# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**
Dundigal, Hyderabad -500 043

## MECHANICAL ENGINEERING
## TUTORIAL QUESTIONBANK

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| **Course Name** | **APPLIED THERMODYNAMICS** |
| **Course Code** | AME007 |
| **Semester** | IV |
| **Branch** | Mechanical Engineering |
| **Year** | 2018 –2019 |
| **Course Faculty** | Dr.P. Srinivas Rao, Professor<br>Mr. Aravind Reddy, Assistant Professor |

### OBJECTIVES:
**The course should enable the students to:**

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| I | Visualize the construction and working of internal combustion engines, compressors and refrigeration systems. |
| II | Compare the ideal and real working of thermodynamic cycles for performanceevaluation. |
| III | Understand the subsystems of internal combustionsystems. |
| IV | Evaluate different refrigeration systems and air-conditioning systems using p-h charts. |

### COURSE LEARNING OUTCOMES:
**Students, who complete the course, will have demonstrated the ability to do the following:**

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| AME007.01 | Understand main idea and importance behind the 2 - S and 4 - S IC engines. |
| AME007.02 | Analyze the working of the basic components in the IC engines. |
| AME007.03 | Understand the combustion process and also how it does affect the performance of the IC engines. |
| AME007.04 | Apply the thermodynamic principles in the design of an IC engines. |
| AME007.05 | Formulate and perform the procedures required for the maintenance and operation of IC engines. |
| AME007.06 | Compare different IC engines and develop a system which meets the requirements. |
| AME007.07 | Knowledge of Fuel Requirements and Fuel Rating. |
| AME007.08 | Testing and Performance of I.C Engines. |
| AME007.09 | Analyze the working of the basic components in the Compressors and Refrigeration systems. |
| AME007.10 | Apply the thermodynamic principles in the design of Compressors and refrigeration system. |
| AME007.11 | Formulate and perform the procedures required for the maintenance and operation of compressors and refrigeration systems. |
| AME007.12 | Compare different compressors and refrigeration systems and develop a system which meets the requirements. |
| AME007.13 | Understand the process of pressure enthalpy charts that are used in the Refrigeration systems. |
| AME007.14 | Introduction to concepts of power and refrigeration cycles. Their efficiency and coefficients of performance. |
| AME007.15 | Ability to use modern engineering tools, software and equipment to analyze energy transfer in required air-condition application. |
| AME007.16 | Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc. |

| UNIT – I | | | |
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| I C ENGINES | | | |
| PART - A (SHORT ANSWER QUESTIONS) | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | What is valve timing diagram why the inlet valve is opened before TDC and closed after BDC? | Remember | AME007.01 |
| 2 | What is combustion efficiency and combustion back duration? | Understand | AME007.01 |
| 3 | What is fluid friction in an engine? | Remember | AME007.01 |
| 4 | What are the products formed during combustion process? | Remember | AME007.01 |
| 5 | What is an internal combustion engine? | Understand | AME007.01 |
| 6 | What is scavenging? | Remember | AME007.01 |
| 7 | What is meant by compression ratio? | Understand | AME007.01 |
| 8 | Define firing order. | Remember | AME007.01 |
| 9 | What do you mean by SFC? | Remember | AME007.02 |
| 10 | Define mean effective pressure. | Understand | AME007.03 |
| 11 | Obtain the expression for mean effective pressure of an Otto cycle. | Remember | AME007.02 |
| 12 | List the three principal factors that influence engine performance. | Understand | AME007.03 |
| 13 | What are the different kinds of fuels used in an IC? | Remember | AME007.02 |
| 14 | Briefly explain the petroleum refining process. | Remember | AME007.03 |
| 15 | What are the important qualities of SI and CI engine fuel? | Remember | AME007.02 |
| 16 | How are SI and CI engine fuels rated? | Understand | AME007.03 |
| 17 | What are the functional requirements of an injection system? | Remember | AME007.01 |
| 18 | How the injection system classified? | Remember | AME007.01 |
| 19 | Define carburation. | Understand | AME007.01 |
| 20 | With a neat sketch explain an induction coil. | Understand | AME007.01 |
| PART - B (LONG ANSWER QUESTIONS) | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | Give classification of IC Engines. | Understand | AME007.01 |
| 2 | Distinguish between SI engines and CI engines? | Understand | AME007.01 |
| 3 | Sketch and explain the valve timing diagram of a four stroke Otto cycle engine? | Understand | AME007.01 |
| 4 | In what respect two stroke engines differs from 4-stroke engine Discuss. | Understand | AME007.01 |
| 5 | Explain fuel injection system of an SI engine? | Remember | AME007.01 |
| 6 | What are the different lubrication systems available for IC engines? | Understand | AME007.02 |
| 7 | Discuss the importance of cooling system for an IC engines. Describe different cooling systems? | Understand | AME007.03 |
| 8 | List out the properties of fuel for (i) SI engine (ii) CI engine. | Understand | AME007.02 |
| 9 | Explain lubrication system for IC engines? | Understand | AME007.03 |
| 10 | Explain cooling system for IC engines? | Remember | AME007.02 |
| 11 | What is the main difference between an Otto cycle and Diesel cycle? Derive the expression for mean effective pressure of the Diesel cycle. | Remember | AME007.02 |
| 12 | Explain with a neat sketch the working principle of a mechanical governor. | Remember | AME007.03 |
| 13 | Explain why a rich mixture is required for the following<br>i. Idling<br>ii. Maximum power<br>iii. Sudden acceleration | Understand | AME007.02 |
| 14 | Describe the essential part of a modern carburetor. | Understand | AME007.02 |
| 15 | What is the purpose of using a governor in CI engines? What are the two major types of governors? | Understand | AME007.03 |
| 16 | Draw a schematic diagram of fuel feed pump and explain its working principle. | Remember | AME007.02 |

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| 17 | What are the different kinds of fuels used in an IC engine? | Understand | AME007.03 |
| 18 | How are SI and CI engine fuels rated? | Remember | AME007.02 |
| 19 | Explain reversible and irreversible processes. Is it possible to realise these processes. | Understand | AME007.02 |
| 20 | Explain briefly the Diesel cycle with the help of p-v and T-S diagrams and derive anexpression for the ideal efficiency of a Diesel cycle. | Understand | AME007.03 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | What are the homogeneous and heterogeneous mixtures? In which engines these mixtures are used? Explain. | Remember | AME007.02 |
| 2 | What is the importance of additives in lubricants? | Understand | AME007.03 |
| 3 | Basic energy requirements for spark ignition engine. | Remember | AME007.02 |
| 4 | What are the different variables that effects knocking in an CI engine can an operator usually able to control hose effects explain. | Remember | AME007.03 |
| 5 | Explain the process of ignition delay of CI engine while representing on pressure time diagram. | Remember | AME007.02 |
| 6 | Illustrate with diagram the effect of ignition delay on the rate of pressurized in the CI engine. | Remember | AME007.02 |
| 7 | What is meant by crank case ventilation? Explain the details? | Remember | AME007.03 |
| 8 | Give a brief account of air pollution due to engine exhaust. | Remember | AME007.04 |
| 9 | What are the causes and problems of improper combustion of IC engines? | Remember | AME007.05 |
| 10 | What are the different variables that effects knocking in an SI engine can an operator usually able to control hose effects explain? | Remember | AME007.04 |
| **UNIT-II** | | | |
| **COMBUSTION IN S I ENGINES AND CI ENGINES** | | | |
| **PART - A (SHORT ANSWER QUESTIONS)** | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | What is the normal combustion and abnormal combustion in SI engine? | Understand | AME007.04 |
| 2 | What is called flame front and flame velocity? | Understand | AME007.05 |
| 3 | What is knocking in both SI and CI engines? | Remember | AME007.04 |
| 4 | What decides severity of knocking in both SI and CI Engines? | Remember | AME007.05 |
| 5 | What is pre ignition and optimum ignition timing? | Remember | AME007.04 |
| 6 | What is ignition delay period? | Remember | AME007.05 |
| 7 | Define suction induced swirl and combustion induced swirl? | Remember | AME007.04 |
| 8 | What is mixture strength? How it influences the combustion? | Remember | AME007.05 |
| 9 | What are anti-knock agents? Main difference between working of anti-knock agent in SI and CI ENGINES? | Remember | AME007.04 |
| 10 | What is a combustion chamber? What are the different combustion zones in combustion chamber? | Understand | AME007.06 |
| 11 | What are the types of ignition systems | Remember | AME007.07 |
| 12 | Give the two methods of cooling systems? | Remember | AME007.06 |
| 13 | List the properties of lubricants? | Remember | AME007.07 |
| 14 | Factors affecting normal combustion in SI system? | Understand | AME007.06 |
| 15 | What are the properties of liquid fuels? | Remember | AME007.07 |
| 16 | What are the tests for identifying pre-ignition? | Understand | AME007.06 |
| 17 | Differentiate auto ignition and detonation | Understand | AME007.07 |
| 18 | What are the effects of detonation? | Understand | AME007.06 |
| 19 | How to control detonation? | Understand | AME007.07 |
| 20 | How to control detonation? | Understand | AME007.06 |

## PART - B (LONG ANSWER QUESTIONS)

| S. No | Question | Blooms Taxonomy Level | Course Learning Outcomes |
|---|---|---|---|
| 1 | State and explain different combustion stages in SI engine. | Remember | AME007.06 |
| 2 | State and explain different combustion stages in CI engine. | Understand | AME007.07 |
| 3 | Explain knocking, properties and its effects in CI engine. | Understand | AME007.06 |
| 4 | Explain different types of combustion chambers in SI and CI engines. | Understand | AME007.07 |
| 5 | Explain the need for air motion and types.<br>Factors influencing knocking in SI and CI engine. | Understand | AME007.06 |
| 6 | What are the requirements of fuel for a diesel engine? | Understand | AME007.07 |
| 7 | Differentiate between normal combustion and abnormal combustion phenomena in case of SI Engine. | Understand | AME007.06 |
| 8 | What is the importance of variables like flame speed flame front in case of delay period. | Remember | AME007.07 |
| 9 | Explain knocking additives | Understand | AME007.06 |
| 10 | Discuss air flow movements in CI engines | Understand | AME007.07 |
| 11 | Explain the Splash lubrication system with the diagram | Remember | AME007.06 |
| 12 | Explain the carburetor working principle with diagram | Understand | AME007.07 |
| 13 | What are the types of fuel injection systems? Explain anyone with a neat sketch? | Understand | AME007.06 |
| 14 | How to tell a two stroke cycle engine from a 4 stroke cycle engine? | Remember | AME007.07 |
| 15 | Explain the Pressure feed system with a diagram? | Remember | AME007.06 |
| 16 | In what respect four-stroke diesel cycle (compression Ignition) engine differs from four stroke cycle spark ignition engine? | Remember | AME007.07 |
| 17 | What do you mean by Pre-ignition? How can it be detected? | Understand | AME007.06 |
| 18 | Explain the difference between Pre-ignition, auto-ignition and detonation. | Remember | AME007.06 |
| 19 | What is meant by ignition delay? Explain the steps in SI engines ignition delay? | Understand | AME007.07 |
| 20 | Why do we feel the necessity of cooling an IC engine? Explain briefly the following methods of cooling IC engines: Air-cooling and Liquid - cooling? | Understand | AME007.06 |

## PART - C (ANALYTICAL QUESTIONS)

| S. No | Question | Blooms Taxonomy Level | Course Learning Outcomes |
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| 1 | What are the harmful effect of overheating of an engine explain. | Understand | AME007.06 |
| 2 | Why battery ignition system is preferred in most of the engines. | Understand | AME007.07 |
| 3 | What are the effects of super charging on engine performance? | Understand | AME007.06 |
| 4 | How does scavenging takes place in 2 stroke petrol engine? | Understand | AME007.07 |
| 5 | What are the undesirable effects if an engine under cool? | Understand | AME007.06 |
| 6 | How liquid cooling system is better than air cooling system in an IC engine. | Understand | AME007.07 |
| 7 | Find the mean effective pressure and torque developed by the engine in the previous problem if its rating is 4 kW at 1500 rpm. | Remember | AME007.06 |
| 8 | What do u mean by charge? What type of charge to be sent for petrol engine for better performance? | Understand | AME007.07 |
| 9 | Why firing order is important to run an IC engine. Mention firing order of four - stroke four cylinders, six cylinder engines. | Remember | AME007.06 |
| 10 | Why the actual efficiency much lower than air standard efficiency explain with major losses. | Remember | AME007.06 |

| UNIT-III | | | |
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| TESTING AND PERFORMANCE | | | |
| PART - A (SHORT ANSWER QUESTIONS) | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | Define brake power? | Remember | AME007.06 |
| 2 | Define mechanical efficiency? | Remember | AME007.06 |
| 3 | List the devices used to measure the cylinder pressure. | Understand | AME007.06 |
| 4 | What is an indicated power? | Understand | AME007.06 |
| 5 | What are the various losses of IC Engine? | Understand | AME007.06 |
| 6 | How do you determine heat losses explain with sankey diagram? | Understand | AME007.06 |
| 7 | Define clearance ratio. | Understand | AME007.06 |
| 8 | What is specific fuel consumption? | Remember | AME007.06 |
| 9 | Define volumetric efficiency? | Understand | AME007.06 |
| 10 | What is the use of heat balance sheet of an engine | Understand | AME007.06 |
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| 11 | Classify positive displacement compressors. | Remember | AME007.06 |
| 12 | State the basic function of an air dryer in a compressor. | Remember | AME007.06 |
| 13 | Write the capacity range of a vertical type reciprocating compressors. | Understand | AME007.06 |
| 14 | Define a compressor. | Understand | AME007.06 |
| 15 | Classify non-positive displacement compressors | Remember | AME007.06 |
| 16 | Mention the primary element of a centrifugal compressor. | Remember | AME007.06 |
| 17 | Classify different types of compressors. | Remember | AME007.06 |
| 18 | When are the rotary compressors employed? | Understand | AME007.06 |
| 19 | Classify rotary type compressors. | Remember | AME007.06 |
| 20 | Mention the primary element of an axial compressor. | Remember | AME007.06 |
| PART - B (LONG ANSWER QUESTIONS) | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | Explain the Morse test to fins the frictional power. | Understand | AME007.06 |
| 2 | What is William's line .how do you measure frictional power using this. | Remember | AME007.06 |
| 3 | Discuss different types of dynamometers. | Understand | AME007.06 |
| 4 | Write short notes on Exhaust gas analysis. | Remember | AME007.06 |
| 5 | Define the following terms: Indicated Power, Brake power, Friction Power, Mechanical efficiency, Mean effectiveness. | Understand | AME007.06 |
| 6 | What is the significance of heat balance sheet? Discuss the procedure to draw heat balance sheet for CI engine. | Understand | AME007.06 |
| 7 | Explain Isothermal work done | Understand | AME007.06 |
| 8 | Derive equation for work done of reciprocating air compressor with T-S and p-V diagrams. | Understand | AME007.06 |
| 9 | Explain about intercooling. | Understand | AME007.06 |
| 10 | Explain the phenomenon of knocking in SI engines? What are the different factors influencing the knocking? | Understand | AME007.06 |
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| 11 | Explain multistage compression | Understand | AME007.09 |
| 12 | Derive volumetric efficiency of air compressor | Understand | AME007.10 |
| 13 | Classify compressors | Remember | AME007.11 |
| 14 | What is the condition for maximum efficiency in multistage compression? | Understand | AME007.09 |
| 15 | Enumerate the applications of compressed air? How are air compressors classified? | Understand | AME007.09 |
| 16 | Classify dynamic compressors. Explain the working of a axial compressor. | Remember | AME007.11 |

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| 17 | State how the air compressors are classified? | Remember | AME007.09 |
| 18 | Explain the working of a reciprocating compressor | Remember | AME007.10 |
| 19 | Classify rotary compressors. Explain the working of a rotary compressor | Remember | AME007.11 |
| 20 | Classify dynamic compressors. Explain the working of a centrifugal compressor. | Remember | AME007.09 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | The data recorded during the trial of a two stroke diesel engine are as follows: Engine speed =1500rpm Load on brakes =110kg brake arm =900mmDetermine the following:<br>(a) Brake torque, (b) Power available at the brakes of the engine. | Understand | AME007.06 |
| 2 | During testing a two stroke, diesel engine with rope brake dynamometer, the following were recorded: Engine speed =700rpm Diameter of brake drum =600mm Diameter of rope =50mm Dead load on the brake drum=35kg Spring balance reading =4.5kg Find the power available at the brakes, in KW. | Remember | AME007.06 |
| 3 | During the trial on a single cylinder, four stroke, diesel engine the following are noted: Load on hydraulic dynamometer=950N Dynamometer constant =7500 Fuel used per hour = 10.5kg/hr Calorific values of fuel =50000kJ/Kg Engine speed =400rpm. Calculate brake thermal efficiency of the engine | Remember | AME007.06 |
| 4 | An Otto cycle four stroke gas engine has a cylinder 25cm in diameter and the stroke of the piston is 40cm. It operates under the following conditions: Speed =200rpm misfires per minute =10 Mean effective pressure=6.2kg/cm2 Mechanical efficiency =80% Determine (a) IHP, (b) BHP and (c) Friction horse power. | understand | AME007.06 |
| 5 | Calculate the volumetric efficiency of a petrol engine of 6cm bore and 9cm stroke if each cylinder sucks 0.0025kg of charge during suction stroke. Assume R as 29.27. | Remember | AME007.06 |
| 6 | A four cylinder engine running at 1200rpm developed 25.3BHP. The average torque when one cylinder was cut out was 10.5kg_m. Determine the indicated thermal efficiency, if the calorific value of the fuel used is 10000kcal/kg, and the engine uses 0.25kg of petrol per BHP hour. | Remember | AME007.06 |
| 7 | In the Morse test with a four cylinder four stroke petrol engine, the following data were obtained for a particular setting and speed.<br>BHP with all cylinders working =32.0<br>BHP with No 1 cylinder cut off=21.6<br>BHP with No 2 cylinder cut off=22.3<br>BHP with No 3 cylinder cut off=22.5<br>BHP with No 4 cylinder cut off=23.0<br>Estimate the IHP of the engine and its mechanical efficiency. | Remember | AME007.06 |
| 8 | During the trial of a single cylinder, four stroke oil engine, the following observations were recorded: Bore and Stroke =300mm x 450mm Engine speed=220rpm Duration of trial =60minutesFuel consumption =7.0kgCalorific valve of fuel=45000kJ/kg Area of indicator diagram =320mm$^2$Length of indicator diagram=60mmSpring index=1.1bar/mm Net load on brakes =130kgBrake drum diameter =1650kgTotal weight of jacket cooling water =500kgTemperature rise of jacket cooling water=400 Temperature of exhaust gases=300air Consumption=300kgAssume specific heat of exhaust gases= 1.004 kJ/kg K, specific heat of water =4.185kJ/kg k and room temperature =25$^0$C Determine the followinga Power available at brakes. b. Indicated power developed, c. Mechanical efficiency, d. Thermal efficiency, e. Heat balance sheet. | Remember | AME007.06 |

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| 9 | The following readings are observed during the trial of a single cylinder, four stroke diesel engine. Fuel used per hour=11kg;mass analysis of fuel is carbon 85%, oxygen 14%, non-combustibles 1%;calorific value of fuel is 50000kJ/kg. The volumetric analysis of the exhaust gases is carbon dioxide 8.5%, oxygen 10%, and nitrogen 81.5%. Temperature of exhaust gases is 400c. Specific heat of Exhaust gases is 1.05kJ/kg. Partial pressure of steam in the exhaust gases is 0.030bar.Ambient temperature is $20^0$c.Calculate the percentage of heat carried away by the exhaust gases. | Remember | AME007.06 |
| 10 | During the trial on a single cylinder, four stroke, diesel engine the following are noted: Load on hydraulic dynamometer=950N Dynamometer constant =5500 Fuel used per hour = 10.5kg/hr Calorific values of fuel =20000kJ/Kg Engine speed =400rpm. Calculate brake thermal efficiency of the engine. | Remember | AME007.06 |

## UNIT-IV

## ROTARY, DYNAMIC AND AXIAL FLOW

### PART - A (SHORT ANSWER QUESTIONS)

| S. No | Question | Blooms Taxonomy Level | Course Learning Outcomes |
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| 1 | What is volumetric efficiency in case of compressor? | Understand | AME007.09 |
| 2 | Define slip factor? | Understand | AME007.10 |
| 3 | Define pressure coefficient. | Understand | AME007.11 |
| 4 | What is the difference between reciprocating and rotary compressors? | Understand | AME007.09 |
| 5 | What is stalling? | Understand | AME007.10 |
| 6 | Draw p-v and T-S diagram of a MULTI stage reciprocating compressors? | Understand | AME007.11 |
| 7 | What is the function of an intercooler in compressors? | Remember | AME007.09 |
| 8 | What are rotary compressors? | Remember | AME007.10 |
| 9 | What is the difference between positive displacement and non-positive displacement compressors? | Remember | AME007.11 |
| 10 | What do you mean by Choking? | Remember | AME007.09 |
| 11 | Specify the function of a diffuser. | Remember | AME007.10 |
| 12 | Mention the primary component of a rotary compressor. | Remember | AME007.11 |
| 13 | Write the function of a rotor in rotary compressors. | Remember | AME007.09 |
| 14 | Define stage in a Axial flow Compressor. | Remember | AME007.11 |
| 15 | Mention the definition of ‘Degree of Reaction”. | Understand | AME007.12 |
| 16 | Write the formula for Blade loading coefficient in a Axial flow compressor. | Remember | AME007.13 |
| 17 | State or define Volumetric efficiency of a reciprocating compressor. | Remember | AME007.11 |
| 18 | How an Air compressor may be controlled? | Remember | AME007.12 |
| 19 | Why the clearance volume of a air compressor is kept minimum? | Remember | AME007.13 |
| 20 | Mention the types of rotary compressors. | Remember | AME007.11 |

### PART - B (LONG ANSWER QUESTIONS)

| S. No | Question | Blooms Taxonomy Level | Course Learning Outcomes |
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| 1 | State how the air compressors are classified. | Understand | AME007.09 |
| 2 | Explain the working of roots blower. | Remember | AME007.10 |
| 3 | Explain the working of vane blower and also draw the actual p -v diagram of a compressor. | Remember | AME007.11 |
| 4 | What is rotary compressor?How are they classified? | Remember | AME007.09 |
| 5 | Draw the velocity diagram of an axial flow compressor. | Understand | AME007.10 |
| 6 | What do you mean by multistage compression? And state its advantages? | Understand | AME007.11 |
| 7 | Draw velocity diagrams of centrifugal compressors. | Understand | AME007.11 |
| 8 | Compare between reciprocating and rotary compressors. | Understand | AME007.12 |

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| 9 | Compare between axial flow and centrifugal compressors. | Understand | AME007.13 |
| 10 | Discuss of working centrifugal compressors. | Remember | AME007.11 |
| 11 | Describe with a neat sketch the construction and working of a single-stage single-acting reciprocating air compressor. | Understand | AME007.12 |
| 12 | Describe briefly an axial flow compressor. | Remember | AME007.13 |
| 13 | Write short notes on<br>a) clearance in compressors<br>b) free air delivered and displacement<br>c)compressor performance | Understand | AME007.11 |
| 14 | Explain with a neat sketch actual p-V diagram for a single stage compressor. | Understand | AME007.12 |
| 15 | What is a centrifugal compressor? How does it differ from an axial flow compressor? | Understand | AME007.13 |
| 16 | Write short notes on<br>a) control of compressors<br>b) intercooler<br>c)compressed air motors | Understand | AME007.11 |
| 17 | Explain the working of a reciprocating compressor with its sectional view diagram. | Understand | AME007.11 |
| 18 | Explain with a neat sketch actual p-V diagram for a two- stage compressor. | Understand | AME007.12 |
| 19 | Define the following efficiencies as applied to reciprocating air compressors:<br>a) compressor Efficiency<br>b) Isothermal Efficiency<br>c) Adiabatic Efficiency<br>d) Mechanical Efficiency | Remember | AME007.13 |
| 20 | Mention the advantages and disadvantages of multi stage compression. | Understand | AME007.11 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | An air compressor takes in air at 1 bar and 20 $^0$ C and compresses it according to law pv $^{1.2}$ = constant .It is then delivered to a receiver at a constant pressure of 10 bar. R=0.287 KJ/Kg Determine: (i) Temperature at the end of compression (ii) Work done and heat transferred during compression per kg of air. | Remember | AME007.09 |
| 2 | A single–stage, double-acting compressor has a free air delivery (FAD) of 14 m3/min. measured at 1.013 bar and 150C. The pressure and temperature in the cylinder during induction are 0.95 bar 320 C. The delivery pressure is 7 bar and index of compression and expansion, n=1.3.The clearance volume is 5 % of the swept volume. Calculate (i) Indicated power required (ii) Volumetric efficiency. | Remember | AME007.10 |
| 3 | Air at 103 K Pa and 27 $^0$C is drawn in LP cylinder of a two stage air compressor and is isentropic ally compressed to 700 KPa. The air is then cooled at constant pressure to 37 $^0$C in an intercooler and is then again compressed isentropic ally to 4 MPa in the H.P cylinder, and is then delivered at this pressure Determine the power required to run the compressor if it has to deliver 30 m$^3$ of air per hour measured at inlet conditions. | Remember | AME007.11 |
| 4 | A roots blower compresses 0.08 m$^3$ of air from 1.0 bar to 1.5 bar per revolution .Calculate the compressor efficiency. | Remember | AME007.12 |
| 5 | A centrifugal compressor delivers 16.5 kg/s of air with a total head pressure ratio of 4:1 .The speed of the compressor is 1500 r.p.m. Inlet total head temperature is 20$^0$ C, slip factor 0.9 Power input factor 1.04 and 80 % isentropic efficiency. Calculate: Overall diameter of the impeller ii. Power input | Remember | AME007.13 |

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| 6 | A multi stage axial flow compressor delivers 20 kg/sec of air. The inlet stagnation condition is 1 bar and 17 $^0$ C. The power consumed by the compressor is 4350 kW .Calculate (i) The delivery pressure (ii)Number of stages (iii) Overall isentropic efficiency of the compressor. | Understand | AME007.11 |
| 7 | An axial flow compressor with an overall isentropic efficiency of 85 % draws air at 20$^0$ C and compresses it in the pressure ratio 4:1.The mean blade speed and flow velocity are constant throughout the compressor. Assuming 50 % reaction blading and taking blade velocity as 180 m/sec. and work input factor as 0.82.calculate (i) Flowvelocity (ii) Number of stages. | Understand | AME007.13 |
| 8 | A Centrifugal compressor used as a super charger for aero-engines handles 150 kg/min of air. The suction pressure and temperature are 1bar and 290K. the suction velocity is 80 m/s. after compression in the impeller the conditions are 1.5bar 345K and 220 m/s. Calculate:<br>a) Isentropic efficiency<br>b) power required to drive the compressor<br>c) The overall efficiency of the unit.<br>It may be assumed that K.E. gained in the impeller is entirely converted into pressure in the diffuser. | Understand | AME007.14 |
| 9 | Air at a temperature of 300K flows in a centrifugal compressor running at 18000 r.p.m. Isentropic total head efficiency= 0.76, outer diameter of blade tip= 550mm, slip factor= 0.82. calculate<br>A) the temperature rise of air passing through the compressor<br>B) the static pressure ratio. | Remember | AME007.15 |
| 10 | A multi stage axial flow compressor delivers 20 kg/sec of air. The inlet stagnation condition is 1 bar and 19$^0$ C. The power consumed by the compressor is 5350 kW .Calculate (i) The delivery pressure (ii)Number of stages (iii) Overall isentropic efficiency of the compressor | Remember | AME007.13 |

## UNIT - V

## REFRIGERATION

### PART - A (SHORT ANSWER QUESTIONS)

| S. No | Question | Blooms Taxonomy Level | Course Learning Outcomes |
|---|---|---|---|
| 1 | Define refrigeration? | Understand | AME007.11 |
| 2 | Define (i) actual COP (ii) Theoretical COP. | Understand | AME007.12 |
| 3 | What is the difference between wet compression and dry compression? | Understand | AME007.11 |
| 4 | Write short notes on p-h chart. | Understand | AME007.12 |
| 5 | What is unit of refrigeration | Remember | AME007.13 |
| 6 | What is the function of capillary tube in vapour compression refrigeration system? | Remember | AME007.11 |
| 7 | What are the different components of vapour compression system | Remember | AME007.12 |
| 8 | What is the effect of sub cooling | Understand | AME007.13 |
| 9 | State demerits of air refrigeration system | Understand | AME007.11 |
| 10 | What is the function of Expansion valve? | Understand | AME007.12 |
| 11 | Define (i) COP(iii) Relative COP | Understand | AME007.13 |
| 12 | Mention a reversed heat engine cycle and its function. | Understand | AME007.11 |
| 13 | Write the operations in a vapour refrigeration cycle. | Understand | AME007.11 |
| 14 | Why is wet compression not preferred. | Remember | AME007.12 |
| 15 | Define refrigerating system? | Remember | AME007.13 |
| 16 | Specify the main characteristic feature of an air refrigeration system | Remember | AME007.11 |
| 17 | State elements of refrigerating system. | Remember | AME007.12 |
| 18 | Why an analyzer-rectifier combination is used in absorption refrigeration cycle. | Remember | AME007.13 |
| 19 | State merits of air refrigeration system. | Understand | AME007.11 |

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|---|---|---|---|
| 20 | Mention the Effect of superheating. | Understand | AME007.12 |
| **PART - B (LONG ANSWER QUESTIONS)** | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | Describe a simple vapour compression cycle giving clearly its flow diagram. | Remember | AME007.11 |
| 2 | Show the vapour compression cycle on T-S diagram when the vapour is dry saturated, super-heated. | Remember | AME007.12 |
| 3 | What are the factors that affect the performance of a vapour compression system and explain? | Remember | AME007.13 |
| 4 | What are desired properties of refrigerants. | Understand | AME007.11 |
| 5 | Explain with neat sketch the working of a vapour absorption system. | Understand | AME007.12 |
| 6 | Compare between vapour compression and vapour absorption systems. | Understand | AME007.13 |
| 7 | Explain air refrigeration system. | Understand | AME007.11 |
| 8 | Explain reversed Carnot cycle on T-S diagram, | Understand | AME007.12 |
| 9 | What are the different components of vapour compression system and explain with neat sketch | Remember | AME007.13 |
| 10 | Classify and explain refrigerants. | Understand | AME007.11 |
| 11 | Differentiate clearly between open and closed air refrigeration systems. | Understand | AME007.11 |
| 12 | State merits and demerits of 'vapour compression system' over 'air refrigeration system'. | Understand | AME007.12 |
| 13 | Enumerate the properties and uses of commonly used refrigerants. | Understand | AME007.13 |
| 14 | Write the important refrigeration applications.<br>Elements of refrigeration system. | Understand | AME007.11 |
| 15 | State the functions of the following parts of a simple vapour compression system: compressor, condenser, expansion valve and evaporator. | Remember | AME007.12 |
| 16 | Give the comparison between a vapour compression system and a vapour absorption system. | Remember | AME007.11 |
| 17 | Briefly explain pressure enthalpy chart. | Remember | AME007.12 |
| 18 | Explain practical vapour absorption system. | Understand | AME007.13 |
| 19 | Write the functions of parts of a simple vapour compression system. | Understand | AME007.11 |
| 20 | Show the vapour compression cycle on T-S diagram when the vapour is super-heated and wet after compression. | Understand | AME007.12 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | |
| **S. No** | **Question** | **Blooms Taxonomy Level** | **Course Learning Outcomes** |
| 1 | An air refrigeration system operates between 1 MPa and 100 K Pa is required to produce a cooling effect of 2000 KJ/min. Temperature of the air leaving the cold chamber is -5 $^0$ C and at leaving the cooler is 30 $^0$ C. Neglect losses and clearance in the compressor and expander determine (i) Mass of air circulated per min (ii) Compressor work ,expander work ,cycle work(iii) COP and power in KW required | Understand | AME007.13 |
| 2 | 28 tonnes of ice from and at 0 $^0$ C is produced per day in an ammonia refrigerator. The temperature range in the compressor is from 25 $^0$C to -15 $^0$C.The vapour is dry and saturated at the end of compression and an expansion valve is used. Assuming a co efficient of performance of 62 % of the theoretical, calculate the power required to drive the compressor. take latent heat of ice is 335 KJ/kg. | Remember | AME007.14 |
| 3 | A refrigerator operating on stand vapour compression cycle has a coefficient performance of 6.5 and is driven by a 50 KW | Remember | AME007.15 |

<table>
<tr><td></td><td>compressor. The enthalpies of saturated liquid and saturated vapour refrigerant at the operating condensing temperatures of 35 $^0$ C are 62.55 KJ/Kg and 201.45 KJ/Kg. The standard refrigerant vapour leaving evaporator has an enthalpy of 187.53kJ/kg. Find the refrigeration temperature at compressor discharge. The Cp of refrigerant vapour may be taken to be 0.6155 kJ/kg.$^0$C.</td><td></td><td></td></tr>
<tr><td>4</td><td>In a simple vapour compression cycle the piston displacement volume for compressor is 1.5 liters per stroke and its volumetric efficiency is 80 %.The speed of compressor is 1600 rpm. Find the power rating of compressor and refrigerating effect.</td><td>Understand</td><td>AME007.13</td></tr>
<tr><td>5</td><td>Ice is formed at 0°C from water at 20°C. The temperature of the brine is – 8°C. Find out the kg of ice formed per kWh. Assume that the refrigeration cycle used is perfect reversed Carnot cycle. Take latent heat of ice as 335 kJ/kg.</td><td>Remember</td><td>AME007.14</td></tr>
<tr><td>6</td><td>A refrigerating machine of 6 tonnes capacity working on Bell-Coleman cycle has an upper limit of pressure of 5.2 bar. The pressure and temperature at the start of the compression are 1.0 bar and 16°C respectively. The compressed air cooled at constant pressure to a temperature of 41°C enters the expansion cylinder. Assuming both expansion and compression processes to be adiabatic with $\gamma$= 1.4, calculate :<br>(i)Co-efficient of performance.<br>(ii)Quantity of air in circulation per minute.<br>(iii)Piston displacement of compressor and expander.<br>(iv)Bore of compressor and expansion cylinders. The unit runs at 240 r.p.m. and is double-acting. Stroke length = 200 mm.<br>(v)Power required to drive the unit<br>For air take $\gamma$= 1.4 and $c_p$= 1.003 kJ/kg K.</td><td>Remember</td><td>AME007.15</td></tr>
<tr><td>7</td><td>A simple vapour compression plant produces 5 tonnes of refrigeration. The enthalpy values at inlet to compressor, at exit from the compressor, and at exit from the condenser are 183.19, 209.41 and 74.59 kJ/kg respectively. Estimate :<br>(i)The refrigerant flow rate,<br>(ii)The C.O.P.,<br>(iii)The power required to drive the compressor, and<br>(iv)The rate of heat rejection to the condenser.</td><td>Remember</td><td>AME007.13</td></tr>
<tr><td>8</td><td>A vapour compression heat pump is driven by a power cycle having a thermal efficiency of 25%. For the heat pump, refrigerant-12 is compressed from saturated vapor at 2.0 bar to the condenser pressure of 12 bar. The isentropic efficiency of the compressor is 80%.Saturated liquid enters the expansion valve at 12 bar. For the power cycle 80% of the heat rejected by it is transferred to the heated space which has a total heating requirement of 500 kJ/min. Determine the power input to the heat pump compressor. The following data for refrigerant-12may be used :
<table>
<tr><td rowspan="2">Pressure, bar</td><td rowspan="2">Temperature, °C</td><td colspan="2">Enthalpy, kJ/kg</td><td colspan="2">Entropy, kJ/kg K</td></tr>
<tr><td>Liquid</td><td>Vapour</td><td>Liquid</td><td>Vapour</td></tr>
<tr><td>2.0</td><td>– 12.5</td><td>24.57</td><td>182.0</td><td>0.0992</td><td>0.7035</td></tr>
<tr><td>12.0</td><td>49.31</td><td>84.21</td><td>206.24</td><td>0.3015</td><td>0.6799</td></tr>
</table></td><td>Remember</td><td>AME007.14</td></tr>
<tr><td>9</td><td>A refrigeration machine is required to produce i.e., at 0°C from water at 20°C. The machine has a condenser temperature of 298 K while the evaporator temperature is268 K. The relative efficiency of the machine is 50% and 6 kg of Freon-12 refrigerant is circulated through the system per minute. The refrigerant enters the compressor with a dryness fraction of0.6. Specific heat of water is</td><td>Remember</td><td>AME007.15</td></tr>
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|---|---|---|---|
| | 4.187 kJ/kg K and the latent heat of ice is 335 kJ/kg. Calculate the amount of ice produced on 24 hours. | | |
| 10 | An air refrigeration system operates between 1 MPa and 200 K Pa is required to produce a cooling effect of 3000 KJ/min. Temperature of the air leaving the cold chamber is -5 $^0$C and at leaving the cooler is 40 $^0$ C. Neglect losses and clearance in the compressor and expander determine (i) Mass of air circulated per min (ii) Compressor work ,expander work ,cycle work(iii) COP and power in KW required | Remember | AME007.13 |

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