L-2/T-1/NAME Date : ~~27/04/2024~~ 18/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2022-2023

Sub : **NAME 219** (Marine Engines and Fuels)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

The symbols have their usual meaning. Assume reasonable value of any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. **Answer to Question No. 1 is compulsory.**

Answer any **TWO** questions from the rest.

1. (a) What is an "Engine performance curve"? Draw such a curve and explain how different parameters affect an engine's performance. **(10) (C1P1)**

   (b) Draw schematic diagram of both SI and CI engine. Point out the unique engine parts and explain their functions in the respective engine. **(15) (C2P1)**

   (c) Is "Hydro-electric Power Plant" a source of renewable energy? Justify your answer. **(10) (C4P1)**

   (d) Make a comparative study on "Pintle Nozzle" and "Pintaux Nozzle" and also provide their neat sketches. **(10) (C3P1P2)**

2. (a) State appropriate assumptions for fuel injection computation in CI Engine. And derive the expression of actual nozzle velocity. **(8)**

   (b) A 4-cylinder 4-stroke CI engine develops 260 kW at 2000 rpm with brake specific fuel consumption of 0.31 kg/kW-hr. Determine the size of the double-hole injection nozzle if the injection pressure is 175 bar and the pressure in the combustion chamber is 50 bar. The period of injection is 30° of crank angle. Orifice discharge coefficient is 0.88. And specific gravity of fuel is 0.80. If the injection nozzle was single-hole, then calculate the percentage increase in nozzle diameter compared to double-hole nozzle. **(15)**

   (c) What is a "Geo-thermal Plant"? Explain how power is produced in a 'Liquid-Dominated Geo-thermal Plant". **(7)**

3. (a) A 4-stroke 6-cylinder diesel engine, running at 750 rpm requires a fuel amount of 3000 lb/hr. Air is needed 20 cft/lb. The calorific value of fuel is 18000 BTU/lb. And, AFR (Air Fuel Ratio) = 24, IHP (Indicated Horse Power) = 7000 HP, strike length = 2.0 ft. bore = 20 inch. Calculate the following: **(20)**

   (i) Specific fuel consumption
   (ii) Thermal efficiency
   (iii) Air flow rate
   (iv) mean effective pressure
   (v) Volumetric efficiency

   (b) Explain the combustion process periods with necessary diagrams. **(10)**

Contd P/2

NAME 219

4. (a) Derive the expression of instantaneous piston speed (Up) for an engine with bore = B, crank offset = a, stroke length = S, turning speed = N, crank angle = θ, connecting rod length = r. **(15)**

Also, show that the ratio of instantaneous piston speed and average piston speed can be written as –

$$\frac{Up}{\overline{Up}} = \frac{\pi}{2}\sin\theta\left[1+\left\{\frac{\cos\theta}{\sqrt{R^2-(\sin\theta)^2}}\right\}\right]$$

where, R = r/a.

(b) Define "Engine Knocking". Compare between SI and CI engine knocking with necessary sketches. Also, provide solutions on how to reduce engine knocking. **(15)**

SECTION – B

There are **FOUR** questions in this section. **Answer to Question No. 5 is compulsory.**
Answer any **TWO** questions from the rest.

5. (a) Briefly describe different aspects need to be taken into consideration when choosing a main engine for a ship. **(15) (C6P1)**

(b) Why cooling of engine is required? Explain cooling system in marine engine. **(10) (C3P1)**

(c) How to improve octane number of a fuel? **(10) (C5P1)**

(d) Explain the effect of pressure ratio on performance of gas turbines. **(10) (C1P1)**

6. (a) Make a comparison between direct and indirect type of combustion chamber. **(7)**

(b) Describe Ricardo's turbulent head-side valve combustion chamber with pros and cons. **(13)**

(c) The requirement of air motion and swirl in a C.I. engine combustion chamber is much more stringent than in an S.I. engine. Justify this statement. **(10)**

7. (a) Explain the working principle of thermo-syphon system of cooling with advantages and disadvantages. **(10)**

(b) Differentiate between wet sump and dry sump lubrication system. **(10)**

(c) What are lubricants? Write down the functions of lubricants. **(10)**

Contd P/3

NAME 219

8. (a) Describe the mist lubrication system with neat sketches. Mention the advantages and disadvantages of this system. **(15)**

(b) In an air-standard Brayton Cycle, the air enters the compressors at 0.1 MPa, 15°C. The pressure leaving the compressor is 1.0 MPa and the maximum temperature in the cycle is 1100°C. Determine – **(15)**

(i) The pressure and temperature at each point in the cycle.

(ii) The compressor work, turbine work, back work ratio, net work developed, thermal efficiency.

Course Outcomes:

Course Learning Outcome (CO)	
CO -1	**Explain** basic performance parameters of internal combustion (IC) engines
CO -2	**Describe** main components of IC engine
CO -3	**Explain** the impact of different cooling systems, injection nozzles, and combustion chambers on engine parameters e.g., warm-up time, performance, emission
CO -4	**Identify** different renewable energy sources, availability, and practical applications
CO -5	**Analyze** the fuel quality and fuel requirements of SI and CI engine
CO -6	**Apply** knowledge to choose engines for different types of vessels

L-2/T-1/NAME **Date: 02/05/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **HUM 113** (Economics)

Full Marks: 140 Time: 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Clarify the concepts of gross domestic product (GDP), gross national product (GNP), and net national product (NNP). Explain the expenditure method of calculating GDP and justify why inflation is taken into consideration for calculating GDP. **(13)**

   (b) What do you understand by households' disposable income? Illustrate the circular flow of income and expenditure in an open economy. **(10 1/3)**

2. (a) Briefly discuss the determinants of the four components of aggregate expenditure and define marginal propensity to consume (MPC) and marginal propensity to save (MPS). **(13)**

   (b) Illustrate macroeconomic equilibrium using the 45° –line diagram, the Keynesian cross. **(10 1/3)**

3. (a) Describe the causes and consequences of inflation in your own words. **(13)**

   (b) What is 'consumer price index (CPI)' and 'GDP deflator'? Table 1 presents hypothetical data on consumer goods and services, and their respective weights and prices. Calculate CPI-based rate of inflation. **(10 1/3)**

Table 1:

Category	Price index for each category		
	Weight	Year 1	Year 2
Food and beverage	0.221	5000	5340
Housing	0.535	6350	7600
Medical care	0.045	4000	4475
Others	0.199	380	450
	1.00		

4. (a) Draw the short-run cost curves using a hypothetical cost table. Show graphically the short-run profit maximization for a firm with the help of marginal cost (MC), marginal revenue (MR) average cost (AC) and marginal revenue (MR) curves. **(13)**

   (b) Derive the conditions for profit maximization of a firm. Imagine that a firm's total cost and total revenue functions are respectively **(10 1/3)**

   $$TC = 12 + 16Q + 3Q^2 \quad \text{and} \quad TR = 48Q - Q^2$$

   Find the output level and the maximum level of profit.

Contd P/2

HUM 113/NAME

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define production possibility frontier (PPF). Illustrate the following applications of PPF: **(8 1/3)**

   (i) Choice between necessities and luxuries.

   (ii) Choice between current consumption goods and investment.

   (iii) Choice between public goods and private goods.

   (b) What are the assumptions of cardinal theory of utility maximization? **(5)**

   (c) Mathematically derive the cardinal theory of utility maximization both for independent and interdependent commodities. **(10)**

6. (a) How would you estimate the demand for computers for building smart Bangladesh? **(8 1/3)**

   (b) What do you mean by the concept of market demand for a commodity? Explain graphically. **(7)**

   (c) (i) Calculate equilibrium price and quantity from the following demand and supply functions and show the result in a graph: **(8)**

   $P = 0.25Q + 18$

   $P = -0.40Q + 70$

   where Q stands for quantity and P stands for price.

   (ii) What will happen to the equilibrium price and quantity if Government imposes a unit tax of Tk. 5 per unit?

   (iii) Describe the change in the equilibrium points on the same graph.

7. (a) Explain how does technology affect the supply of a commodity in general. **(5 1/3)**

   (b) How would you derive the formula for measuring cross price elasticity of demand? Explain the formula with suitable examples. **(8)**

   (c) What do you mean by substitution effect and income effect of a price change? Graphically, show that price effect is equal to substitution effect and income effect. Present and explain all necessary diagrams. **(10)**

8. (a) What do you mean by budget line? Briefly explain consumer's equilibrium with the help of budget line and indifference curves. **(6 1/3)**

   (b) State and prove the application of Euler's theorem in the theory of distribution of production. **(12)**

   (c) Describe the internal economics of large scale production. **(5)**

L-2/T-1/NAME **Date : 22/04/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2022-2023

Sub : **MATH 281** (Vector Analysis and Differential Equations)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Solve the differential equation $x\frac{d^3y}{dx^3}+\frac{d^2y}{dx^2}=12x$ **(10)**

   (b) Solve the differential equation $x^2\frac{d^2y}{dx^2}-3x\frac{dy}{dx}+4y=2x^2$. **(12)**

   (c) Solve $[xD^2+(x-1)D-1]y=x^2$ by the method based on factorization of operators. **(13)**

2. Given the differential equation

$$2x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}-(2x+1)y=0$$

   (a) Find the nature of singularity of the differential equation. **(5)**

   (b) Solve the differential equation by Fröbenius method. **(30)**

3. (a) Express $f(x)=x^4+2x^3+2x^2-x-3$ in terms of Legendre polynomials. **(11)**

   (b) Prove the recurrence relation $nP_n(x)=(2n-1)xP_{n-1}(x)-(n-1)P_{n-2}(x)$. **(12)**

   (c) Prove that $\int_{-1}^{1}x^2P_{n-1}(x)P_{n+1}(x)\,dx=\frac{2n(n+1)}{(4n^2-1)(2n+3)}$. **(13)**

4. (a) Prove that $xJ_n'(x)=nJ_n(x)-xJ_{n+1}(x)$. **(12)**

   (b) Prove that $J_2'(x)=\left(1-\frac{4}{x^2}\right)J_1(x)+\frac{2}{x}J_0(x)$. **(10)**

   (c) Prove that $\int_0^1 xJ_n(\alpha x)J_n(\beta x)\,dx=\begin{cases}0 & \text{if } \alpha\neq\beta\\ \frac{1}{2}[J_{n+1}(\alpha)]^2 & \text{if } \alpha=\beta\end{cases}$ **(13)**

   where α and β are the roots of $J_n(x)=0$.

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MATH 281/NAME

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) An automobile travels 5 miles due west, then 3 miles 60° north of west. Represent these displacements graphically and determine the resultant displacement (i) graphically, (ii) analytically. **(10)**

(b) If a, b, c are non-coplanar vectors, determine whether the vectors $\mathbf{r}_1 = 2\mathbf{a} - 3\mathbf{b} + \mathbf{c}$, $\mathbf{r}_2 = 3\mathbf{a} - 5\mathbf{b} + 2\mathbf{c}$ and $\mathbf{r}_3 = 4\mathbf{a} - 5\mathbf{b} + \mathbf{c}$ are linearly independent or dependent. If dependent find a relation among them. **(15)**

(c) Find the shortest distance from (6, –4, 4) to the line joining (2, 1, 2) and (3, –1, 4). **(10)**

6. (a) A particle moves so that its position vector is given by $\mathbf{r} = \cos\omega t\,\mathbf{i} + \sin\omega t\,\mathbf{j}$ where ω is a constant. Show that **(12)**

(i) the velocity **v** of the particle is perpendicular to **r**,

(ii) the acceleration **a** is directed toward the origin and has magnitude proportional to the distance from the origin,

(iii) $\mathbf{r} \times \mathbf{v}$ = a constant vector.

(b) Find the equation for the osculating plane to the curve $x = 3t - t^3$, $y = 3t^2$, $z = 3t + t^3$ at the point where $t = 1$. **(12)**

(c) Find the divergence of gradient Φ, where $\Phi = r^5$. **(11)**

7. (a) Determine whether the vector field **F** has a scalar or vector potential and then find its potential **(13)**

$$\mathbf{F} = \mathbf{i}(y\sin z - \sin x) + \mathbf{j}(x\sin z + 2yz) + \mathbf{k}(xy\cos z + y^2)$$

(b) Evaluate $\int_C \mathbf{F}.d\mathbf{r}$ where $\mathbf{F} = (xz^2 + y, z - y, xy - z)$ and C is the curve $x^2 + y^2 = a^2$, $z = h$ from $(0, a, h)$ to $(a, 0, h)$. **(11)**

(c) Usign Green's theorem in plane, evaluate $\oint_C [(y - \sin x)dx + \cos x dy]$ where C is the triangle whose vertices are (0, 0), $(\frac{\pi}{2}, 0)$ and $(\frac{\pi}{2}, 1)$. **(11)**

8. (a) State Stokes' theorem and verify it for $\mathbf{F} = (2x - y)\mathbf{i} - yz^2\mathbf{j} - y^2z\mathbf{k}$ for the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ and its boundary. **(20)**

(b) Applying alternative form of divergence theorem, transform to a triple integral and evaluate $\iint_S \left(x^3 dydz + x^2 ydzdx + x^2 zdxdy\right)$, where S is the closed surface bounded by the planes z = 0, z = b and the cylinder $x^2 + y^2 = a^2$. **(15)**

L-2/T-1/NAME Date : 27/03/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2022-2023

Sub : **MME 293** (Shipping Materials)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer all of therm.

1. (a) Analyse what happens to the impurity oxide that enter the blast furnace in the correct sequence up to their removal. **(15)**

   (b) The density of two polypropylene materials is 0.904 g/cm^3 respectively, while the associated percent crystallinity of those two materials are 62.8 and 54.4 respectively. Calculate (i) densities of totally crystalline and totally amorphous polypropylene and (ii) density of a specimen having 74.6% crystallinity. **($11\frac{1}{4}$)**

2. (a) Compare between acid processes and basic processes for steelmaking. Which of them will you choose for a pig iron containing 3% carbon, 1% silicon, 1% phosphorus and 0.1% sulfur? Defend your choice. **(15)**

   (b) Elucidate the reason of using double slagging process for steelmaking in Electric Arc. Furnace (EAF) instead of single slag practice. **($11\frac{1}{4}$)**

3. (a) Suppose you have ordinary low carbon steel (%C<0.2) and the option of adding C, Ni, and Cr as alloying elements. Your target is to make steel blades suitable for surgical instruments. State which alloying elements you will add and in what amount with clear reasoning(s). **($15+11\frac{1}{4}=26\frac{1}{4}$)**

   What is secondary hardening in tool steel? With necessary diagram, relate the influence of different factors on secondary hardening of tool steel.

   Or

   (b) A ferrous alloy is required that has good castability, good wear resistance and a high degree of ductility. Suggest an alloy and explain how each desired property is present in your alloy. If a little more strength is required instead of ductility, can you think of a way to fulfil the requirement without changing the composition of your chosen alloy? **($15+11\frac{1}{4}=26\frac{1}{4}$)**

   "Tool steels should always be at least double tempered" – assess the statement.

Contd P/2

4. (a) What do you understand by "Season Cracking" and "Dezincification"? Mention the conditions required for season cracking. Suggest the composition of a brass alloy that will provide resistance to dezincification and evaluate your suggestion. Can you strengthen this brass alloy by heat treatment? Justify your answer. **($26\frac{1}{4}$)**

Or.

(b) "Obstructing the motion of dislocation is the main goal of various strengthening processes used for metal" – Justify the assertion correlating with metal strengthening mechanism. Select a Non-Destructive Technique (NDT) for detecting surface defects of austenitic stainless steel and briefly describe the technique. **($15+11\frac{1}{4}=26\frac{1}{4}$)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) A cylindrical specimen of steel (E = 210 GPa) having an original diameter of 12.8 mm is tensile tested to fracture and found to have an engineering yield strength of 300 MPa and an engineering fracture strength of 460 MPa. If its cross-sectional diameter at fracture is 10.7 mm, determine: (i) the ductility of the steel, (ii) the true stress at fracture and (iii) The true strain at yield point. **(6+6+6)**

(b) A testing organization has arranged a heat treatment program and you are supposed to participate there for heat treating a 0.20% carbon steel part to make its surface hard of around 1000 VHN. Describe the surface hardening technique you recommend. **(17)**

6. (a) Explain how coring occurs with respect to copper-nickel phase diagram. Also explain the problems associated with a cored structure and its rectification process. **(20)**

(b) Spheroidizing heat treatment is generally used to produce a toughened hypereutectoid steel. Explain the required heat treatment process. **(15)**

7. (a) A steel company produced a steel sample having 0.40% C for a particular application. As an engineer, determine (i) the fraction of ferrite and cementite phases, (ii) the fraction of pro-eutectoid ferrite and pearlite and (iii) the fraction of eutectoid ferrite at a temperature just below the eutectoid temperature. **(4+4+4)**

(b) Describe the effect of crystal structure and grain size on ductile to brittle transition temperature of material. **(7+7)**

(c) "Coarse grain structure has opposite effect on creep resistance and tensile strength"- justify. **(9)**

Contd P/3

MME 293(NAME)

8. (a) An alloy producing company designed an alloy containing metals A and B Melting points of A and B are 408°C and 561°C respectively. The are mutually soluble in the liquid state (completely), but partially soluble in the solid state. At 77°C a eutectic composition is formed with 28.1% A and 71.9% B. At eutectic temperature the solubility of B in A is 8.0% and that of A in B is 8.8%. Assume that at room temperature, the solubility of each is almost 0%. **(13+6+6)**

(i) Draw the A-B equilibrium phase diagram to scale on a piece of graph paper labelling all points, lines and areas.

(ii) For 60% A-40% B alloy composition, determine the compositions and relative amounts of the phases present at 1°C above the eutectic temperature.

(iii) Draw the microstructures of the 97% A-03% B alloy composition at 800°C and at room temperature.

(b) Draw TTT diagram and show cooling curves for producing (i) 100% martensite, (ii) 100% coarse pearlite, (iii) 100% fine pearlite and (iv) 50% coarse pearlite and 50% martensite. **(10)**
