CBCS SCHEME

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15MAT41

Fourth Semester B.E. Degree Examination, July/August 2022
Engineering Mathematics – IV

Time: 3 hrs. Max. Marks: 80

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use statistical table is permitted.

Module-1

1 a. Using Taylor's series method, solve $dy = (xy - 1)dx$, $y(1) = 2$ at $x = 1.02$ considering upto 3rd degree term. **(05 Marks)**

b. Using Runge – Kutta method of fourth order, solve $\frac{dy}{dx} = \frac{y-x}{y+x}$, $y(0) = 1$ at the point $x = 0.2$ by taking step length $h = 0.2$. **(05 Marks)**

c. Given that $\frac{dy}{dx} = x - y^2$, $y(0) = 0$, $y(0.2) = 0.02$, $y(0.4) = 0.0795$, $y(0.6) = 0.1762$. Compute y at $x = 0.8$ by Adams – Bashforth predictor – corrector method. **(06 Marks)**

OR

2 a. Using modified Euler's method, find an approximate value of y when $x = 0.1$ given that $\frac{dy}{dx} = x + y$ and $y = 1$ when $x = 0$. Take $h = 0.1$ and perform three iterations. **(05 Marks)**

b. Solve $\frac{dy}{dx} = 2y + 3e^x$ $y(0) = 0$ using Taylors series method an find $y(0.1)$. **(05 Marks)**

c. Apply Milne's method to compute $y(1.4)$ correct to four decimal places given $\frac{dy}{dx} = x^2 + \frac{y}{2}$ the data $y(1) = 2$, $y(1.1) = 2.2156$, $y(1.2) = 2.4649$, $y(1.3) = 2.7514$. **(06 Marks)**

Module-2

3 a. Given $\frac{d^2y}{dx^2} = x^3\left(y + \frac{dy}{dx}\right)$ $y(0) = 1$, $y'(0.1) = 0.5$, evaluate $y(0.1)$ using 4th order – Runge – Kutta method. **(05 Marks)**

b. Express $f(x) = x^3 + 2x^2 - 4x + 5$ interms of Legendre polynomials. **(05 Marks)**

c. If α and β are the roots of $J_n(x) = 0$ then prove that $\int_0^1 xJ_n(\alpha x)J_n(\beta x)dx = 0$ if $\alpha \neq \beta$. **(06 Marks)**

OR

4 a. Using the Milne's method obtain the approximate solution at the point $x = 0.4$ of the problem $\frac{d^2y}{dx^2} + 3x\frac{dy}{dx} - 6y = 0$, $y(0) = 1$, $y'(0.1) = 0.1$. Given :

$y(0.1) = 1.03995$ $y'(0.1) = 0.6955$ $y(0.2) = 1.138036$
$y'(0.2) = 1.258$ $y(0.3) = 1.29865$ $y'(0.3) = 1.873$ **(05 Marks)**

b. Prove that $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}}\sin x$. **(05 Marks)**

c. State and prove Rodrigue's formula. **(06 Marks)**

Module-3

5 a. Derive Cauchy's Riemann equations in Cartesian form. **(05 Marks)**

b. Using Cauchy's residue theorem evaluate the integral $\int_C \frac{e^{2z}}{(z+1)^4} dz$ where C is the circle $|z| = 3$. **(05 Marks)**

c. Find the bilinear transformation which maps the points Z = 0, i, ∞ onto the points W = 1, –i, –1, respectively. Find the invariant points. **(06 Marks)**

OR

6 a. State and prove Cauchy's theorem. **(05 Marks)**

b. Given $u - v = (x - y)(x^2 + 4xy + y^2)$ find the analytic function $f(z) = u + iv$. **(05 Marks)**

c. Discuss the transformation $W = e^z$. **(06 Marks)**

Module-4

7 a. Derive mean and variance of the Binomial distribution. **(05 Marks)**

b. The probability that an individual suffers a bad reaction from an injection is 0.001. Find the probability that out of 2000 individuals more than 2 will get a bad reaction. **(05 Marks)**

c. The joint probability distribution of two random variable X and Y as follows :

x \ y	–2	–1	4	6
1	0.1	0.2	0.0	0.3
2	0.2	0.1	0.1	0.0

Determine :
i) Marginal distribution of X and Y
ii) Covariance of X and Y
iii) Correlation of X and Y. **(06 Marks)**

OR

8 a. Derive mean and standard deviation of exponential distribution. **(05 Marks)**

b. The life of an electric bulb is normally distributed with average life of 2000 hours and standard deviation of 60 hours. Out of 2500 bulbs find the number of bulbs that are likely to last between 1900 and 2100 hours. Given that $P(0 < z < 1.67) = 0.4525$. **(05 Marks)**

c. The joint probability distribution of two random variable X and Y as follows :

x \ y	–4	2	7
1	1/8	1/4	1/8
5	1/4	1/8	1/8

Determine :
i) Marginal distribution of X and Y
ii) Covariance of X and Y
iii) Correlation of X and Y. **(06 Marks)**

Module-5

9 a. Explain the following terms :
i) Null hypothesis
ii) Type I and Type II error
iii) Significance level. **(05 Marks)**

b. Find he student 't' for the following variables values in a sample of eight – 4, –2, –2, 0, 2, 2, 3, 3 taking the mean of the universe to be zero. **(05 Marks)**

c. Find the fixed probability vector of the regular stochastic matrix :

$$A = \begin{bmatrix} 1/2 & 1/4 & 1/4 \\ 1/2 & 0 & 1/2 \\ 0 & 1 & 0 \end{bmatrix}.$$ **(06 Marks)**

OR

10 a. A coin is tossed 1000 times and head turns up 540 times. Decide on the hypothesis that the coin is unbiased. **(05 Marks)**

b. A set of five similar coins is tossed 320 times and the result is

Number of heads	0	1	2	3	4	5
Frequency	6	27	72	112	71	32

Test the hypothesis that the data follow a binomial distribution for v = 5 we have $\chi^2_{0.05} = 11.07$. **(05 Marks)**

c. A students study habits are as follows. If he studies one night, he is 60% sure not study the next night. On the other hand if he does not study one night, he is 80% sure not to study the next night. In the long run how often does he study? **(06 Marks)**

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15MATDIP41

Fourth Semester B.E. Degree Examination, July/August 2022
Additional Mathematics – II

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Find the rank of the matrix by elementary row transformations: $A = \begin{bmatrix} 4 & 0 & 2 & 1 \\ 2 & 1 & 3 & 4 \\ 2 & 3 & 4 & 7 \\ 2 & 3 & 1 & 4 \end{bmatrix}$. (05 Marks)

b. Solve the following system of equations by Gauss elimination method
$x + y + z = 9$
$x - 2y + 3z = 8$
$2x + y - z = 3$ (05 Marks)

c. Find all the eigen values and the corresponding eigen vectors for the matrix.
$A = \begin{bmatrix} 7 & -2 & 0 \\ -2 & 6 & -2 \\ 0 & -2 & 5 \end{bmatrix}$. (06 Marks)

OR

2 a. Reduce the matrix to echelon form and find the rank of the matrix.
$A = \begin{bmatrix} 0 & 2 & 3 & 4 \\ 2 & 3 & 5 & 4 \\ 4 & 8 & 13 & 12 \end{bmatrix}$. (05 Marks)

b. Solve the following system of equations by Gauss elimination method:
$x_1 - 2x_2 + 3x_3 = 2$
$3x_1 - x_2 + 4x_3 = 4$
$2x_1 + x_2 - 2x_3 = 5$ (05 Marks)

c. Verify Cayley-Hamilton theorem for the matrix $A = \begin{bmatrix} 1 & 2 \\ 2 & -1 \end{bmatrix}$ Find A^{-1}. (06 Marks)

Module-2

3 a. Solve $\frac{d^2y}{dx^2} - 4y = \cosh(2x-1) + 3^x$. (06 Marks)

b. Solve $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 4y = 0$ given that $y = 0$, $\frac{dy}{dx} = -1$ at $x = 1$. (05 Marks)

c. Solve by the method of undetermined coefficient $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 4e^{3x}$. (05 Marks)

OR

4 a. Solve $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 6y = e^x$. (05 Marks)

b. Solve $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 5y = 0$ subject to, $\frac{dy}{dx} = 2$, $y = 1$ at $x = 0$. (05 Marks)

c. Solve by the method of variation of parameters $y'' + a^2y = \sec ax$. (06 Marks)

Module-3

5 a. Find: $L\{t \sin at\}$ **(05 Marks)**

b. Given $f(t) = \begin{cases} E & 0 < t < a/2 \\ -E & a/2 < t < a \end{cases}$ where $f(t+a) = f(a)$. Show that $L\{f(t)\} = \frac{E}{S}\tanh\left(\frac{as}{4}\right)$. **(06 Marks)**

c. Find $L\{(3t^2 + 4t + 5)u(t-3)\}$. **(05 Marks)**

OR

6 a. Find $L\left\{\frac{1-e^{at}}{t}\right\}$. **(05 Marks)**

b. Prove that $L(\sin at) = \frac{a}{s^2 + a^2}$. **(05 Marks)**

c. Express the following function in terms of the unit step function and hence find their Laplace transform:

$$f(t) = \begin{cases} \sin t & 0 < t \le \pi/2 \\ \cos t & t > \pi/2 \end{cases}$$ **(06 Marks)**

Module-4

7 a. Find the inverse Laplace transform of $\frac{1}{(s+1)(s+2)(s+3)}$. **(05 Marks)**

b. Find $L^{-1}\left\{\log\left(1 + \frac{a^2}{s^2}\right)\right\}$. **(05 Marks)**

c. Solve the differential equation $y'' - 3y' + 2y = 0$, $y(0) = 0$, $y'(0) = 1$ by Laplace transform techniques. **(06 Marks)**

OR

8 a. Find $L^{-1}\left\{\frac{s+5}{s^2 - 6s + 13}\right\}$. **(05 Marks)**

b. Find $L^{-1}\{\cot^{-1}(s/a)\}$. **(05 Marks)**

c. Solve, $y'' + a^2y = \sin t$ with $y(0) = 0$, $y'(0) = 0$. Using Laplace transform. **(06 Marks)**

Module-5

9 a. The probability that 3 students A, B, C solve a problem are 1/2, 1/3, 1/4 respectively. If the problem is simultaneously assigned to all of them, what is the probability that the problem is solved? **(05 Marks)**

b. The probability that a team wins a match is 3/5. If this team play 3 matches in a tournament, what is the probability that the team i) win all the matches ii) loose all the matches. **(05 Marks)**

c. State and prove Baye's theorem. **(06 Marks)**

OR

10 a. Prove that

$$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(A \cap C) - P(B \cap C) + P(A \cap B \cap C).$$ **(06 Marks)**

b. A box contains 3 white, 5 black and 6 red balls. If a ball is drawn at random. What is the probability that it is entire red or white? **(05 Marks)**

c. In a bolt factory there are four machines A, B, C, D manufacturing respectively 20%, 15%, 25%, 40% of the total production. Out of these 5%, 4%, 3%, 2% are defective. If a bolt drawn random was found defective what is the probability that it was manufactured by A. **(05 Marks)**

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CBCS SCHEME

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Fourth Semester B.E. Degree Examination, July/August 2022
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use of thermodynamics data hand book allowed.

Module-1

1 a. Derive an expression for the air standard efficiency of a diesel cycle with the help of P-V and T-S diagrams. **(08 Marks)**

b. Air enters the compressor of a gas turbine plant at 20°C and compressed with pressure ratio 3.5. The isentropic efficiency of the compressor is 80%. The air is then heated in a heat exchanger having 70% effectiveness. The maximum cycle temperature is 650°C. The isentropic efficiency of the turbine is 75%. Neglecting the losses find thermal efficiency of the cycle. Take R = 287J/kgK and $\gamma = 1.4$. **(08 Marks)**

OR

2 a. Derive an expression for optimum pressure ratio for maximum specific power output in terms of maximum and minimum temperatures of the brayton cycle. **(08 Marks)**

b. An engine working on ideal otto cycle has a swept volume of $0.12m^3$ and clearance volume of $0.03m^3$. The pressure and temperature at the beginning of compression are 1 bar and 100°C. If the pressure at the end of constant volume heat addition is 25 bar, calculate : i) air standard efficiency ii) temperature and pressure at all salient points. **(08 Marks)**

Module-2

3 a. What are the drawbacks of Carnot cycle as a reference cycle? **(02 Marks)**

b. Explain with T – S diagrams the effect of pressure and temperature on the Rankine cycle. **(06 Marks)**

c. A Rankine cycle using water as the working fluid operates between the pressure limits of 10KPa and 15000KPa. The maximum temperature of the cycle is 600°C. Determine the cycle efficiency and the steam flow rate. **(08 Marks)**

OR

4 a. With neat sketch and T–S diagram, derive an expression for the thermal efficiency of a Rankine cycle with Reheat. **(08 Marks)**

b. Steam from a boiler enters a turbine at 25 bar and expands to condenser pressure of 0.2 bar. Determine the Rankine cycle efficiency neglecting pump work when, i) steam is 80% dry at turbine inlet ii) steam is saturated at turbine inlet. Inlet by 76.1°C. Take : T_S at 25 bar = 223.9°C, h_{sup} at 25 bar, 300°C = 3008.8 kJ/kg ; s_{sup} = 6.644kJ/kgK. **(08 Marks)**

Module-3

5 a. Define the terms : i) Stoichiometric air ii) Enthalpy of formation iii) Combustion efficiency. **(06 Marks)**

b. During a test on single – cylinder, four stroke oil engine, the following results were obtained.
Cylinder bars = 20cm, Stroke = 40cm, mean effective pressure = 6bar, Torque = 407 Nm, Speed = 250rpm, fuel consumption = 4 kg/h, C.V. of fuel = 43MJ/kg, Cooling water flow rate = 4.5 kg/min, air used = 30 kg/kg of fuel, Rise in temperature of cooling water = 45°C. Temperature of exhaust gases = 420°C, Room temperature = 20°C CP of exhaust gases = 1 kJ/kgK, CP of water = 4.18 kJ/kgK. Find IP, BP and draw heat balance sheet on hour basis. **(10 Marks)**

OR

6 a. Explain the factors affecting detonation. **(06 Marks)**

b. Methane is burned with atmospheric air. The analysis of the products of combustion on a dry basis is as follows :
CO_2 = 10%, O_2 = 2.37%, CO = 0.53% and N_2 = 87.1%. Calculate the air fuel ratio and the percent theoretical air and determine the combustion equation. **(10 Marks)**

Module-4

7 a. Determine the terms :
i) C.O.P ii) T.O.R iii) Dew point temperature iv) Relative humidity. **(04 Marks)**

b. With a neat sketch explain vapour absorption refrigeration system. **(06 Marks)**

c. A vapor compression refrigerator of 10 tonnes capacity using Freon – 12 as the refrigerant has an evaporator temperature of 10°C and a condenser temperature of 30°C. Assuming simple saturation cycle, determine : i) mass flow rate of refrigerant ii) C.O.P. Take CPV = 0.72 kJ/kgK. **(06 Marks)**

OR

8 a. Mention any 4 properties of a good refrigerant. **(04 Marks)**

b. With the help of psychrometric chart explain i) Sensible heating ii) cooling and dehumidifying. **(04 Marks)**

c. Atmospheric air at 101.325 KPa has 30°C DBT and 15°C DPT. Without using psychrometric chart, using the property values from the tables, calculate :
i) Partial pressures of air and water vapour ii) Specific humidity iii) Relative humidity iv) Vapour density iv) Enthalpy of moist air. **(08 Marks)**

Module-5

9 a. What are the advantages of multi-stage compression? **(04 Marks)**

b. Derive an expression for the optimum pressure ratio to get minimum work in case of a 2 stage reciprocating air compressor. **(06 Marks)**

c. A single –stage double – acting air compressor is required to deliver $14m^3$ of air per minute measured at 1.013 bar and 15°C. The delivery pressure is 7 bars. Take clearance volume as 5% of the swept volume and index of compression and expansion as n = 1.3. Calculate :
i) Volumetric efficiency ii) Delivery temperature iii) Indicated power. **(06 Marks)**

OR

10 a. What are steam nozzles? How they are classified? **(04 Marks)**

b. What are the effects of super saturation in a nozzle? **(04 Marks)**

c. A single cylinder, double acting air compressor is required to deliver $100m^3$/min of air at a mean piston speed of 500m/min measured at 1 bar and 15°C. The air is delivered at 7 bar. Assume a clearance volume of $1/15$th of swept volume per stroke. Find volumetric efficiency, speed, bore, stroke for the following two cases.
i) If ambient and suction conditions are same.
ii) If ambient and suction conditions are different.
Take : Ambient pressure = 1 bar
Ambient temp = 15°C
Suction pr = 0.98 bar
Suction temp = 30°C
L/D = 1.25. **(08 Marks)**

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CBCS SCHEME

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Fourth Semester B.E. Degree Examination, July/August 2022
Fluid Mechanics

Time: 3 hrs. Max. Marks: 80

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Define following and mention their units :
- i) Mass density
- ii) Dynamic viscosity
- iii) Surface tension
- iv) Bulk modulus. **(08 Marks)**

b. A U – tube manometer is used to measure the pressure of oil of specific gravity 0.85 flowing in a pipe line. Its left end is connected to the pipe and the right limb is open to the atmosphere. The centre of the pipe is 100mm below the level of mercury (specific gravity = 13.6) in the right limb of the difference of mercury level in the two limbs is 160mm, Determine the absolute pressure of the oil in the pipe. **(08 Marks)**

OR

2 a. Define the following terms :
- i) Buoyancy
- ii) Centre of Buoyancy
- iii) Meta centre
- iv) Meta centric height. **(06 Marks)**

b. A circular plate 1.5m diameter is submerged in water, with its greatest and least depths below the surface being 2m and 0.75m respectively.
Determine :
- i) The total pressure on one face of the plate
- ii) The position of the centre of pressure. **(10 Marks)**

Module-2

3 a. Derive the continuity equation for 3 dimensions in Cartesian co-ordinates. **(10 Marks)**

b. What is the irrotational velocity field associate with the potential
$\phi = 3x^2 - 3x + 3y^2 + 16t^2 + 12zt$.
Does the flow field satisfy the incompressible continuity equation? **(06 Marks)**

OR

4 a. Derive Euler's equation of motion and obtain an expression for Bernoulli's equation from Euler's equation of motion and also mention the assumptions made. **(10 Marks)**

b. A jet of water of 60mm diameter strikes a curved vane at its centre with a velocity of 18m/s. The curved vane is moving with a velocity of 6m/s in the direction of the jet. The jet is deflected through an angle of 165°. Assuming the plate to be smooth find :
- i) Thrust on the plate in the direction of jet
- ii) Power of the jet
- iii) Efficiency of the jet. **(06 Marks)**

Module-3

5 a. Derive Hagen-Poisoulle's equation for viscous flow through a circular pipe. **(10 Marks)**

b. Oil of specific gravity 0.82 is pumped through a horizontal pipeline 150mm in diameter and 3km long at the rate of $0.015 m^3/s$. The pump has an efficiency of 68% and required 7.5KW to pump the oil.
   i) What is the dynamic viscosity of the oil
   ii) Is the flow Laminar? **(06 Marks)**

OR

6 a. Derive Darcy's equation for head losses due to friction in a circular pipe. **(08 Marks)**

b. Three pipes of diameters 300mm, 200mm and 400mm and length 450mm, 255m and 315m respectively are connected in series. The difference in water surface levels in two tanks is 18m. Determine the rate of flow of water if co-efficient of friction are 0.0075, 0.0078 and 0.0072 respectively considering : i) Minor losses ii) Neglecting minor losses. **(08 Marks)**

Module-4

7 a. Explain the terms :
   i) Boundary layer thickness
   ii) Displacement thickness
   iii) Momentum thickness
   iv) Energy thickness. **(06 Marks)**

b. The velocity distribution in the boundary layer is given by $\frac{u}{U} = \frac{Y}{\delta}$, where u is the velocity at a distance y form the plate and u = U at y = δ, δ being the boundary layer thickness. Find :
   i) The displacement thickness
   ii) The momentum thickness
   iii) The energy thickness
   iv) The value of δ^*/θ. **(10 Marks)**

OR

8 a. Explain the terms lift and drag on airfoil. **(04 Marks)**

b. Using Buckingham's theorem, show that the velocity through a circular orifice is given by

$$V = \sqrt{2gH} \quad \phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$$

where H = head causing flow, D = Diameter of the orifice, μ = co-efficient of viscosity, ρ = Mass density and g = Acceleration due to gravity. **(12 Marks)**

Module-5

9 Write short notes on :
   a. Internal energy and enthalpy
   b. Speed of sound
   c. Stagnation and sonic properties
   d. Normal and oblique shocks. **(16 Marks)**

OR

10 Write short notes on :
   a. Necessity of CFD
   b. Limitations of CFD
   c. Philosophy behind CFD
   d. Applications of CFD. **(16 Marks)**

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