatic starting, load sharing and stopping of generators in response to load changes is effected. (10)
10. Describe how the starting torque of electric induction motors may be improved by using EACH of the following:
- (a) wound rotor; (5)
  - (b) double cage. (5)

11. (a) Describe, with the aid of a sketch, a synchroscope. (8)
- (b) State TWO methods of paralleling generators if the synchroscope is inoperative. (2)

### Section C

12. As Chief Engineer Officer of an older vessel which has recently been purchased, write a report to the Superintendent Engineer detailing the items that should be inspected to ensure that the *conditions of assignment* are satisfactorily complied with. (10)
13. (a) State the system of classification for access doors passing through watertight bulkheads of a vessel. (3)
- (b) State THREE circumstances under which all watertight doors must be closed when situations are defined as potentially hazardous. (3)
- (c) Explain the safety features built into the watertight door operating system to enhance safety to personnel. (4)
14. As Chief Engineer Officer, outline the essential information to be supplied to the drydock management prior to drydocking a vessel. (10)

### Section A

1. With reference to a ship's air conditioning plant:
  - (a) define the term *comfort zone*; (2)
  - (b) state the objectives of maintaining the conditioned air within the *comfort zone*; (3)
  - (c) state, with reasons, FIVE areas from which the conditioned air must not be recirculated. (5)
  
2. With reference to centrifugal pumps:
  - (a) state the operating principle of a centrifugal pump and why it is unnecessary to fit a relief valve to it; (2)
  - (b) state two impeller types and which type of application they would be best suited for; (2)
  - (c) explain why cavitation occurs and how to possibly reduce by design. (6)
  
3.
  - (a) List the laboratory tests that may be carried out on specimens of steel for ships' plate, stating reasons for these tests. (6)
  - (b) Outline FOUR features of a fracture in a component which would assist in the verification that brittle fracture had occurred. (4)
  
- 4.(a) With reference to shipboard sewage treatment plants, describe the principle of operation of EACH of the following:
  - (i) Biological (3)
  - (ii) Physical (3)
  - (b) Explain why sewage systems involving aerobic action are to be preferred to those with anaerobic action. (2)
  - (c) Explain the meaning and significance of biological oxygen demand. (2)
  
5. With reference to finstabilisers:
  - (a) sketch a block diagram showing an automatic control system; (4)
  - (b) describe the operation of the system sketched in part (a); (4)
  - (c) explain how the stabilising fin forces are generated. (2)
  
6. With reference to lubricating oil:

- (a) state SIX tests that may be carried out on used lubricating oil; (6)
- (b) outline FOUR possible causes of deterioration of the oil that may be indicated in the tests carried out in part (a). (4)
7. With reference to automatic control:
- (a) sketch a pneumatic proportional plus integral controller; (6)
- (b) explain the term *integral saturation*; (2)
- (c) explain the action to be taken by the operator in the event of integral saturation occurring. (2)
8. The company, with which you are employed, requests that all Chief Engineer Officers prepare standing orders regarding the prevention and detection of fires in the machinery spaces.
- Compile such a list of recommendations to be submitted to central office. (10)

## Section B

9. With reference to electrical short circuits:
- (a) state, with reasons, THREE factors that will influence the severity of a short circuit; (6)
- (b) explain the role of reactance when selecting protective devices. (4)
10. With reference to alternating current generators:
- (a) explain the meaning of the term *synchronous impedance*; (4)
- (b) explain, with the aid of phasor diagrams, the effect of altering the excitation of one of a pair of machines that is operating in parallel. (6)
11. (a) Explain why it is necessary to provide reverse power protection for a.c. generators operating in parallel. (2)
- (b) Sketch a generator protecting circuit. (5)
- (c) Explain how to check the operation of the reverse power trip. (3)

## Section C

12. (a) Explain why conventional liquid carriers are divided by longitudinal bulkheads. (2)
- (b) Explain why ore carriers may be fitted with wing tanks. (2)
- (c) State, other than the carriage of liquids, the purposes of double bottom tanks in dry cargo ships. (2)
- (d) A dry cargo ship which has just completed loading is observed to be listing to starboard significantly. The only available means of correcting the list is by adjusting the contents of two large adjacent double bottom ballast tanks port and starboard. The port tank is empty whilst the starboard is half full.
- Describe, with reasons, the action a Chief Engineer Officer would advise. (4)
13. (a) Explain the Harmonised System of Survey & Certification (HSSC). (4)
- (b) With reference to the load line certificate explain what will be inspected and how these items are kept in compliance. (6)
14. (a) State the system of classification for access doors passing through watertight bulkheads of a vessel. (3)
- (b) State THREE circumstances under which all watertight doors must be closed when situations are defined as potentially hazardous. (3)
- (c) Explain the safety features built into the watertight door operating system to enhance safety to personnel. (3)

## Engineering Knowledge - General July 2015

### Section A

1. (a) Describe, with the aid of a Strain versus Time diagram, how a creep test is carried out to determine the strain rate of the material under test. (6)  
(b) Explain EACH of the stages sketched in the diagram in part (a). (4)
2. Accidents have occurred due to premature or accidental release of CO<sub>2</sub> into the machinery spaces.
  - (a) State the safety procedure that the Chief Engineer Officer should adopt with respect to maintenance being carried out on the system by contractors. (3)
  - (b) State the procedure prior to the safe release of CO<sub>2</sub> into the machinery space in the event of fire. (4)
  - (c) Describe the factors that should be considered prior to re-entry of the machinery spaces after the release of CO<sub>2</sub> gas. (3)
3. With reference to bacteria harmful to humans in drinking and washing water:
  - (a) state the constraints placed on the installation and use of systems for shipboard production of fresh water; (3)
  - (b) state the maintenance and treatment recommended for fresh water tanks; (3)
  - (c) describe how the entire fresh water system can be made free from bacteria; (3)
  - (d) state an acceptable residual value in the fresh water tanks to ensure the correct concentration of treatment in the system. (1)
4. Describe, with the aid of a sketch, the operation of a static Oily Water Separator which conforms to current MARPOL regulations and utilises a pump on the discharge side of the separator. (10)
5. (a) Explain how power is transmitted through main propulsion shafting. (3)  
(b) State THREE operational factors that may induce high stress in shaft coupling bolts. (3)  
(c) Sketch a hydraulic type of shaft coupling bolt. (4)
6. With reference to a ram type steering gear, explain how it may be determined that defective steering may be due to EACH of the following, stating the actions that should be taken to maintain steering capability:
  - (a) a twisted rudder stock; (5)
  - (b) worn pump internals; (3)
  - (c) air in the system. (2)



7. (a) Sketch a block diagram of a fully automated air conditioning system for accommodation spaces, annotating the relevant temperatures and relative humidities throughout the system. (7)
- (b) Describe how bacteria are prevented from multiplying to a harmful level in an air conditioning system. (3)
8. As Chief Engineer Officer, write a report to the Superintendent Engineer listing recommendations for the safety precautions to be adopted when servicing accommodation lifts. (10)

### Section B

9. State the main electrical items covered in a Classification Society periodical survey. (10)
10. (a) Explain why it is necessary to provide reverse power for a.c generators operating in parallel. (2)
- (b) Describe, with the aid of a sketch, a reverse power relay trip. (8)
11. Describe, with the aid of a block diagram, the operation of a load sensing electronic governor controller for an a.c. generator. (10)

### Section C

12. (a) State the advantages and disadvantages of aluminium alloy in ship building. (4)
- (b) Describe, with the aid of a sketch, a method of welding aluminium panels. (6)
13. (a) Explain why twin skeg rudders may be fitted on some vessels. (3)
- (b) Explain the advantages of a twin skeg installation in modern vessels with a large cargo carrying capacity. (7)
14. With reference to a bulk carrier, describe, as Chief Engineer Officer, the inspection that should be carried out on the upper topside areas. (10)

## Section A

1. (a) List the laboratory tests that may be carried out on specimens of steel for ships' plate, stating reasons for these tests. (6)
- (b) Outline FOUR features of a fracture in a component which would assist in the verification that brittle fracture had occurred. (4)
2. With reference to the lubrication of refrigeration compressors:
  - (a) state the advantage of using fully synthetic oils; (2)
  - (b) explain why oil may be carried over from the compressor; (3)
  - (c) describe a device which returns oil from the compressor discharge to the compressor sump; (3)state TWO reasons why an accumulation of oil in the evaporator is undesirable. (2)
3. With reference to fin stabilisers:
  - (a) sketch a block diagram showing an automatic control system; (4)
  - (b) describe the operation of the system sketched in part (a); (4)
  - (c) explain how the stabilising fin forces are generated. (2)
4. With reference to centrifugal pumps:
  - (a) Sketch the pump characteristic curves; (3)
  - (b) define *net positive suction head*; (1)
  - (c) discuss the difference between the required and available suction head; (3)
  - (d) describe pump cavitation, explaining how it affects the pump. (3)
5. With reference to pneumatically operated control valves:
  - (a) state the reason for fitting valve positioners; (4)
  - (b) with the aid of a sketch, explain valve hysteresis and how it affects the process; (4)
  - (c) describe how the design and routine maintenance can limit hysteresis. (2)

6. With reference to fresh water HI-FOG fire fighting systems:
- (a) sketch such a system; (6)
  - (b) state how the system in (a) is activated; (2)
  - (c) state, with a reason, a suitable location for the above system. (2)
7. As Chief Engineer Officer write a set of standing orders that comply with the company's SMS system.
- State who should be reading and signing them. (10)
8. (a) Explain how power is transmitted through main propulsion shafting. (3)
- (b) State THREE operational factors that may induce high stress in shaft coupling bolts. (3)
- (c) Sketch a hydraulic type of shaft coupling bolt. (4)

### Section B

9. With reference to testing High Voltage equipment:
- (a) explain why earthing down is considered essential; (2)
  - (b) state the operating voltage for an insulation resistance tester (meggar) suitable for 6.6 KV equipment; (1)
  - (c) describe how an insulation resistance test is carried out on High Voltage equipment, making reference to personnel safety; (5)
  - (d) explain why infra red temperature measurement is used on High Voltage equipment. (2)
10. With reference to main circuit breakers on a switchboard:
- (a) sketch a main circuit breaker when in test position, explaining the function tests that (5)
  - (b) can be carried out; (5)
  - (c) list the routine maintenance for the main circuit breakers; (3)
  - (d) state why it is bad practice to open circuit breakers whilst under load and under what (2)
  - (e) conditions it would be carried out. (2)
11. (a) Describe, with the aid of a sketch, a static excitation system for a generator. (8)
- (b) Explain TWO advantages of static excitation. (2)

## Section C

12. (a) With reference to the overhaul of a ship side valve in dry dock explain, as Chief Engineer Officer, what information should be given to the docking company prior to work commencing. (5)
- (b) Describe how the valves would be overhauled stating the precautions to be taken before returning the ship to service. (5)
13. With reference to large fixed bladed propellers:
- (a) describe, with the aid of a sketch, EACH of the following:
- (i) the effect of hull fouling; (3)
- (ii) operation in clean hull, ballast condition. (3)
- (b) explain why fitting a *light propeller* may be beneficial. (4)
14. With reference to defects found in the steelwork of ballast tanks:
- (a) explain the factors that may cause defects in ballast tanks; (4)
- (b) state, with reasons, areas most likely to be affected and how they may be indicated; (4)
- (c) state methods employed to minimise damage, caused by the factors in (a). (2)

### Section A

1. Describe, with the aid of a sketch, the principle of operation of a capacitance electrode level measuring transmitter. (10)
  
2. With reference to main thrust block arrangements:
  - (a) explain how the tilting pads assist in the formation of an oil wedge; (2)
  - (b) describe the actions that may be taken if upon inspection the pads are found to be:
    - (i) lightly scored; (2)
    - (ii) wiped; (2)
  - (c) explain how the thrust clearance may be measured, stating a typical value; (2)
  - (d) state the possible effects if the thrust clearance is incorrect. (2)
  
3. With reference to static oily water separators, explain EACH of the following:
  - (a) why the supply pump should be carefully selected and matched to the separator; (2)
  - (b) how the separator achieves effective separation; (4)
  - (c) how the physical properties of each of the fluids to be separated affects the rate and effectiveness of separation. (4)
  
4. Describe the principle of operation of EACH of the following heat exchanger types, stating a suitable application for EACH type:
  - (a) parallel flow; (3)
  - (b) contra flow; (3)
  - (c) mixed flow. (4)
  
5.
  - (a) Sketch the hydraulic circuit for a ram type steering gear that complies with the single failure concept and automatic isolation. (6)
  - (b) Describe how automatic isolation, for the hydraulic circuit sketched in part (a), is achieved within 45 seconds should leakage of system oil occur. (4)
  
6.
  - (a) Sketch a block diagram of a fully automated air conditioning system for accommodation spaces, annotating the relevant temperatures and relative humidities throughout the system. (7)
  - (b) Describe how bacteria are prevented from multiplying to a harmful level in an air conditioning system. (3)

7. As Chief Engineer Officer, prepare standing orders for working with gas cutting and gas welding equipment, including the storage of spare bottles. (10)
8. As Chief Engineer Officer appointed to a newly acquired vessel, write a report to the Superintendent Engineer describing the inspection that should be carried out to ensure satisfactory condition and operation of the ship's fire fighting equipment. (10)

### Section B

9. (a) Describe, with the aid of a sketch, a static excitation system for a generator. (8)
- (b) Explain TWO advantages of static excitation. (2)
10. With reference to the paralleling of a.c. generators:
- (a) outline the requirements of synchronisation; (2)
- (b) explain how KW power is shared; (1)
- (c) explain how Kvar power is shared; (1)
- (d) state SIX types of damage that may be caused when machines are incorrectly synchronised. (6)
11. (a) Explain the principle of operation of an insulation resistance test, stating why the test is carried out on a regular basis. (6)
- (b) Describe how EACH of the following electrical tests is carried out:
- (i) resistance; (2)
- (ii) continuity. (2)

### Section C

12. With reference to roll reduction systems, explain the principles of operation of EACH of the following, stating the advantages and disadvantages of EACH:
- (a) bilge keels; (5)
- (b) passive uncontrolled tanks. (5)
13. During sea trials, extensive noise measurements are taken in accordance with the *Code of Practice for Noise Levels in Ships*.
- (a) State and explain the unit of sound measurement. (2)
- (b) State the noise level above which personnel are required to wear ear protection. (1)
- (c) Explain how a ship's crew may be made aware of the hazards posed by exposure to excessive noise. (2)

(d) Explain how the noise levels can be reduced in the design of EACH of the following:

(i) diesel generators; (3)

(ii) ventilation fans and trunkings. (2)

14. Explain the methods adopted in modern shipbuilding practice to prevent hull fractures due to corrosion fatigue, making reference to the sequence of assembly of the plating and welding and the subsequent protection on completion of construction. (10)

### Section A

#### Attempt SIX questions only from this section

1. State the inspections, instructions and maintenance that should be carried out on main sea water pipelines, strainers and ship's side valves to minimise the risks of engine room flooding. (10)
  
2. (a) With reference to a vapour compression refrigeration plant, explain why EACH of the following conditions are desirable:
  - (i) superheating at the compressor suction; (3)
  - (ii) undercooling at the condenser outlet. (3)(b) Describe, with the aid of a Pressure-Enthalpy diagram, how the evaporator cooling load is affected by the conditions stated in Q2(a). (4)
  
3. With reference to centrifugal pumps:
  - (a) state the operating principle of a centrifugal pump and why it is unnecessary to fit a relief valve to it; (2)
  - (b) state TWO impeller types, explaining which type of application EACH would be best suited for; (4)
  - (c) explain why cavitation occurs, and how it is reduced by design (4)
  
4. With reference to stern tube bearings:
  - (a) explain why white metal lined bearings are susceptible to failure; (5)
  - (b) outline the merits of nonmetallic bearings. (5)



5. Sketch a hydraulic circuit for a FOUR ram steering gear that allows FIVE different ram combinations to be used, identifying EACH ram and valve combination. (10)
6. (a) Explain EACH of the following control terms:
- (i) cascade; (2)
  - (ii) split range. (2)
- (b) Describe, with the aid of a sketch, a control system that may be enhanced by the inclusion of cascade control. (6)
7. As Chief Engineer Officer on board a vessel which has lost 500 litres of lubricating oil from the stern tube system overnight, write a report to superintendent outlining the actions taken to rectify the leakage and any other further recommendations. (10)
8. The company, with which you are employed, requests that all Chief Engineer Officers prepare standing orders regarding the prevention and detection of fires in the machinery spaces.
- Compile such a list of recommendations to be submitted to central office. (10)

## Section B

Attempt TWO questions only from this section

9. With reference to electrical short circuits:
- (a) state, with reasons, THREE factors that will influence the severity of a short circuit; (6)
  - (b) explain the role of reactance when selecting protective devices. (4)
10. With reference to a THREEphase electrical distribution system:
- (a) discuss the advantages and disadvantages of an insulated neutral system; (8)
  - (b) state how an earthed neutral system is earthed and the measures taken to limit the maximum earth fault current . (2)
11. (a) State the reasons why direct on line starting for large induction motors such as those for bow and stern thruster units may not be viable. (2)
- (b) Describe, with the aid of a sketch, a starting system that may be used for such motors. (8)

**Attempt TWO questions only from this section**

12. Sketch FIVE methods used to prevent the distortion of ships' plates and frames during major welded hull repairs in dry dock. (10)

13. During sea trials, extensive noise measurements are taken in accordance with the *Code of Practice for Noise Levels in Ships*.

(a) State and explain the unit of sound measurement. (2)

(b) State the noise level above which personnel are required to wear ear protection. (1)

(c) Explain how a ship's crew may be made aware of the hazards posed by exposure to excessive noise. (2)

(d) Explain how the noise levels can be reduced in the design of EACH of the following:

(i) diesel generators; (3)

(ii) ventilation fans and trunkings. (2)

14. With reference to the classification of ships, explain EACH of the following:

(a) why ships are built to classification society rules;

(b) the meaning of the notation +:100A1;

(c) how a ship remains in class throughout the life of the vessel.

Section A

1. Discuss the factors that lead to the selection of materials for use in a sea water cooled, multi-tubular heat exchanger. (10)
  
2. With reference to machinery parts under cyclic loading, describe, with the aid of sketches, how the propagation of even the smallest of cracks can lead to total component failure. (10)
  
3. With reference to main thrust block arrangements:
  - (a) explain how the tilting pads assist in the formation of an oil wedge; (2)
  - (b) describe the actions that may be taken if upon inspection the pads are found to be:
    - (i) lightly scored; (2)
    - (ii) wiped; (2)
  - (c) explain how the thrust clearance may be measured, stating a typical value; (2)
  - (d) state the possible effects if the thrust clearance is incorrect. (2)
  
4. Describe, with the aid of a sketch, the operation of a static Oily Water Separator which conforms to current MARPOL regulations and utilises a pump on the discharge side of the separator. (10)
  
5. With reference to tunnel type bow thrusters:
  - (a) explain why some vessels are fitted with more than one bow thruster; (2)
  - (b) discuss the options available in terms of prime mover and transmission systems. (8)
  
6. (a) Sketch a diagrammatic arrangement of a fully automatic direct expansion domestic refrigeration system which supplies a number of cold rooms. (5)  
(b) State, with reasons, FIVE desirable thermodynamic properties of a refrigerant. (5)

7. Following a serious machinery space fire, the engine room was abandoned and an inert gas smothering agent used to extinguish the fire.

Write a report to the Superintendent Engineer detailing the sequence of events which led to this course of action and the subsequent actions taken to enable the vessel to proceed on passage. Include conclusions and recommendations in the report.

(10)

8. With reference to automatic control:

- (a) sketch a pneumatic proportional plus integral controller; (6)
- (b) explain the term *integral saturation*; (2)
- (c) explain the action to be taken by the operator in the event of *integral saturation* occurring. (2)

## Section B

9. With reference to insulated and earthed electrical systems operating at High Voltage:
- (a) state the regulations pertaining to tankers; (4)
  - (b) describe, with the aid of a sketch, a method to detect earth leakage in EACH of the following systems:
    - (i) earthed; (3)
    - (ii) insulated. (3)
10. (a) Explain the meaning of EACH of the following types of electrical equipment:
- (i) intrinsically safe; (2) (2)
  - (ii) flameproof; (2) (2)
  - (iii) increased safety; (2) (2)
  - (iv) pressurised enclosure. (2) (2)
- (b) State TWO types of lighting equipment that may be installed in the pump room areas of a crude petroleum carrier. (2) (2)
11. Describe, with the aid of a block diagram, how automatic starting, load sharing and stopping of generators in response to load changes is effected. (10) (10)

## Section C

12(a) Describe, with the aid of a sketch, how a hydraulically operated folding hatch cover opens and closes.(7)

(b) Explain how the water tightness and security of the hatch cover sketched in part (a) can be ascertained before proceeding to sea. (3)

13(a) State, with reasons, the potential hazards that may be present in EACH of the following spaces:

- (i) an oily bilge tank; (2) ( 2 )
- (ii) a ballast tank; (2) ( 2 )
- (iii) a refrigerated space. (2) ( 2 )

(b) State the procedures to be undertaken prior to entering enclosed spaces. (4)

State the pr

14 With reference to roll reduction systems, explain the principles of operation of EACH of the following, stating the advantages and disadvantages of EACH:

- (i) Bilge keels (5)
- (ii) Passive Uncontrolled Tanks (5)

# Engineering Knowledge - General October 2016

ENGINEERING KNOWLEDGE – GENERAL October 2016

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. Describe, with the aid of a graph, EACH of the following types of ferrous material failure, stating ONE practical example of EACH:
  1. creep; (5)
  2. fatigue. (5)
  
2. The steering gear operation of a vessel that recently experienced a heavy storm is found to be abnormally sluggish.
  - (a) State FIVE reasons for possible malfunction of the gear. (5)
  - (b) State the corrective actions that may be carried out at sea, that will allow the vessel to continue to the nearest port. (5)
  
3. With reference to refrigeration systems:
  - (a) explain why undercooling of the refrigerant at the condenser outlet is desirable; (3)
  - (b) describe, with the aid of a sketch, how a heat exchanger could be incorporated in the circuit to enhance undercooling; (5)
  - (c) explain the possible consequences of the refrigerant having a dryness fraction at the compressor suction. (2)
  
4. Discuss the advantages and disadvantages of electrical remote monitoring and control systems compared to pneumatic systems. (10)
  
5. (a) Describe the principle of operation of a biological sewage treatment plant. (4)



- (b) Explain how anaerobic conditions can occur within a sewage treatment plant, stating the hazards that may be encountered. (4)
- (c) Explain the meaning and significance of the term *biological oxygen demand*. (2)

- 
6. As a prerequisite to its promotion programme, the head office of your company requests prospective Chief Engineer Officers to submit a report, detailing the responsibilities of a Chief Engineer Officer.

As an aspiring Chief Engineer Officer compile such a report. (10)

7. (a) Sketch a muff type propeller shaft coupling. (5)
- (b) Describe the actions to be taken if the coupling sketched in part (a) does not readily disconnect during routine tailshaft inspection in drydock. (5)
8. (a) Discuss the merits of a condition monitoring system compared to other maintenance regimes. (5)
- (b) Describe how the data is gathered, stored and evaluated on a computer based vibration analysis system. (5)

---

## Section B

9. With reference to electrical shortcircuits:
- (a) state, with reasons, THREE factors that will influence the severity of a short circuit; (6)
  - (b) explain the role of reactance when selecting protective devices. (4)
10. With reference to *star delta* starters used for three phase induction motors:
- (a) explain in detail why this type of starter is employed; (4)
  - (b) explain, with the aid of a circuit diagram, the sequence of operation of a star delta starter. (6)
11. Describe, with the aid of a diagram, a shaft generator that uses a frequency converter. (10)

## Section C

12. (a) State FOUR reasons for transverse watertight bulkheads in ship construction. (4)
- (b) State the minimum number of transverse watertight bulkheads and their location. (4)
- (c) Describe how watertight bulkheads are tested. (2)
13. (a) Explain why fatigue cracks occur in a ship's hull, stating the locations where they may be found. (3)
- (b) Describe the hull inspection that should be carried out in drydock to ascertain the maintenance and repairs that may need to be carried out. (7)
14. As Chief Engineer officer, write a dry dock specification for the repair of the following damage that has occurred, stating what factors have to be considered when costing the repairs. (10)
- Damage to water ballast tank number 1 port wing. The shell plating 15 mm thick for approx 2 metres square has to be removed and replaced along with the relevant damaged stiffeners.

## Engineering Knowledge - General December 2016

### Section A

1. With reference to fuel oil viscosity:
  - (a) explain why correct fuel oil viscosity is necessary; (2)
  - (b) describe TWO methods for the measurement of viscosity that are suitable for the inclusion into a pneumatic or electronic control system; (6)
  - (c) state, with reasons, a control action for a viscosity controller. (2)
  
2.
  - (a) Sketch a muff type propeller shaft coupling. (5)
  - (b) Describe the actions to be taken if the coupling sketched in part (a) does not readily disconnect during routine tailshaft inspection in drydock. (5)
  
3. With reference to pump selection, state TWO types of pump for EACH of the following applications, stating why they are suitable:
  - (a) bilge pumping; (2)
  - (b) cargo oil stripping; (2)
  - (c) sewage sludge; (2)
  - (d) lubricating oil circulating; (2)
  - (e) sea water circulating. (2)
  
4. As Chief Engineer Officer appointed to a newly acquired older vessel, compile a list of all the checks that would be required of the ship's steering gear and associated equipment, given that no hand over from the previous owners had taken place. (10)
  
5. With reference to a ship's air conditioning plant:
  - (a) define the term *comfort zone*; (2)
  - (b) state the objectives of maintaining the conditioned air within the *comfort zone*; (3)
  - (c) state, with reasons, FIVE areas from which the conditioned air must not be recirculated. (5)

6. With reference to bacteria harmful to humans in drinking and washing water:
- (a) state the constraints placed on the installation and use of systems for shipboard production of fresh water; (3)
  - (b) state the maintenance and treatment recommended for fresh water tanks; (3)
  - (c) describe how the entire fresh water system can be made free from bacteria; (3)
  - (d) state an acceptable residual value in the fresh water tanks to ensure the correct concentration of treatment in the system. (1)
7. The company, with which you are employed, requests that all Chief Engineer Officers prepare standing orders regarding the prevention and detection of fires in the machinery spaces.
- Compile such a list of recommendations to be submitted to central office. (10)
8. (a) Describe, with the aid of sketches, how the test pieces for a Class 1 pressure vessel are obtained. (6)
- (b) List the tests which are carried out on the test pieces described in part (a). (4)

---

## Section B

9. With reference to voltage variation profiles caused by load changes imposed on alternating current generators when starting large motors on line:
- (a) sketch a voltage dip, showing an acceptable recovery time; (2)
  - (b) state FOUR salient factors that cause the variation in part (a); (4)
  - (c) outline FOUR salient factors that assist recovery from the deviation shown in part (a). (4)
10. With reference to a.c switchboards:
- (a) state, with reasons, the protective devices that are fitted; (5)
  - (b) state why a breaker may fail to open under prolonged low voltage conditions; (2)
  - (c) explain the actions to be taken should a main generator circuit breaker stay connected despite repeated efforts to trip it off the board. (3)
11. Describe, with the aid of a sketch, an electronic soft starting system that may be used for large a.c. induction motors. (10)

---

## Section C

12. Explain, with the aid of a mid-ship half sectional sketch of a container ship, how strength is built into this type of vessel whilst still allowing access to the cargo holds. (10)
  
13. As Chief Engineer Officer on a new vessel which is experiencing severe aft end vibration at full service speed, write a report to the Engineer Superintendent suggesting reasons for the vibration and recommendations for further sister vessels presently under construction. (10)
  
14. With reference to a bulk carrier, describe, as Chief Engineer Officer, the inspection that should be carried out on the upper topside areas. (10)



## SQA Markers' Feedback- General: Date April 2016

### MARKERS REPORT FORM PART I

SUBJECT: 041-35 Engineering General

DATE: 04 April 16

#### General Comments on Examination Paper

#### General Comments of Specific Examination Questions

Q1. Well answered by most candidates but the basic often omitted such as, all staff to be instructed on the position and use of the emergency bilge system and sea water system as well as the cross overs.

Q2. This one was well answered some lost marks due to not giving a description as well as the drawing for the P/E diagram.

Q3. This question was well attempted by all those that did it.

Q4 This question was answered well but some candidates a bit scarce on details of reason for failures of the bearings.

Q5 This question was well answered by all. The only comment would be that the question asked for four ram answering with rotary vane is not going to get any marks.

Q6 Part (a) of this question some confusion over the term cascade control this led to reduction in the marks as well as losing marks in part (b)

Q7 This question had some interesting scenario's but generally it was well answered.

Q8 This question then some of the basics missing such as sounding caps to be replaced ensure that no tie open there.

Q9 Those that attempted this answered well. Part (b) not so well very few giving facts such as motor may have values reactance and sub transient.

Q10 This question was well attempted by those doing it.

Q11 Part (a) well done there is more than one option for part (b) one option that is not going to work is drawing a DOL starter circuit.

Q12 Well attempted most candidates went for the other two question in this section.#

Q13 This question was answered well some lost marks for not explaining how noise levels can be reduced they just gave a sketch rather than explaining.

Q14 This question was well attempted a lot of those doing this one missed the fact that building to class has a large impact on the insurance, chartering, sale and purchasing as well as the financing for ship

# SQA Markers' Feedback- General: Date July 2016

## MARKERS REPORT FORM

### PART I

SUBJECT: 041-35 Engineering Knowledge - General

DATE: 11<sup>th</sup> July 2016

#### General Comments on Examination Paper

Highest mark 87%                      Lowest mark 25%                      Average mark 63.3%

The majority of candidates were well prepared and passed the examination with few problems. The issues pertaining to the questions where candidates lost marks are detailed below:

#### General Comments of Specific Examination Questions

##### **Question 1**

Candidates did not score highly in this question as they did not go deep enough into the reasons for the selection of the materials for this type of heat exchanger.

##### **Question 4**

Most candidates scored well, almost a third who attempted this question getting full marks. Some candidates are still producing old fashioned two stage separators and scored zero marks.

##### **Question 5(b)**

The answers to this question could do with updating as there are some newer types of drive that candidates do not seem to be aware of.

##### **Question 6**

The answers produced for this question were really poor. At this level a simple four block diagram (compressor, condenser, expansion valve and evaporator) is not detailed enough. What about the receiver, dryer, sight glass, room thermostat etc? In part (b) a lot of candidates stated desirable properties but not the reasons - read the question.

##### **Question 12**

Sketches in part (a) were generally below average. Many sketches were poorly annotated, if at all. For part (b) a large number of candidates described three different methods of testing water tightness. This is not what the question is asking – it is how the hatch cover is sitting on the hatch seal or gasket when cleated down. Some candidates answered this very well and augmented their answer with a sketch. Candidates who went down the three different methods route got one mark out of the three available.

# SQA Markers' Feedback- General: Date December 2015

## MARKERS REPORT FORM

### PART I

SUBJECT: 041-35 Engineering Knowledge - General

DATE: 14<sup>th</sup> December 2015

#### General Comments on Examination Paper

Highest mark 85%                      Lowest mark 33                      Average mark 64.5%

Reasonably high pass rate and average mark indicates that most candidates were very well prepared for this examination. Seven of the failures scored between 40 and 49 marks and one candidate failed on the 40% rule because they did not score enough marks in Section B. Most questions were well answered and I only have a few comments as listed below.

#### General Comments of Specific Examination Questions

##### **Question 5**

(a) Most candidates got full marks for drawing very good systems showing automatic isolation and bypass valves. A small number of candidates sketched two basic 100% torque units but did not state this on their sketch or in the explanation in part (b).

(b) Only one candidate scored full marks for the description of how the system sketched in part (a) achieves automatic isolation, most others were not able to provide an answer that matched what they had sketched or followed a logical explanation and scored no marks for part (b) even though they had achieved full marks for part (a).

##### **Question 7**

Some candidates went off track and started talking about electric welding sets and electrodes.

##### **Question 9**

A small number of candidates got this completely wrong by sketching and describing an automatic voltage regulator.

##### **Question 12**

Chief Engineer candidates are being asked the “principles of operation” of the roll reduction systems not a “sketch and describe” as seen in the Class 2 papers. Only four candidates scored full marks for this question, most managed to get around half marks and that was mainly due to marks allocated for stating the advantages and disadvantages of both systems and did not explain how the systems worked.

##### **Question 13**

(b) A number of candidates just drew sketches but did not explain how the noise levels could be reduced. I awarded some marks if the sketches were well annotated but it must be remembered that whilst a sketch is welcome to enhance an answer, it does not replace a written explanation - if that is what is asked for.

# SQA Markers' Feedback- General: Date March 2015

## MARKERS REPORT FORM PART I

SUBJECT: 041-35 Engineering General

DATE: 23 March 2015

### General Comments on Examination Paper

#### General Comments of Specific Examination Questions

Q1 Most candidates answered well only losing marks on part (b) they just gave the same answer for part (a) we were looking for the objectives for maintaining the comfort zone ie. removal of excess heat reduce moisture etc.

Q2. Well answered by the majority of candidates

Q3 Most candidates received most of the marks, lost marks then for missing test such as micro and macro examinations for the steel.

Q4.. Well answered by those that attempted this.

Q5. Part 9a) a number of candidates missed out the ship log reference so lost marks in this part of answer

Q6 Well answered by most.

Q7 Most that attempted received the majority of marks.

Q8 Well answered by those that attempted this with just some minor items missing

Q9. Part (a) well attempted part (b) a lot of candidates struggled to get the salient points into there answer

Q10 Those that attempte3d this did well.

Q11. Part (a) well answered. Part (b) caused the most problem as the candidates did not answer the question fully so lost marks. The question asked for generator protecting circuit this should contain more than the reverse power trip as this is only one of the protections for generators.

Q12 Most candidates answered this well although some missed the fact that longitudinal bulkheads are also for adding strength

Q13 Part (a) caused some problems.

Q14 The majority of candidates answered this well.

# SQA Markers' Feedback- General: Date October 2015

## MARKERS REPORT FORM

SUBJECT: 041-35 Engineering General

DATE: 12 Oct 15

### General Comments on Examination Paper

#### General Comments of Specific Examination Questions

Q1..Well answered by most But there is also Macro as well as the more obvious ones.

Q2.Reasonably well answered by most. The crankcase is at gas inlet pressure when stationary which allows the miscible oil to be readily carried over with the gas.

Q3. Well answered by majority.

Q4 Pump question well attempted.

Q5.Well attempted by most part (a) asked for reason for fitting a valve positioner there are more than one reason.

Q6. Well attempted some of the sketches were not the best.

Q7 Well attempted although some candidates forgot to mention the company SMS requirements with regard to the content of the chief engineers standing orders..

Q8. Well attempted by most

Q9.Well answered by the majority of candidates.

Q10 On the whole well answered but you should remember that the motor winding mechanism can also be tested..

Q11 Well answered by most.

Q12.Well attempted although a few candidates gave information for the docking company with regards to the ship and not the question specific of sea water valve overhaul.

Q13 Light propeller has nothing to do with the weight of the prop.

Q14 Well answered by most.

# SQA Markers' Feedback- General: Date July 2015

## MARKERS REPORT FORM

SUBJECT: 041-35 Engineering Knowledge - General

DATE: 13<sup>th</sup> July 2014

### General Comments on Examination Paper

Highest mark 87%                      Lowest mark 33%                      Average mark 68.3%

High pass rate and high average mark indicates that most candidates were very well prepared for this examination, however the responses to Section C were concerning and a number of candidates only scraped by the marks required to pass this section even though they had done very well in Sections A and B.

My comments below are not intended to be critical, there were a lot of excellent scripts, I am merely providing guidance for future candidates.

### General Comments of Specific Examination Questions

#### **Question 1**

- (a) Few candidates mentioned temperature when describing the creep test.
- (b) Most candidates scored 3 marks for this part but very few mentioned a reduction in cross sectional area at stage three which would have given them the extra mark.

#### **Question 3(d)**

Most candidates stated 0.2 ppm chlorine. The answer I was looking for was higher than this since the chlorine will deplete as it passes through the system. Ship Captains Medical Guide recommends 0.5ppm in the tanks.

#### **Question 4**

Some candidates sketched and described a Simplex Turbulo type of separator and simply put a pump on the discharge side. No marks awarded for this tactic. Even the modern Turbulo MPB has the pump on the supply side.

#### **Question 6(a)**

A number of candidates stated that they would check the degree of twist from the angle of the rudder in the steering flat but this will have no relevance since the indicator is fitted on top of the stock and the twist is further down.

#### **Question 12(b)**

There were three different answers provided for this question:

- 1) MIG welding process showing two aluminium plates being welded together – full marks;
- 2) Bolting aluminium to steel using nylon washers etc - zero marks;
- 3) Bonding aluminium to steel using explosive welding process – some marks for describing it as a welding process although it wasn't quite what was asked for.

#### **Question 13**

This was by far the lowest scoring question in the paper. A lot of candidates (from all colleges) explained or stated emphatically and repeatedly in both parts of the question that the twin skeg arrangement was primarily so that the ship could run aground and not cause damage to the propellers and rudders. Whilst I did award a mark for this as an advantage in the unlikely event of going aground, it is not why this design is used in large tankers and containerships for example. A large number of candidates sketched various set ups showing single screw & skeg, twin screw & single skeg and the twin screw/ twin skeg. Why? This is not asked for, does not answer the question and does not merit any marks.

## SQA Markers' Feedback- General: Date Oct 2016

### MARKERS REPORT FORM

SUBJECT: 041-35 Engineering General

DATE: 17 Oct 16

#### General Comments on Examination Paper

Sketches varied from the good to poor the candidates must realise that the sketch that they do **MUST BE ABLE TO OPERATE**, If it is not then you will lose marks.

#### General Comments of Specific Examination Questions

Q1..Although a sketch was not asked for a good number gave graph to emphasise their answer, this is good but candidates should ensure that they draw a relevant one for their answer. .

Q2 Well attempted by most candidates should always read the question thoroughly as the sub heading is telling you where the examiner wishes you to answer the question on. For example the steering gear was sluggish due to heavy weather recently so they were attempting to direct your thought as to what could be the problem with the rams bearings and safety devices not routine faults such as dirty filters or low oil level. You are meant to be answering these as prospective chief engineers not at seconds. The corrective action was also poorly answered

Q3. Part a was answered well with some using graph to explain their answer. Part b caused the most consternation.. A heat exchanger normally has two fluids flow through it heating one and cooling another. A system that uses an expansion valve to flash of leaving the liquid to pass to the second expansion valve and evaporator does not fulfil the criteria for a heat exchanger. Part c when we refer to dryness fraction in fridge plants we are not referring to water vapour trapped in the gas it refers to the state of the gas itself.

Q4 Poor attempted when using the term DICUSS we expect the answer to be written in such a manner that you make a case for the one that you would be wishing to promote. Using bullet point just to give advantages and disadvantages will not get you the full marks.

Q5 This was well attempted again sketches were used to illustrate the answer for part a..the rest of the parts were well done.

Q6. Well attempted by those that chose to complete this question.

Q7 Sketches could be a bit rough also there were some that missed out important details such as the nut the seal so rendered the answer incorrect.

Q8. Again part a was a discussion type answer but not a lot of discussion in the written submissions. Remember that what you write is what has to be marked we cannot give marks for assumptions of what you meant?.

#### Section B

Q9..This question was reasonably answered but some answers lost the point with particular reference to part a

Q10 Part a was the part that caused the most loss of marks some candidates happy to only mention the starting current being 6 to 8 times more. There is more to the answer than this what are the consequences with regard to

the generator switch board and protective devices.

Q11 Some candidates only completed the sketch to be able to allocate the full marks we also require your description of how it operates to ensure that you understand the operation of the shaft alternator and associated equipment.

#### Section C

Q12. The candidates answer then could be a bit short it asked for reasons just putting down one word answer is not going to get you the full marks as you are not showing any depth of knowledge.. When it asked to state the minimum you should have been doing that not giving the rules and never answering the question asked.

Q13 This was well attempted by most though some candidates missed the stern tube wear down or the rudder measurement.

Q14 The question asked for a specification for repair. Saying yard supply material is insufficient you have to be specific in the repair information very few asked for or specified the type of plate or for certification for the plate or the welders for carrying out the repair.

The answers did not look like the answers from chief engineers as they lacked some depth to them.