INTERGRATED CIRCUIT DESIGN

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Assignment - 1

Ques 1. Explain the application of IC.

Ans. Integrated Circuits (ICs) find widespread applications across various fields due to their compact size, efficiency, and versatility. Here are some key applications of ICs:

The development of integrated circuits led to the development of numerous household products, CD players, computers, and televisions. Additionally, the proliferation of chips contributed to the globalization of cutting-edge electronic equipment.

The IC is easily breakable, so to be attached to a circuit board, it is often housed in a plastic package with metal pins. Integrated circuits can function as an oscillator, amplifiers, microprocessors or even as computer memory.

Computing and Microprocessors: Microprocessors and microcontrollers are critical components in computers and embedded systems.

Memory Devices: ICs are used to create memory devices such as RAM (Random Access Memory) and ROM (Read-Only Memory).

Digital Signal Processing (DSP): ICs designed for DSP are used in applications like audio and video processing, telecommunications, and speech recognition.

Communication Systems: ICs play a vital role in communication systems, including transceivers, amplifiers, modulators, and demodulators. They are essential in devices like mobile phones, radios, and networking equipment.

Analog Electronics: Analog ICs, such as operational amplifiers(op-amps) and analog-to-digital converters (ADCs), are used in analog signal processing, amplification, and conversion.

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Power Management: ICs designed for power management regulate and control the supply of power in electronic devices.

Sensor Interface: ICs are used to interface with various sensors, converting analog signals from sensors (e.g., temperature sensors, pressure sensors) into digital signals that can be processed by microcontrollers.

Automotive Electronics: ICs are extensively used in automotive applications for engine control units, safety systems, infotainment, and various sensors throughout thevehicle.

Consumer Electronics: ICs are integral to numerous consumer electronics, including TVs, audio systems, cameras, and smartdevice
Medical Electronics: In medical applications, ICs are used in devices such as heart rate monitors, imaging equipment, anddiagnostic tools.

Industrial Control Systems: ICs are employed in industrial automation and control systems, where they facilitate the monitoring and control of manufacturing processes, machinery, and other industrial operations.

RFID (Radio-Frequency Identification): RFID ICs are used inidentification and tracking systems, allowing for the wireless transfer of data between tags and readers.

Space Exploration: ICs are used in spacecraft and satellite systems for communication, navigation, and data processing.

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Ques 2. Describe the types of IC.

Ans. There are several types of ICs based on their functionality:

Analog ICs: These ICs process continuous signals, such as those in audio and radio frequency applications. IC chip is created by using the analogue design process when ICs are utilized as regulators, filters and oscillators and Optimal power dissipation, gain and resistance are required.

Digital ICs: The digital design approach is used to create integrated circuits (ICs), which are utilized as computer memories (such as RAM and ROM) and microprocessors. With this approach to design, the circuit density and overall efficiency are both maximized. The ICs created with this technique operate with binary input data like 0 and 1. The process for designing digital integrated circuits is depicted in the diagram below.

Mixed-Signal ICs: These ICs combine both analog and digital circuitry on the same chip, bridging the gap between the two types. The analog and digital design ideas are used in mixed designs. The mixed ICs perform either Analog to Digital or Digital to Analog conversions.

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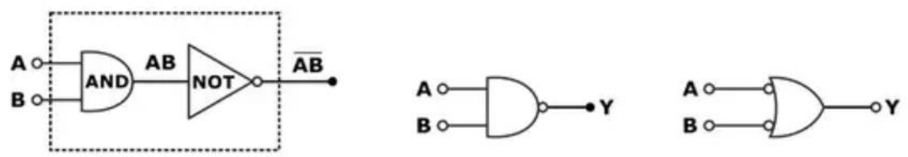
Ques 3. What are universal gates?

Ans. Universal gates are those gates that can perform the tasks of other gates with minor adjustments. Universal gates are logic gates that can be used to implement any other type of logic gate (AND, OR, NOT).
The two most common universal gates are NAND (NOT-AND) and NOR (NOT-OR).

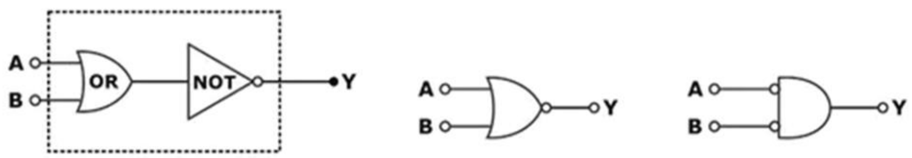
1. NAND: The NAND gate is a AND gate followed by a NOT gate. Thus, we can say it is a AND NOT operation. It may have two or more inputs but only one output. The logical symbols of a NAND Gate and the truth table are shown below.



A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Thus, the logical expression for the output is $Y = \overline{A \cdot B} = \bar{A} + \bar{B}$

The switching circuit of a NAND gate is as shown:



A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

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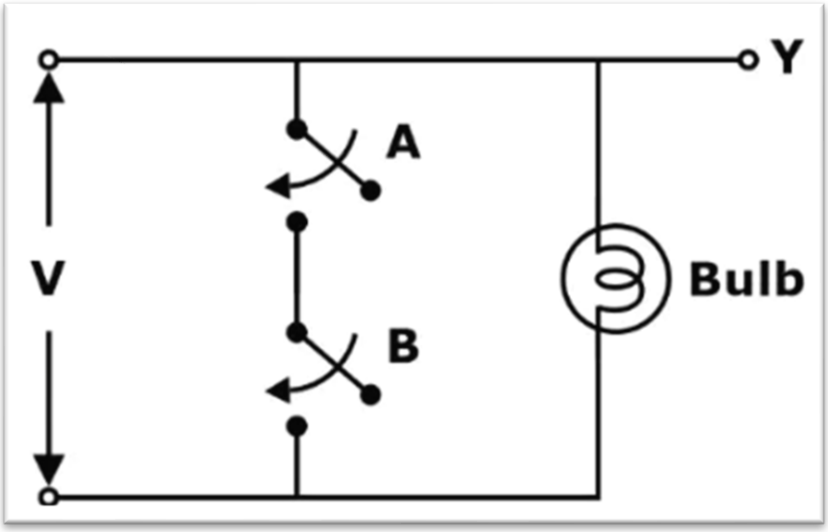
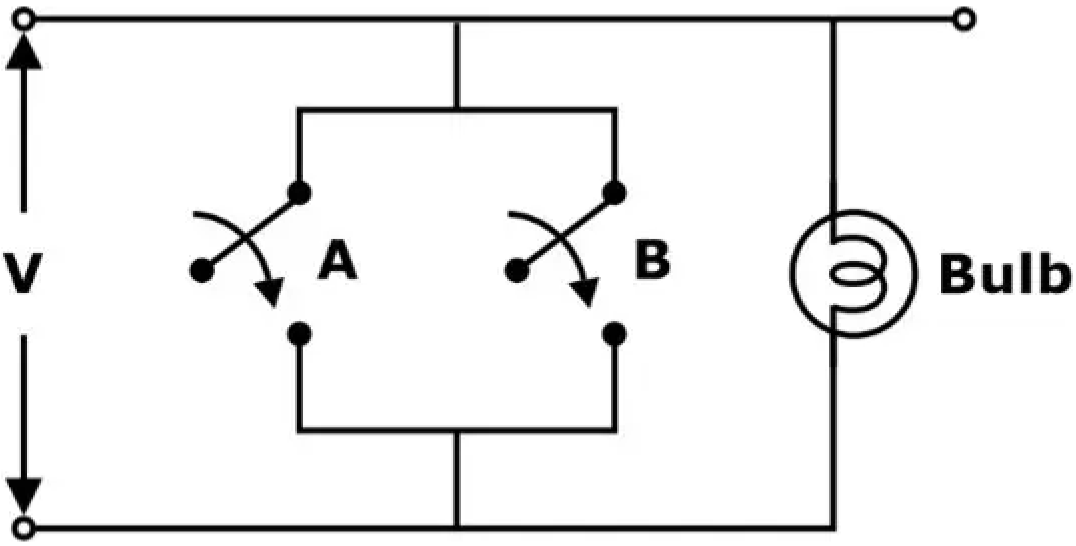


NOR: The NOR gate is one of the universal gates. A NOR gate combines two basic logic gates: an OR gate and a NOT gate. So, we can say it is an OR-NOT operation. It may have two or more inputs and an output. The logical symbols of the NOR Gate are shown:

$$Y = \overline{A + B} = \overline{A}\,\overline{B}$$

The switching circuit of a NOR gate is as shown:



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Ques 4. Explain the adder circuit in detail.

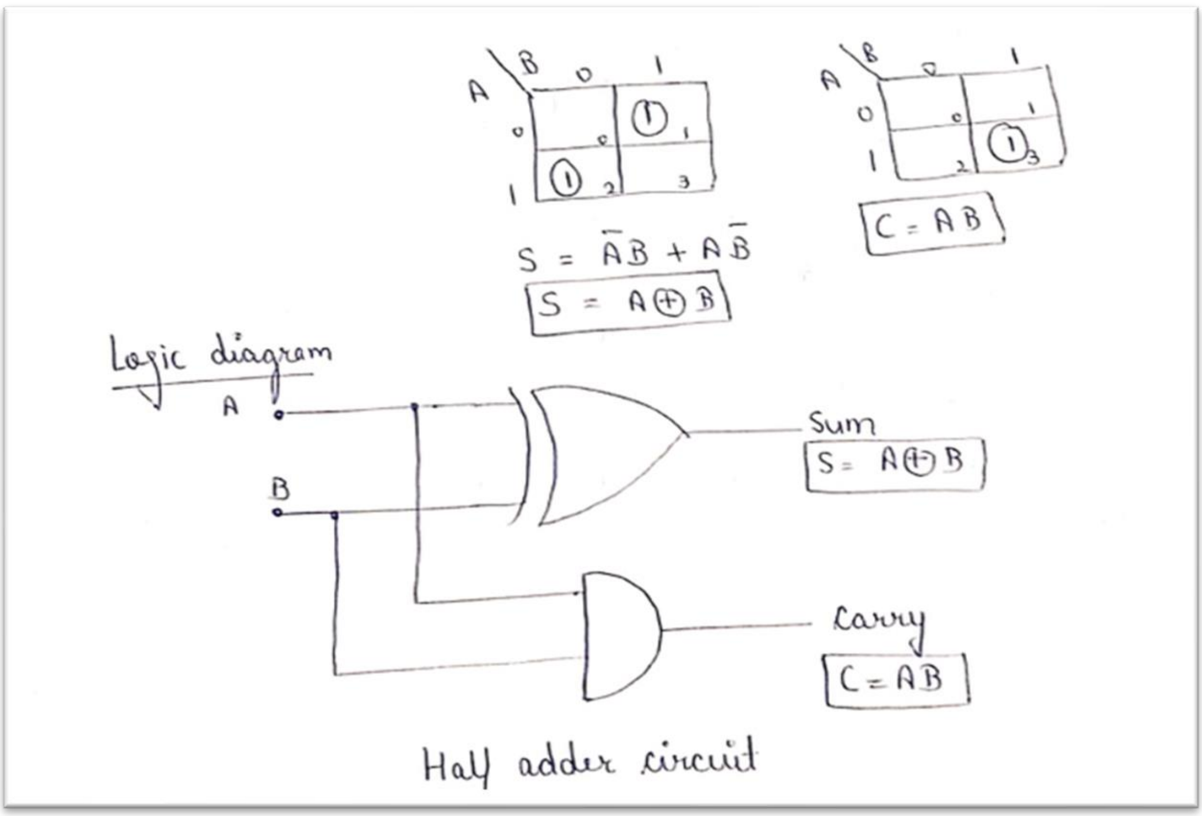
Ans. Half-Adder:

A half-adder adds two bits (A and B) and produces a sum (S)and a carry-out (Cout). The truth table is:

A	B	Sum(S)	Carry-out (Cout)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

The logic equations are:

Sum (S) = A XOR B
Carry-out (Cout) = A AND B



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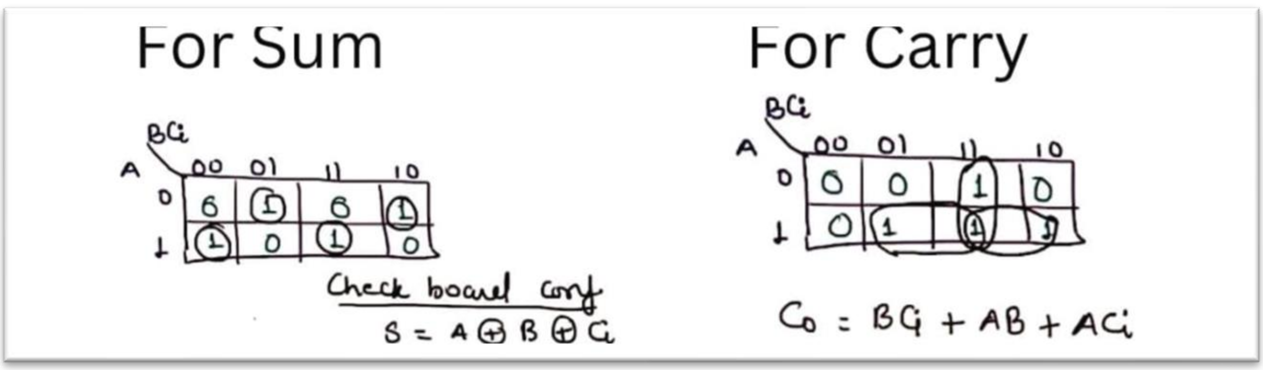
Full-Adder:

A full-adder has three inputs (A, B, Cin) and two outputs(Sum and Carry-out). The truth table is:

A	B	Cin	Sum (S)	Carry-out (Cout)
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

The logic equations are:

Sum (S) = A XOR B XOR Cin
Carry-out (Cout) = (A AND B) OR (B AND Cin) OR (AAND Cin)



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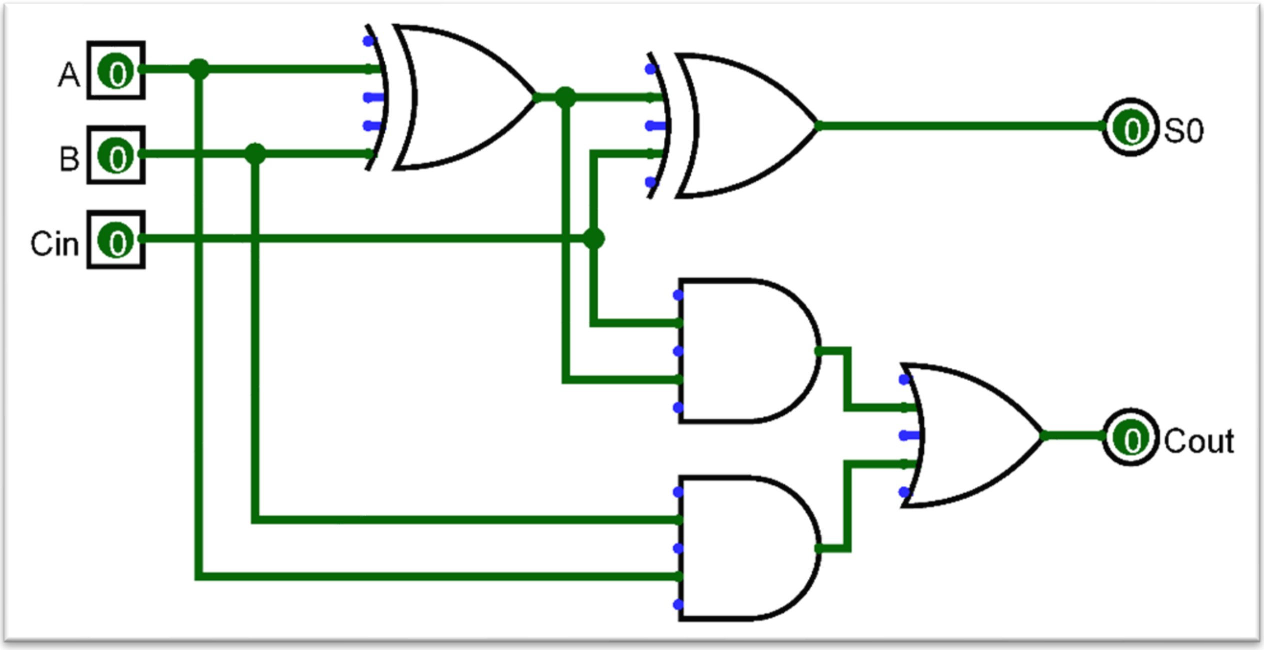

Ques 5. Explain the subtractor circuit in detail.

Ans. A subtractor circuit is used to perform binary subtraction. A binary subtractor can be created by combiningan adder circuit with additional logic gates.

One common method is to use a two's complement representation for negative numbers. This involves invertingall the bits of the number and adding 1 to the result. The subtraction operation is then performed as an addition operation with the two's complement of the subtrahend.

Subtractor circuits can be built using full-adders and additional logic to handle the borrow (Borrow-out) from eachstage.

It's important to note that subtractors can be implemented invarious ways, including using dedicated subtractor ICs or bymodifying adder circuits. The specific implementation may depend on the requirements of the application and the available components.

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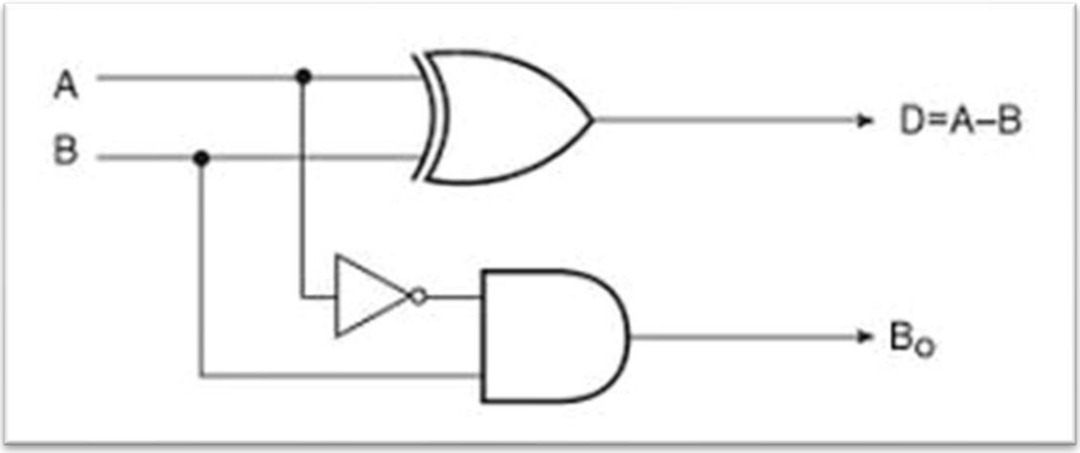
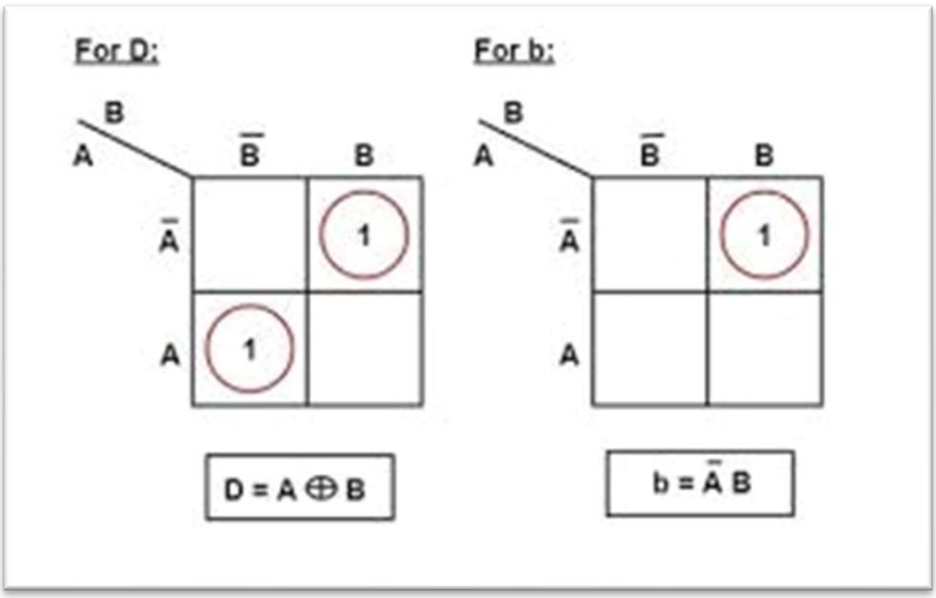


Input		Output	
A	B	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0



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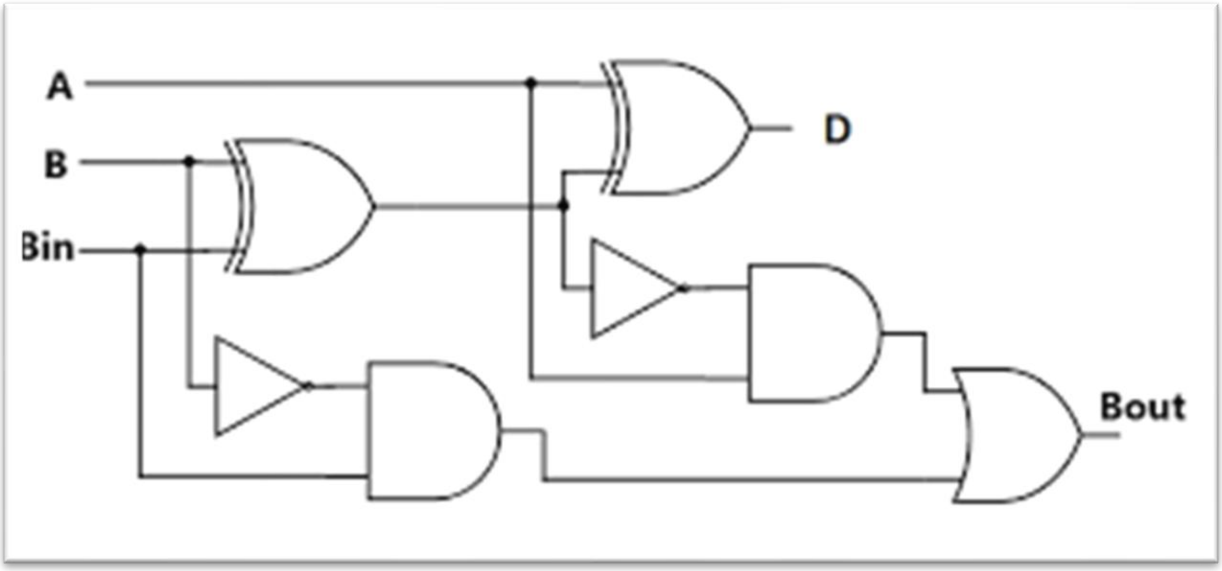
For Full subtractor:



For D:

$A \backslash BB_{in}$	$\bar{B}\bar{B}_{in}$	$\bar{B}B_{in}$	BB_{in}	$B\bar{B}_{in}$
$\bar{A}$		1		1
A	1		1	

$$\boxed{D = A \oplus B \oplus B_{in}}$$

For B_{in}:

$A \backslash BB_{in}$	$\bar{B}\bar{B}_{in}$	$\bar{B}B_{in}$	BB_{in}	$B\bar{B}_{in}$
$\bar{A}$		1	1	1
A			1	

$$B_{out} = \bar{A}B + (\bar{A} + B)B_{in}$$