1. (a) Consider the following code segments. Write down equivalent **MIPS code** for the following program. Clearly explain all the lines in comment   [4]

```
int gcd(int a, int b)
{
    if(a == b) return b ;
    else if (a>b) return (a-b, b);
    else return (a, b-a);
}
```

   (b) Write down the content of the register `$v0, $sp, $ra` after the MIPS code of **Q1(a)** is executed. Show the detailed table of values for the registers. Initial values of the register are as following -   [3]

$pc	$a0	$a1	$v0	$ra	$sp
100	35	14	0	1032	2000

Table 1: Initial Register Content

   (c) Translate the last line of the MIPS code of **Q1(a)** to hexadecimal expression of machine language. Use the following tables for reference -   [3]

2. (a) Explain the reason why we can not consider **I/O Time** or **OS Overhead Time** while calculating the performance of a processor.   [2]

   (b) Shroud is one of the top Player Unknowns' Battle Ground (PUBG) gamer. He has recently won a $699 USD championship in the GameCON 2018. He has just enough budget to buy either the new Samsung 850 EVO 2TB SSD or the NVIDIA GTX 1180 GPU.   [4]

   The new memory module executes the memory instructions 1.8 times faster than the current one and the new GPU would only improve the arithmetic operations by 1.6 times. Which one should Shroud buy for better performance? Show the detailed calculation.

   (c) Calculate the execution time for the PUBG game instructions if clock rate is given at 3.6Ghz   [2]

   (d) How much overall improvement will be possible for the newly added component?   [1]

   (e) Explain effect of Amdahl's law to support the statement that- "we can not improve the overall execution time by 1.8 or 1.6 times just by changing the memory module or the GPU"   [1]

Reg Number	0	1	2-3	4-7	8-15	16-23	24-25	26-27	28	29	30	31
Reg Name	0	at	v0-v1	a0-a3	t0-t8	s0-s8	t8- t9	k0-k1	gp	fp	sp	ra

Table 2: Register Name and Number

Instruction	jr $register
Machine Code	000 00rr rrr0 0000 0000 0000 0000 1000

Table 3: Instruction to Machine Code

	Add	**Mult**	**LW**	**SW**
IC	1000	1200	400	650
CPI	4	8	12	10

Table 4: PUBG Game instructions

3. (a) Determine whether **overflow** occurs in the following **signed** operations in a 5-bit Computer Architecture with detailed calculations.   [2]
   (i) 16 - (-4)   (ii) 15 - 9   (iii) -15 + (-1)   (iv) -7 + 4

   (b) Show the detailed step of simulations for the **Optimized Multiplication Algorithm** for the following multiplication: 101000×110111 [3]

   (c) Mention two advantages of Optimized Multiplication algorithm over Normal Multiplication algorithm   [2]

   (d) You have to divide 01101101 by 0101. Find out the content of Remainder Register if the division algorithm that uses the following block diagram at Figure 1. Show all necessary calculations.   [3]
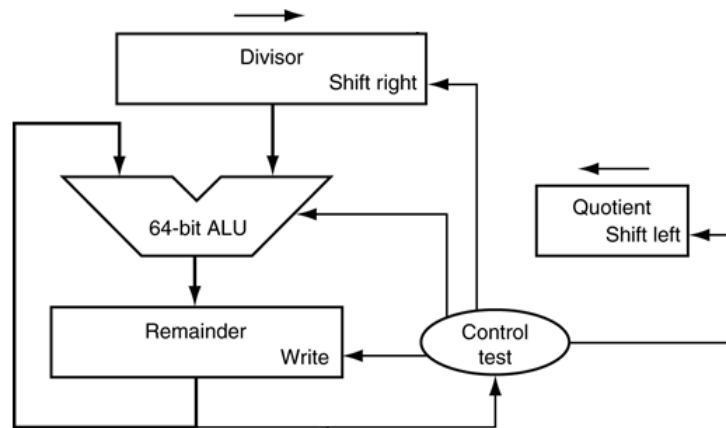

Figure 1: Division Algorithm Block Diagram