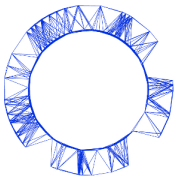


IPhO 2018
Lisbon, Portugal

A1-1

English (Official)

Write down the numbers 0 to 9 in the following table:

0	1	2	3	4	5	6	7	8	9

Part A: Circuit Dimensioning (2.5 points)

A.1 (0.2 pt)

$V_{\text{out}} =$

A.2 (0.5 pt)

#	R_{T1}	R_{T2}	R_{T3}
$\overline{R}$			
σ_R			

A.3 (0.3 pt)
Demonstration:

A.4 (0.4 pt)

$R_\square =$ $\pm$

$\rho_{\text{Carbon film}} =$ $\pm$

A.5 (0.5 pt)
Demonstration:

Measured values:

$R_1 =$
$R_2 =$
$\kappa =$

A.6 (0.3 pt)

R_1 Points	R_x	R_y	R_2 Points	R_x	R_y
Z			Z		
A			H		
B			I		
C			J		
D			K		
E			L		
F			M		
G			N		
V			W		

A.7 (0.3 pt)

Points	V_{out}	Points	V_{out}
A		H	
B		I	
C		J	
D		K	
E		L	
F		M	
G		N	
V		W	

Part B: Characteristic Curves of the JFET transistor (4.5 points)

B.1 (0.2 pt)
$I_{DS} =$

B.2 (0.8 pt)
I_{DS} current values:

Gate/Drain	Z	H	I	J	K	L	M	N	W
Z									
A									
B									
C									
D									
E									
F									
G									
V									

B.3 (0.2 pt)

$f =$

B.4 $(1.2\ \mathrm{pt})$
Use the empty columns to enter corrections factors you deem necessary.
Gate A: $V_{GS} =$ $R_{DS} =$

Drain point	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

Gate B: $V_{GS} =$ $R_{DS} =$

Drain point	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

B.4 (cont.)

Gate C: $V_{GS} =$ $R_{DS} =$

Drain point	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

Gate D: $V_{GS} =$ $R_{DS} =$

Drain point	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

B.4 (cont.)

Gate E: $V_{GS} =$ $R_{DS} =$

Drain point	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

Gate F: $V_{GS} =$ $R_{DS} =$

Drain points	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

B.4 (cont.)

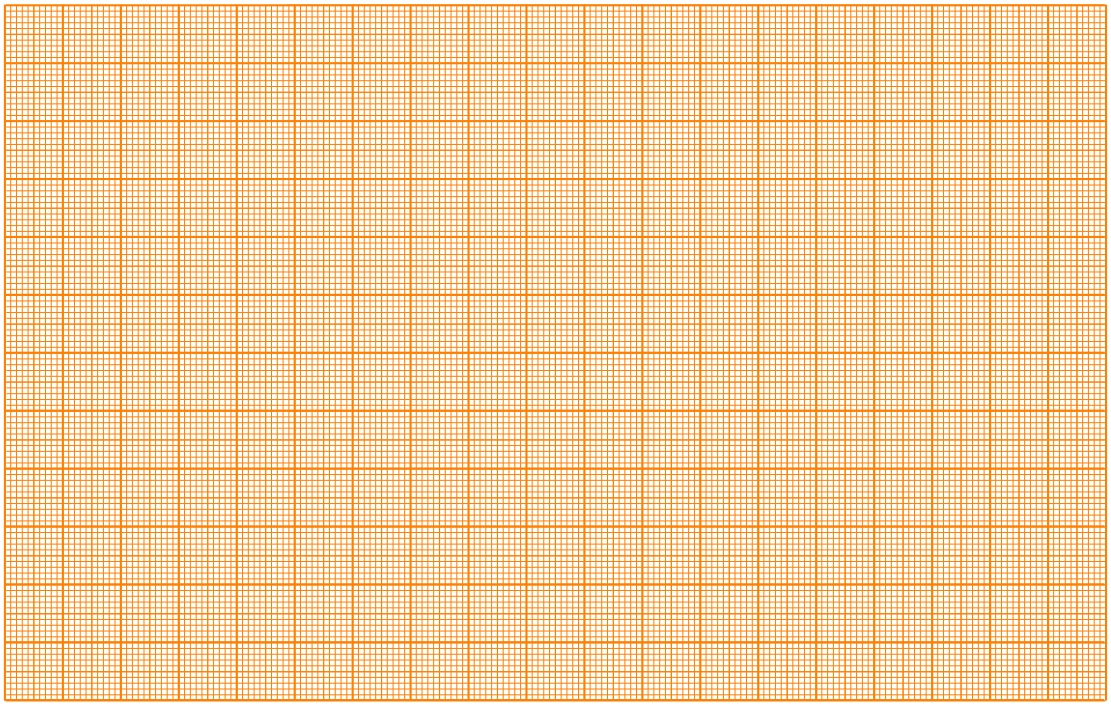
Gate G: $V_{GS} =$ $R_{DS} =$

Drain points	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

Gate V: $V_{GS} =$ $R_{DS} =$

Drain points	V_{out}	V_{out}^{L}	$\boldsymbol{V_{DS}}$	I_{DS}		

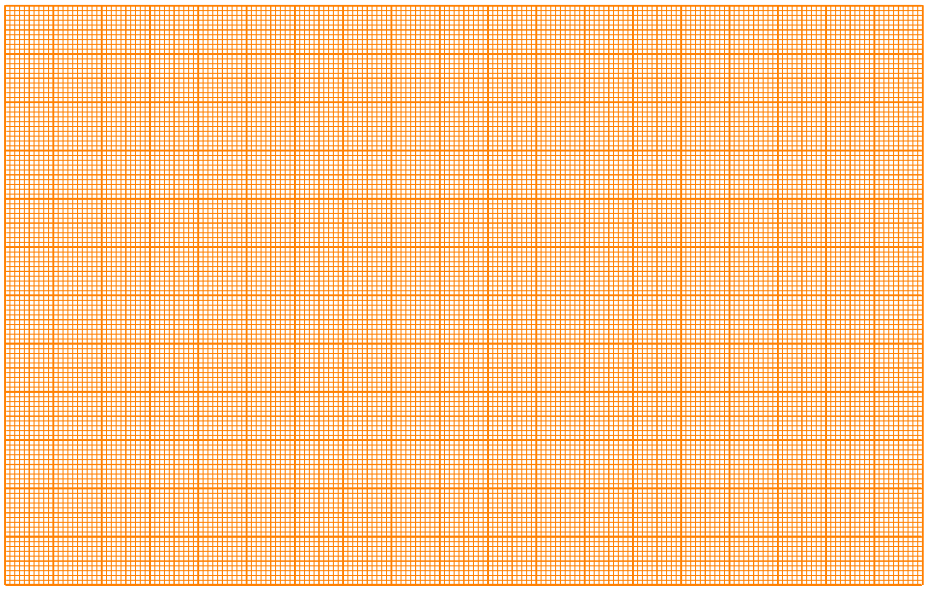
B.5 (0.5 pt)
Output curves:



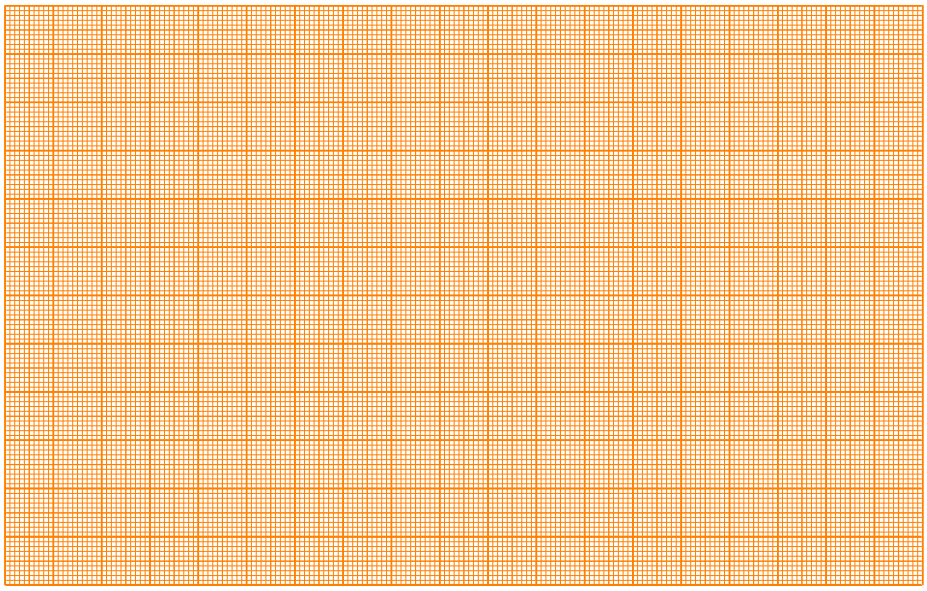
B.6 (0.5 pt)

V_{GS}	R_{DS}

Graph: $R_{DS}(V_{GS})$



B.7 (0.3 pt)
Transfer curve:



B.8 (0.4 pt)

$I_{DSS} =$

$V_P =$

B.9 (0.4 pt)

Measured transconductance: $g =$

Calculated transconductance from JFET model: $g =$

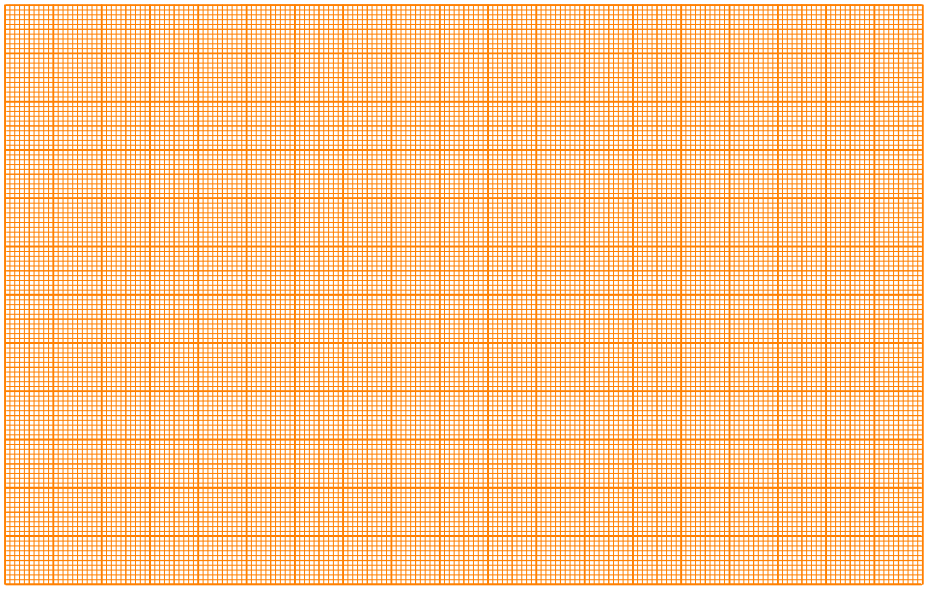
Part C: The Paper Thin Film Transistor (2.0 points)

C.1 (0.8 pt)

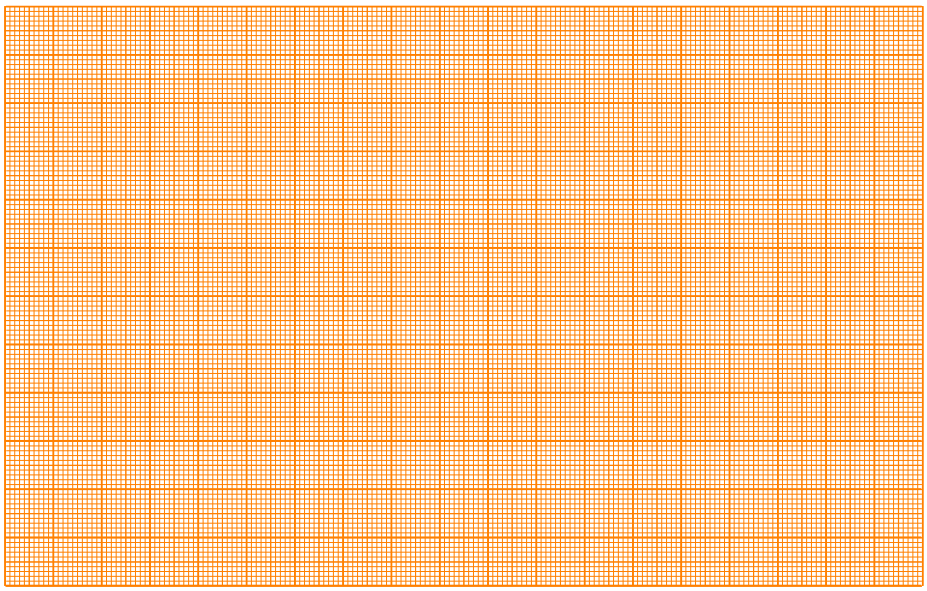
$I_{\text{closed}} =$

t	I	t	I

C.2 $(1.2\ \mathrm{pt})$
Graph: $I_{\mathrm{DS}}(t)$



Auxiliary graph to determine τ_1:



$\tau_1 =$

Part D: Inverter circuit (1.0 points)

D.1 (0.5 pt)

$R_L =$

t	V_{in}	V_{out}

D.2 (0.5 pt)
Graph: $V_{\text{out}}(V_{\text{in}})$