INSTRUCTIONS:

Fill out the hazard analysis and risk assessment below.

HA-001 should be for the lane departure warning function as discussed in the

HA-002 should be for the lane keeping assistance function as discussed in th

Then come up with your own situations and hazards for the lane

When finished, export your spreadsheet as a pdf file so that a re

Hazard ID	Operational Mode	Operational Scenario	Environmental Details
HA-001	OM03 – Normal driving	OS04 – Highway	EN06 – Rain (slippery roa
HA-002	OM03 – Normal driving	OS03 – Country Road	EN01 – Normal conditions
HA-003	OM03 – Normal driving	OS03 – Country Road	EN01 – Normal conditions
HA-004	OM03 – Normal driving	OS04 – Highway	EN01 – Normal conditions

e lecture.
ıe lecture.
assistance system. Fill in the HA-003 and HA-004 rows.
viewer can easily see your work.

Situational Analysis		
Situation Details	**Other Details (optional)**	**Item Usage (function)**
SD02 – High speed		IU01 – Correctly used
SD02 – High speed		IU02 – Incorrectly used
SD02 – High speed		IU01 – Correctly used
SD02 – High speed		IU01 – Correctly used

Situation Description	Function	Deviation
Normal driving on highway roads during raining with high speed and correctly used system	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV04 – Actor effect is too much
Normal driving on country roads during normal conditions with high speed and incorrectly used system	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV03 – Function always activated
Normal driving on country roads during normal conditions with high speed and correctly used system	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	
Normal driving on highway roads during normal conditions with high speed and correctly used system	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV12 – Sensor sensitivity is too high

Hazard Identification		
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**
The LDW function applies an oscillating torque with very high torque (above limit).	EV00 – Collision with other vehicle	High haptic feedback can affect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another vehicle or with road infrastructure.
The driver was misusing the function by taking both hands off the wheel and incorrectly treating the car as a fully autonomous vehicle.	EV00 – Collision with other vehicle	The driver treat the function as if it were meant for fully autonomous driving.
The camera doesn’t work properly, but the function can still be activated.	EV00 – Collision with other vehicle	The camera provides the wrong lane information.
The camera sensors that the vehicle is leaving, even when the vehicle is only a little away from the center of the lane, which is acceptable.	EV00 – Collision with other vehicle	The camera is too sensitive and can make the vehicle not stable.

Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)
The lane departure warning function applies too high an oscillating torque to the steering wheel.	E3 – Medium probability	Driving on a highway could happen in 1 % to 10 % of average operating time.
The driver uses the function improperly.	E2 – Low probability	The driver is on a country road and misusing the system. That combination probably does not happen so often, so the exposure is E2.
Because the final torque is wrong, which will make the vehicle collide with other vehicles.	E3 – Medium probability	Driving on a highway could happen in 1 % to 10 % of average operating time.
The function can be activated so frequently even when the vehicle is very near the center.	E3 – Medium probability	Driving on a highway could happen in 1 % to 10 % of average operating time.

Hazardous Event Classification		
Severity (of potential harm)	**Rationale (for severity)**	**Controllability (of hazardous event)**
S3 – Life-threatening or fatal injuries	Collision with high speed could cause life-threatening injuries	C3 – Difficult to control or uncontrollable
S3 – Life-threatening or fatal injuries	Collision with high speed could cause life-threatening injuries	C3 – Difficult to control or uncontrollable
S3 – Life-threatening or fatal injuries	Collision with high speed could cause life-threatening injuries	C3 – Difficult to control or uncontrollable
S3 – Life-threatening or fatal injuries	Collision with high speed could cause life-threatening injuries	C3 – Difficult to control or uncontrollable

	Determ
Rationale (for controllability)	**ASIL Determination**
It is difficult for the driver to stay calm and react properly.	C
The hands are not on the wheel at high speeds, a vehicle accident would not be controllable.	B
The driver can turn off the system to control the car, but it is hard for the driver to react very fast, like in 50 ms.	C
It is difficult for the driver to stay calm and react properly.	C

nination of ASIL and Safety Goals

Safety Goal
The oscillating steering torque from the lane departure warning function shall be limited.
The lane keeping assistance function shall be time limited and the additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving.
The lane warning departure function shall be deactivated, if the camera subsystem doesn’t work properly.
The threshold of deviation to activate the function must be limited, so that the vehicle will not move left and right very frequently.

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS - Headlamp

Hazard ID	
	Operational Mode
HA-001	Normal Driving

MORE EXAMPLES - Headlamp System

Hazard ID	
	Operational Mode
HA-001	OM03 - Normal Driving
HA-002	OM03 - Normal Driving
HA-003	OM03 - Normal Driving
HA-004	OM03 - Normal Driving
HA-005	OM03 - Normal Driving

System

Sit	
Operational Scenario	**Environmental Details**
City Road	Normal Conditions

Si	
Operational Scenario	**Environmental Details**
OS01 - City Road	EN01 - Normal conditions
OS01 - City Road	EN04 - Snowfall (degraded view)
OS03 - Highway	EN04 - Snowfall (degraded view)
OS02 - Country Road	EN01 - Normal conditions
OS02 - Country Road	EN04 - Snowfall (degraded view)

uational Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
Low Speed	Night time + Obstacle on the road	Correctly Used

tuation Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
SD03 - Low speed	Night time + Obstacle on the road	IU01 - Correctly used
SD03 - Low speed	road and no other illumination	IU01 - Correctly used
SD03 - High speed	Night time + Obstacle on the road or upcoming curve	IU01 - Correctly used
SD02 - High speed	Night time + Oncoming vehicle	IU01 - Correctly used
SD04 - High speed	road and no other illumination	IU01 - Correctly used

Situation Description	Function
Normal Driving on a City Road in Normal Conditions at Low Speed at Night with an Obstacle on the Road	Low beam illuminates the roadway in the dark

Situation Description	Function
Normal Driving on City Road during Normal conditions with Low speed (Night time + Obstacle on the road)	Low beam illuminates the roadway in the dark
view) with Low speed (Night time + Obstacle on the	Low beam illuminates the roadway in the dark
view) with High speed (Night time + Obstacle on the	Low beam illuminates the roadway in the dark
conditions with High speed (Night time + Oncoming	Low beam illuminates the roadway in the dark
(degraded view) with High speed (Night time + Obstacle	Low beam illuminates the roadway in the dark

Hazard Ide	
Deviation	**Deviation Details**
Function not activated	Both headlights stop working

Hazard Ide	
Deviation	**Deviation Details**
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working

entification

Hazardous Event (resulting effect)	Event Details
Front collision with obstacle	obstacle with injury to

entification

Hazardous Event (resulting effect)	Event Details
EV04 - Front collision with obstacle	Vehicle crashes into the obstacle with injury to driver
EV04 - Front collision with obstacle	obstacle with injury to
EV04 - Front collision with obstacle	infrastructure with injury to
EV08 - Collision with other vehicle	oncoming vechile or road
EV04 - Front collision with obstacle	infrastructure with injury to

Hazardous Event Description	Exposure (of situation)
Total loss of low beam	E4 - High probability

Hazardous Event Description	Exposure (of situation)
Total loss of low beam	E4 - High probability
Total loss of low beam	E1 - Very low probability
Total loss of low beam	E2 - Low probability
Total loss of low beam	E4 - High probability
Total loss of low beam	E2 - Low probability

Hazardous

Rationale (for exposure)	Severity (of potential harm)
night driving in the city is a regular activity	S1 - Light and moderate injuries

Hazardous

Rationale (for exposure)	Severity (of potential harm)
night driving in the city is a regular activity	S1 - Light and moderate injuries
unilluminated roads while it is snowing	S1 - Light and moderate injuries
however, heavy snow occurs a few	S3 - Life-threatening or fatal injuries
country driving is part of regular driving	S3 - Life-threatening or fatal injuries
driving, however, heavy snow occurs a	S3 - Life-threatening or fatal injuries

Event Classification
Rationale (for severity)
In city traffiic, speed of vehicle is expected to be low

Event Classification
Rationale (for severity)
In city traffiic, speed of vehicle is expected to be low
In city traffiic, speed of vehicle is expected to be low
On highway speed of vehicle is expected to be high
On country roads speed of vehicle is expected to be high
On country roads speed of vehicle is expected to be high

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	the situation by applying brakes and there is

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	At city speed, most drivers will be able to control the situation by applying brakes and there is additional illmunitation on city roads
C1 - Simply controllable	usually drive at lower end of city speeds and
C2 - Normally controllable	there is some form of illumination on road and
C1 - Simply controllable	illumination to be expected on country road, it will
C3 - Difficult to control or uncontrollable	illumination to be expected on country road, it will

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total Loss of Beam Shall Be Prevented

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total loss of low beam shall be prevented
QM	Total loss of low beam shall be prevented
A	Total loss of low beam shall be prevented
B	Total loss of low beam shall be prevented
B	Total loss of low beam shall be prevented

Hazard & Risk Analysis Definition

Operational Mode

ID	Mode
OM01	Parked
OM02	Ignition on
OM03	Normal driving
OM04	Backward driving
OM05	Degraded driving
OM06	Towing (active)
OM07	Towing (passive)
OM08	Service
OM09	N/A

Operational Scenario

ID	Scenario
OS01	Any Road
OS02	City Road
OS03	Country Road
OS04	Highway
OS05	Mountain Pass
OS06	Off Road
OS07	Road with gradient
OS08	Road with bump
OS09	Road tunnel
OS10	Road with construction site
OS11	N/A

Situation Details

ID	Scenario
SD01	Low speed
SD02	High speed
SD03	Normal acceleration
SD04	High acceleration
SD05	Normal braking
SD06	High braking
SD07	N/A

Item Usage

ID	Mode
IU01	Correctly used
IU02	Incorrectly used
IU03	N/A

Environmental Details

ID	Scenario
EN01	Normal conditions
EN02	Sun blares (degraded view)
EN03	Fog (degraded view)
EN04	Snowfall (degraded view)

EN05	Cross-wind (lateral force)
EN06	Rain (slippery road)
EN07	Snow (slippery road)
EN08	Glace (slippery road)
EN09	N/A

S

Remarks
Car is parked, ignition is off
Car is parked, ignition is on
Car is driving
Car is driving
Limp home mode
Towing another car
Beeing towed by another car
Vehicle is in repair garage
not applicable or not relevant

Remarks
road type
road type
road type
road type
road type
road type
road attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Remarks
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
not applicable or not relevant

Remarks
Intended usage
Unintended usage (foreseeable)
not applicable or not relevant

Remarks
weather attribute
weather attribute
weather attribute
weather attribute

weather attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Reference
OM01 - Parked
OM02 - Ignition on
OM03 - Normal driving
OM04 - Backward driving
OM05 - Degraded driving
OM06 - Towing (active)
OM07 - Towing (passive)
OM08 - Service
OM09 - N/A

Reference
OS01 - Any Road
OS02 - City Road
OS03 - Country Road
OS04 - Highway
OS05 - Mountain Pass
OS06 - Off Road
OS07 - Road with gradient
OS08 - Road with bump
OS09 - Road tunnel
OS10 - Road with construction site
OS11 - N/A

Reference
SD01 - Low speed
SD02 - High speed
SD03 - Normal acceleration
SD04 - High acceleration
SD05 - Normal braking
SD06 - High braking
SD07 - N/A

Reference
IU01 - Correctly used
IU02 - Incorrectly used
IU03 - N/A

Reference
EN01 - Normal conditions
EN02 - Sun blares (degraded view)
EN03 - Fog (degraded view)
EN04 - Snowfall (degraded view)

EN05 - Cross-wind (lateral force)
EN06 - Rain (slippery road)
EN07 - Snow (slippery road)
EN08 - Glace (slippery road)
EN09 - N/A

Deviation

ID	Deviation (Guideword)
DV01	Function not activated
DV02	Function unexpectedly activated
DV03	Function always activated
DV04	Actor effect is too much
DV05	Actor effect is too less
DV06	Actor action too early
DV07	Actor action too late
DV08	Actor action before
DV09	Actor action after
DV10	Actor effect is reverse
DV11	Actor effect is wrong
DV12	Sensor sensitivity is too high
DV13	Sensor sensitivity is too low
DV14	Sensor detection too early
DV15	Sensor detection too late
DV16	Sensor detection before
DV17	Sensor detection after
DV18	Sensor detection is reverse
DV19	Sensor detection is wrong
DV20	N/A

Hazardous Events (possibe effects)

ID	Hazardous Event
EV-07	None
EV-06	Front collision with oncoming traffic
EV-05	Front collision with ahead traffic
EV-04	Front collision with obstacle
EV-03	Rear collision with trailing traffic
EV-02	Side collision with other traffic
EV-01	Side collision with obstacle
EV00	Collision with other vehicle
EV01	Collision with train
EV02	Collision with pedestrian
EV03	Car spins out of control
EV04	Car comes off the road
EV05	Car catches file
EV06	N/A

Remarks	Reference
Activation error	DV01 - Function not activated
Activation error	DV02 - Function unexpectedly activated
Activation error	DV03 - Function always activated
Quantitative error	DV04 - Actor effect is too much
Quantitative error	DV05 - Actor effect is too less
Timing error	DV06 - Actor action too early
Timing error	DV07 - Actor action too late
Sequence error	DV08 - Actor action before
Sequence error	DV09 - Actor action after
Logical error	DV10 - Actor effect is reverse
Logical error	DV11 - Actor effect is wrong
Quantitative error	DV12 - Sensor sensitivity is too high
Quantitative error	DV13 - Sensor sensitivity is too low
Timing error	DV14 - Sensor detection too early
Timing error	DV15 - Sensor detection too late
Sequence error	DV16 - Sensor detection before
Sequence error	DV17 - Sensor detection after
Logical error	DV18 - Sensor detection is reverse
Logical error	DV19 - Sensor detection is wrong
not applicable or not relevant	DV20 - N/A

Remarks	Reference
	EV-07 - None
	EV-06 - Front collision with oncoming traffic
	EV-05 - Front collision with ahead traffic
	EV-04 - Front collision with obstacle
	EV-03 - Rear collision with trailing traffic
	EV-02 - Side collision with other traffic
	EV-01 - Side collision with obstacle
	EV00 - Collision with other vehicle
	EV01 - Collision with train
	EV02 - Collision with pedestrian
	EV03 - Car spins out of control
	EV04 - Car comes off the road
	EV05 - Car catches file
	EV06 - N/A

Exposure

ID	Description
E0	Incredible
E1	Very low probability
E2	Low probability
E3	Medium probability
E4	High probability

Severity

ID	Description
S0	No injuries
S1	Light and moderate injuries
S2	Severe and life-threatening injuries
S3	Life-threatening or fatal injuries

Controllability

ID	Description
C0	Controllable in general
C1	Simply controllable
C2	Normally controllable
C3	Difficult to control or uncontrollable

Duration (of situation)
Not specified
<1 % of average operating time
1 % to 10 % of average operating time
>10 % of average operating time

Remarks
No injuries
Light and moderate injuries
Severe and life-threatening injuries (survival probable)
Life-threatening injuries (survival uncertain), fatal injuries

Remarks
Controllable in general
99 % or more of all drivers or other traffic participants are usually able to avo
90 % or more of all drivers or other traffic participants are usually able to avo
Less than 90 % of all drivers or other traffic participants are usually able, or

Frequency (of situation)
Occurs less often than once a year for the great majority of drivers
Occurs a few times a year for the great majority of drivers
Occurs once a month or more often for an average driver
Occurs during almost every drive on average

Probability of Injuries
AIS 0 and less than 10 % probability of AIS 1-6
More than 10 % probability of AIS 1-6 (and not S2 or S3)
More than 10 % probability of AIS 3-6 (and not S3)
More than 10 % probability of AIS 5-6

oid harm
oid harm
barely able, to avoid harm

Reference
E0 - Incredible
E1 - Very low probability
E2 - Low probability
E3 - Medium probability
E4 - High probability

Reference
S0 - No injuries
S1 - Light and moderate injuries
S2 - Severe and life-threatening injuries
S3 - Life-threatening or fatal injuries

Reference
C0 - Controllable in general
C1 - Simply controllable
C2 - Normally controllable
C3 - Difficult to control or uncontrollable

ontrollabili	Exposure	Severity			
		S0	S1	S2	S3
C1	E1	QM	QM	QM	QM
	E2	QM	QM	QM	QM
	E3	QM	QM	QM	A
	E4	QM	QM	A	B
C2	E1	QM	QM	QM	QM
	E2	QM	QM	QM	A
	E3	QM	QM	A	B
	E4	QM	A	B	C
C3	E1	QM	QM	QM	A
	E2	QM	QM	A	B
	E3	QM	A	B	C
	E4	QM	B	C	D