## SWE111: ENGINEERING MATHEMATICS I 08/02/20 FIRST SEMESTER

## STUDY QUESTIONS

## **A-SEVERAL REAL VARIABLE FUNCTIONS**

1. Let $f(x, y) = ln(x + y - y)$	- 1`	ν <b>–</b>	$+\nu$	$\dot{x}$	ln(	) =	$\nu$	(x.	f	Let	1.
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- i. Evaluate (a) f(1,1) (b)  $f(e^3,1)$  2mks
- ii. Find and sketch the domain of f.iii. Find the range of f1mk
- iii. Find the range of f2. Given the function:  $h(x, y) = \sqrt{16 - x^2 - y^2}$ 
  - a) Evaluate the value of h at the point  $(\sqrt{3}, 2)$  1mk
  - b) Find and sketch the domain. 2mks
  - c) Find the range 1mk
- 3. Compute the given limits.
  - a)  $\lim_{(x,y)\to(0,4)} \frac{\cosh(xy)}{x^2+y-1}$  b)  $\lim_{(x,y,z)\to(1,1,2)} \frac{e^{x+y-z}}{x-z}$  2mks
- 4. Find all the second partial derivatives of  $f(x,y) = x^3y^5 + 2x^4y$  6mks Hence, verify that the conclusion of Schwarz theorem holds, that is  $f_{xy} = f_{yx}$ . 1mk
- 5. Use implicit differentiation to show that if

$$x^{2} + y^{2} + z^{2} = 3xyz \text{ then } \frac{\partial z}{\partial x} = \frac{2x - 3yz}{3xy - 2z}$$
 2mks

- 6. Determine whether  $u = e^{-x} cos y e^{-y} cos x$  is a solution of Laplace's equation  $u_{xx} + u_{yy} = 0$  2mks
- 7. Find the equation of the tangent plane to the surface

$$z = x^2 + xy + 3y^2$$
 at the point (1,1,5)

- 8. Find the linear approximation of the function  $f(x, y) = \ln(x 3y)$  at (7,2) and use it to approximate f(6.9, 2.06) 3mks
- 9. If  $z = 5x^2 + y^2$  and (x, y) changes from (1, 2) to (1.05, 2.1), compare the values of  $\Delta z$  and dz.
- 10. Use differentials to estimate the amount of metal in a closed cylindrical can that is 10cm high and 4cm in diameter if the metal in the top and bottom is 0.1cm thick and the metal in the sides is 0.05cm thick.
- 11. Given the function  $f(x, y) = x^2y^3 y^4$ , the point P(2,1) and the vector

$$v = i + j$$

- a) Find the gradient of f. 2mks
- b) Evaluate the gradient of f at P. 1mk
- c) Find the directional derivative of f at or the rate of change of f at P in the direction of v 2mks
- 12. Find and classify the critical points of  $f(x, y) = x^3 12xy + 8y^3$  7mks

## **B-NUMERICAL FUNCTIONS OF A REAL VARIABLE**

13. Find, without using a calculator, the exact value of:

(a) 
$$Log_26 - Log_215 + Log_220$$
 (b)  $e^{-2ln5}$  (c)  $\frac{Log_5125}{Log_9234}$  2mks, 1mk, 2mks

14. Solve each of the following in  $\mathbb{R}$  for x

(a) 
$$e^x = 5$$
 (b)  $\ln x = 2$  (c)  $\ln x + \ln(x - 3) = \ln(6x) - \ln(x - 2)$  1mk,1mk, 2mks

- 15. Sketch the curve y = lnx. Hence, or otherwise solve 2 < lnx < 9.
- 16. i. Sketch the curve  $y = e^{2x}$ .
  - ii. Hence, or otherwise find the domain of the function  $f(x) = \sqrt{3 e^{2x}}$ . 1mk
- 17. i. Solve in  $\mathbb{R}$  the equation  $x^2 5x + 6 = 0$ 
  - ii. Hence, or otherwise solve each of the following in  $\mathbb{R}$ :

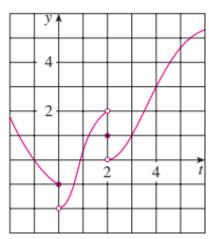
$$ln2 x - 5lnx + 6 = 0 
ex + 6e-x - 5 = 0 
1mk$$

$$3^{2x+2} - 5(3^{x+1}) + 6 = 0$$
 1mk

19. (i) if $Acoshx - Bsinhx \equiv 4e^x - 3e^{-x}$ , find the exact values of $A$ and $B$ . 2mks (ii) Prove that $2 \cosh^2 x - 1 = \cosh(2x)$ 2mks (iii) Show that $a$ ) $coshx + sinhx = e^x$ ( $b$ ) $(coshx + sinhx)^n = \cosh(nx) + \sinh(nx)$ 6mks ( $c$ ) $\frac{1+tanhx}{1-tanhx} = \frac{e^{2x}}{e^x}$ ( $d$ ) $tanh(lnx) = \frac{x^2-1}{x^2+1}$ 1mk (iv) Evaluate $\lim_{x\to\infty} \frac{sinhx}{e^x}$ 1mk (iv) Evaluate $\lim_{x\to\infty} \frac{sinhx}{e^x}$ 1mk 20. If $coshx = \frac{4}{3}$ and $x > 0$ find the exact values of (a) $sinhx$ (b) $tanhx$ 3mks 21. Sketch $y = tanhx$ and $y = cothx$ on separate diagrams. Hence, deduce the range of $f(x) = cothx$ 3mks 22. a) Find the derivative of $y = sinh^{-1}(\frac{x}{a})$ 2mks b) Hence, show that $\int \frac{1}{\sqrt{x^2+a^2}} dx = \ln(x + \sqrt{x^2+a^2}) + K$ 1mk 23. Express $sech^{-1}x$ in $\log arithmic form. 2mks ii. Find all values of x such that sin(2x) = sinx and 0 \le x \le 2\pi 3mks iii. If tanA = \frac{1}{3} and tanB = \frac{1}{7}, show that 2A + B = \frac{\pi}{4} 2mks 25. i. Prove the identities: (a) tan\thetasin\theta + cos\theta = sec\theta (b) \frac{ztan\theta}{1+tan^2\theta} = sin2\theta 3mks ii. If sinx = \frac{1}{3} and secy = \frac{5}{4}, where x and y lie between 0 and \frac{\pi}{2}, evaluate sin(x + y) 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y - 2z = -2} 2mks e^x = \frac{2x - y + z = 3}{x - y -$	19. (i) if $Acoshx' = Bsinhx \equiv 4e^x - 3e^{-x}$ , find the exact values of $A$ and $B$ . 2mks (ii) Prove that $2 \cosh^2 x - 1 = \cosh(2x)$ 2mks (iii) Show that $a$ ) $coshx + sinhx = e^x$ (b) $(coshx + sinhx)^n = \cosh(nx) + \sinh(nx)$ 6mks (c) $\frac{1+teanhx}{1-tanhx} = \frac{e^{2x}}{e^x}$ (d) $tanh(lnx) = \frac{x^2-1}{x^2+1}$ 1mk 20. If $coshx = \frac{5}{3}$ $and x > 0$ find the exact values of (a) $sinhx$ (b) $tanhx$ 3mks 21. Sketch $y = tanhx$ $and y = cothx$ on separate diagrams. Hence, deduce the range of $f(x) = cothx$ 3mks 22. a) Find the derivative of $y = sinh^{-1} \left(\frac{x}{a}\right)$ 2mks 23. Express $sech^{-1}x$ in logarithmic form. 2mks 24. i. Solve the equation $sec^2\theta + 5tan\theta = 7$ in $0 < \theta < 360^{\circ}$ 3mks iii. If $tanA = \frac{1}{3}$ and $tanB = \frac{1}{7}$ , show that $2A + B = \frac{\pi}{4}$ 2mks 25. i. Prove the identities: (a) $tan\thetasin\theta + cos\theta = sec\theta$ (b) $\frac{2tan\theta}{1+tan^2\theta} = sin2\theta$ 3mks ii. If $sinx = \frac{1}{3}$ and $secy = \frac{5}{4}$ , where $x$ and $y$ lie between $0$ and $\frac{\pi}{2}$ , evaluate $sin(x + y)$ 2mks $e^x = coshy + lnz = 3$ 2mks $e^x = coshy$	18.	Find, without using a calculator the exact value of: (a) $sec^{-1}(2)$ (b) $cosh(ln3)$ (c) $sinh^{-1}(3)$	1mk 1	mk, 1mk
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(c) $\frac{1+\tanh x}{1+\tanh x} = e^{2x}$ (d) $\tanh(\ln x) = \frac{x^2-1}{x^2+1}$ [lmk]  (iv) Evaluate $\lim_{x\to a} \frac{\sinh x}{e^x}$ lmk  20. If $\cosh x = \frac{5}{3}$ and $x > 0$ find the exact values of $\frac{1}{(a)\sinh x}$ (b) $\tanh x$ 3mks  21. Sketch $y = \tanh x$ and $y = \coth x$ on separate diagrams.  Hence, deduce the range of $f(x) = \coth x$ 3mks  22. a) Find the derivative of $y = \sinh^{-1}\left(\frac{x}{d}\right)$ 2mks  b) Hence, show that $\int \frac{1}{\sqrt{x^2+a^2}} dx = \ln(x + \sqrt{x^2+a^2}) + K$ 1mk  23. Express $\sinh^{-1}\left(\frac{x}{d}\right)$ 2mks  ii. Find all values of $x$ such that $\sin(2x) = \sin x$ and $0 \le x \le 2\pi$ 3mks  iii. If $\tan A = \frac{1}{3}$ and $\tan B = \frac{1}{7}$ , show that $2A + B = \frac{\pi}{4}$ 2mks  25. i. Prove the identities:  (a) $\tan \theta \sin \theta + \cos \theta = \sec \theta$ (b) $\frac{2\tan \theta}{1+\tan^2 \theta} = \sin 2\theta$ b) $\frac{\sin^2 x}{1+\cos(2x)} = \frac{1}{2}\tan^2 x$ 3mks  ii. If $\sin x = \frac{1}{3}$ and $\sec y = \frac{5}{4}$ , where $x$ and $y$ lie between $0$ and $\frac{\pi}{2}$ , evaluate $\sin(x+y)$ 2mks  26. i. Solve in $\mathbb{R}^3$ the system $\begin{cases} 2x - y + z = 7 \\ 2e^x - \cosh y + \ln z = 3 \\ e^x - \cosh y - 2\ln z = 2 \end{cases}$ 2mks  Determine the domain of $f$ and the limits at its boundaries. 2mks  Deduce the vertical asymptote of $f(x)$ . 1mk  Given that $f(x)$ is represented by the curve $f(x)$ 2mks  Given that $f(x)$ is represented by the curve $f(x)$ 1mk  Given that $f(x)$ is represented by the curve $f(x)$ 1mk  Given that $f(x)$ is represented by the curve $f(x)$ 2mks  1. If $\sin x = \frac{1}{3}$ and $\cos y = \frac{5}{4}$ , where $x$ and $y$ lie between 0 and $\frac{\pi}{2}$ , 2mks  27. Given that $f(x)$ is the curve of the function $f(x) = \frac{\ln x}{x}$ 2mks  Determine the domain of $f$ and the limits at its boundaries. 2mks  Deduce the vertical asymptote of $f(x)$ . 1mk  Find the derivative, $f'(x)$ and the stationary points of $f(x)$ 2mks  Construct the variation table of $f(x)$ . 1mk  Given that $f(x) = \frac{1}{1+x}$ , deduce the curve $f(x)$ of $f(x)$ sketch it on a separate diagram. 1mk  1mk  1i. Investigate the variation of $f(x)$ 2mks  Given that $f(x) = \frac{1}{1+x}$ , deduce the curve $f(x)$ of $f(x)$ 3 sketch it on a separate diagram. 1mk  1ii. Deduce the intervals where $f(x)$ 3 increa	(c) $\frac{1+tanhx}{1-tanhx} = e^{2x}$ (d) $tanh(lnx) = \frac{x^2-1}{x^2+1}$ [mk]  (iv) Evaluate $\lim_{x\to\infty} \frac{\sinh x}{e^x}$ Imk  20. If $coshx = \frac{5}{3}$ and $x > 0$ find the exact values of $\frac{1}{4a} \sinh x$ (b) $tanhx$ 3mks  21. Sketch $y = tanhx$ and $y = cothx$ on separate diagrams.  Hence, deduce the range of $f(x) = cothx$ 3mks  22. a) Find the derivative of $y = \sinh^{-1}\left(\frac{x}{a}\right)$ 2mks  b) Hence, show that $\int \frac{1}{\sqrt{x^2+a^2}} dx = \ln(x + \sqrt{x^2+a^2}) + K$ 1mk  23. Express sech <sup>-1</sup> $x$ in logarithmic form. 2mks  24. i. Solve the equation $\sec^2\theta + 5\tan\theta = 7$ in $0 < \theta < 360^{\circ}$ 3mks  ii. Find all values of $x$ such that $\sin(2x) = \sin x$ and $0 \le x \le 2\pi$ 3mks  iii. If $tanA = \frac{1}{3}$ and $tanB = \frac{1}{7}$ , show that $2A + B = \frac{\pi}{4}$ 2mks  25. i. Prove the identities:  (a) $tan\thetasin\theta + cos\theta = sec\theta$ (b) $\frac{2tan\theta}{1+tan^2\theta} = sin2\theta$ b) $\frac{\sin^2 x}{1+\cos(2x)} = \frac{1}{2}tan^2x$ 3mks  ii. If $sinx = \frac{1}{3}$ and $secy = \frac{5}{4}$ , where $x$ and $y$ lie between $0$ and $\frac{\pi}{2}$ , evaluate $\sin(x + y)$ 2mks  26. i. Solve in $\mathbb{R}^3$ the system $\begin{cases} 2x - y + z = 7 \\ x - 2y + z = 3 \\ x - y - 2z = -2 \end{cases}$ 2mks  27. Given that $C_f$ is the curve of the function $f(x) = \frac{\sin x}{x}$ 2mks  Determine the domain of $f$ and the limits at its boundaries. 2mks  Determine the domain of $f$ and the limits at its boundaries. 2mks  Determine the domain of $f$ and the limits at its boundaries. 2mks  Determine the domain of $f$ and the limits at its boundaries. 2mks  Construct the variation table of $f(x)$ . 1mk  Setch $C_f$ showing clearing the extrema if any and the intercept. 2mks  Given that $h(x) = \frac{1}{f(x)}$ , deduce the curve $C_h$ of $h(x)$ sketch it on a separate diagram. 1mk  1mk  1mk  1mk  1mk  1mk  1mk  1mk				
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b) $13e^{2x-1} = 7e^x$	b) $13e^{2x-1} = 7e^x$	30.			
a) $\ln(u+1)^2 = \ln(u+1) + \ln(u+2) + 2$	(1) (2) (2) (2) (2) (2) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3			Carel	
c) $ln(x+1)^2 = ln(x+1) - ln(x+2) + 2$ 6mks	C) $m(x + 1)^2 = m(x + 1) - m(x + 2) + 2$ Office of the following functions with respect to x	21		OINKS	

1mks

32.



For the function g whose graph is given,

- i. state the value of each quantity, if it exists. If it does not exist, explain why.
- (a)  $\lim_{t\to 0^{-}} g(t)$  (b)  $\lim_{t\to 0^{+}} g(t)$  (g) g(2) (h)  $\lim_{t\to 4} g(t)$ (b)  $\lim_{t\to 0^+} g(t)$  (c)  $\lim_{t\to 0} g(t)$  (d)  $\lim_{t\to 2^-} g(t)$  (e)  $\lim_{t\to 2^+} g(t)$  (f)  $\lim_{t\to 2} g(t)$ 8mks
- ii. Identify the discontinuities of g
- 33. The electric scalar potential in a region of space is given by  $\phi = x^2 + xy^2 + z^2$ . Determine, at the point (-1, 2, -1)
  - a) grad  $\phi$ 2mks
  - b) the directional derivative of  $\phi$  in the direction of the vector  $\mathbf{a} = 2\mathbf{i} + 2\mathbf{j} \mathbf{k}$ 2mks